Pain in pediatric dentistry

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Sometimes life is so sweet I get toothache…

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Chapter 1

General introduction

Introduction

Acute pain is a highly complex, dynamic and subjective experience. It is useful to children to warn them against possible danger and to limit the chance of additional injury. Although, while growing up, children usually learn effective methods to prevent and to cope with everyday pain, untreated pain may have significant and lifelong physiological and psychological consequences (Anand et al., 1997).

The International Association for the Study of Pain (IASP, 1979) has defined pain as: 'An unpleasant sensory and emotional experience associated with actual or potential tissue damage or described in terms of such damage' (p. 249).

The experience of pain is private and subjective, and consequently not directly accessible by others. This could be a difficulty when assessing pain of young children who have limited verbal abilities to describe or report their pain. The assessment of pain, which constitutes the foundation for all pain treatment, thus poses a clinical and research challenge, especially in young children.

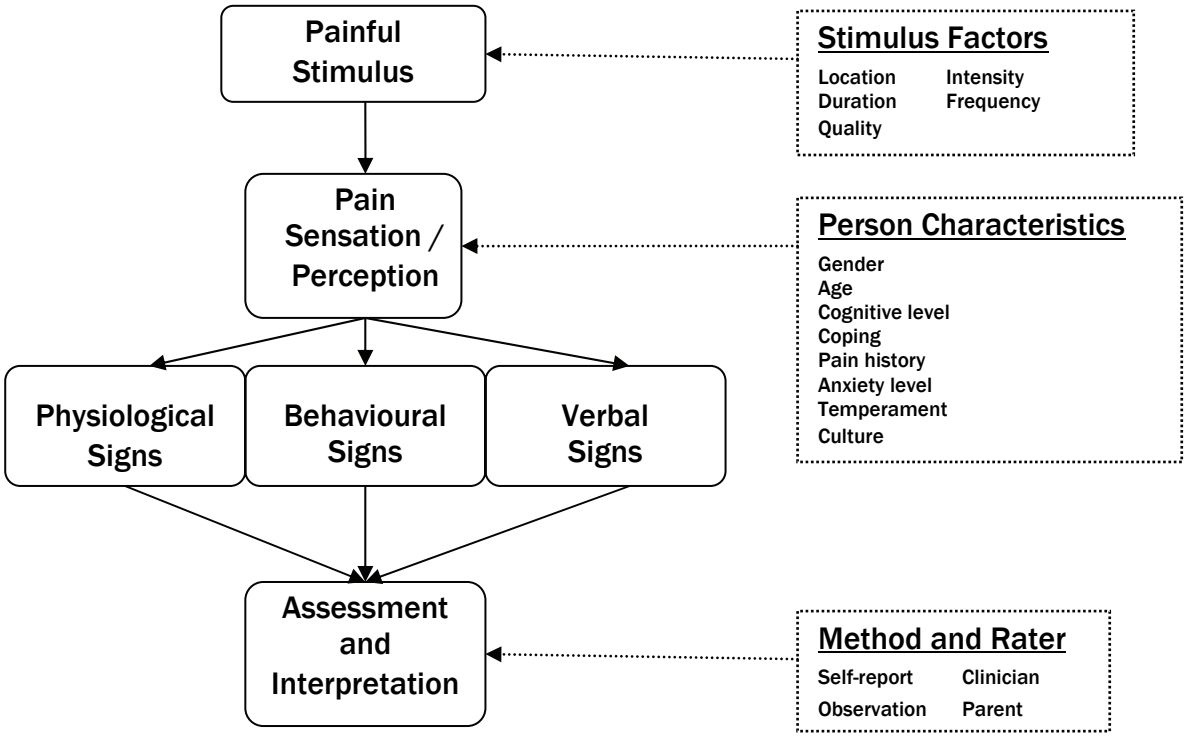
Due to the subjective nature of pain the gold standard in pain assessment is self-report. As this is not always an option with young children, nonverbal behavioural information is often needed as an addition to, or a substitute for self-report.

In the following part of this introduction a number of topics important to assess "dental" pain in young children will be presented, based on the structure of a pain assessment model. Successively the following topics will be discussed: the pain assessment model, painful stimuli in pediatric dentistry, pain sensation, person characteristics, and pain assessment methods. The introduction will be ending with a presentation of the aims and structure of this thesis.

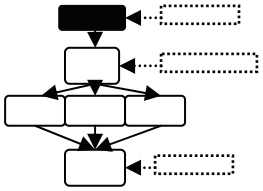
Pain assessment model

Pain often starts with a painful (nociceptive) stimulus followed by a pain sensation. Each nociceptive stimulus creates a unique pain sensation depending on the characteristics of the stimulus (e.g., location, frequency or intensity). Next the pain sensation is expressed in verbal, behavioural and physiological signs which are influenced by the person's characteristics such as age, gender and temperament. These external signals, reactions, can be observed, interpreted and finally assessed. This process is described in a simplified "pain assessment model" (The model is inspired by other models existing in the pain literature e.g., Hadjistavropoulos & Craig, 2002).

Figure 1. Pain assessment model.



Painful stimuli in pediatric dentistry



One of the most common painful stimuli in pediatric dentistry is caused by dental caries and its consequences. The subsequent dental treatment is an other potentially painful experience.

Caries

Unfortunately even children as young as 5-years of age can suffer from caries. In the last three decades of the 20th century, there has been a dramatic decline in caries occurrence in all Western European countries, reaching very low levels. However, a long-term survey in the Netherlands (Poorterman & Schuller, 2006) showed that only 44% of the 5-year-old children still had a caries free dentition in 2005. This percentage was significantly lower than in 1999 when still 51% had a caries free dentition (Kalsbeek et al., 1996). This is something to follow closely, specifically because dental caries occurrence at a young age is said to be predictive of caries development later in the permanent dentition (Vanobbergen et al., 2001).

Oral pain in young children caused by decayed teeth can manifest itself in different ways: children may eat less, sleep less, and/or exhibit negative behaviours. One treatment session under general anaesthesia allowing complete elimination of the caries and return of the oral cavity to good health showed subsequent improvement in the quality of life in children (e.g., eating, sleeping, pain) as reported by their parents (Thomas et al., 2002). Yet some children do not appear to complain verbally at all, even with rampant caries. In pediatric dentistry this makes the recognition of toothache in pre-verbal children, toddlers and pre-schoolers very difficult. Unfortunately, parents often only seek treatment when their child already has severe complaints. As a result, toothache may go unrecognized and the child's suffering is extended unnecessarily.

Local anaesthesia injection

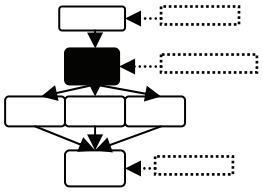
Another potential pain source in pediatric dentistry is the dental treatment itself. The treatment hurts, but its solution, the local anaesthesia injection, is probably one of the most commonly cited pain stimuli in dental treatment.

This idea persists despite many dentists' developing the technique of delivering almost painless injections, although a totally painless injection is impossible to achieve in all circumstances due to injection speed, tissue resistance, injection site

etc. As a consequence, there is a constant search for ways to avoid the invasive and often painful nature of the injection, and to find more comfortable and pleasant means of producing local anaesthesia before starting the dental procedure. One possibility is a computer-automated injection system, a device (the Wand®), that provides a precise injection flow-rate, regardless of tissue resistance. The system maintains a constant positive pressure on the flow of the anaesthetic solution. It is claimed that when advanced slowly, the drops of solution anesthetize the tissue ahead of the needle, thereby yielding a virtually painless needle insertion (Figure 1, Milestone scientific).

Figure 1. The Wand

Pain sensation/perception in children



The painful stimuli described above are according to the pain model of influence on the pain sensation or perception. Pain is both a concrete experience and an abstract concept. Children's understanding of pain and their ability to describe it do change with increasing age in a developmental pattern (Gaffney et al., 2003). Based on a study on children's concepts of specific pains, Harbeck and Peterson (1992) showed that age was a good predictor for the

developmental sequence of children's ability to conceptualize pain. They explain that age, in comparison with developmental stage, not only includes cognitive factors but also the experiences with pain. The understanding of pain causality appears to progress from the child being unable to verbalize a reason why pain hurts, to verbalizing a general, usually external cause of the pain, to finally including physiological or psychological causes.

Infants

Contrary to long-held belief, infants do have the neurological capacity to perceive pain at birth, even premature birth. As pain is the primary sensation that guards against damage to the organism from its external or internal environment, the experience of pain does not need to be based on any prior experience with pain. The first experience of tissue injury is 'painful', in much the same way that touch, smell, vision, or hearing do not need to be learned in order to occur in the human organism. However, the interpretation and meaning of these sensations is thought to develop with experience (Anand & Craig, 1996).

Learning about pain starts from the first pain experience and has profound effects on subsequent pain perception and responses. Untreated or inadequately managed pain in neonates may result in immediate consequences, such as increased heart rate, raised blood pressure, a fall in arterial oxygen saturation and reduced skin blood flow (Whitefield & Grunau, 2000). In the long run there can be changes in pain sensitivity. This was shown in a study on the consequences of un-anesthetized circumcision. Taddio and colleagues found differences in responses to painful vaccination of infants who had undergone unanesthetized circumcision compared with infants who were uncircumcised or who received analgesia during circumcision (Taddio et al., 1995). It could therefore be argued that early pain experience can influence the stimulus response ratio.

Toddlers and preschoolers (1-5 years old)

Pain occurs frequently in young children and teaches them to avoid danger. Stated differently, it is a significant part of growing up. The most common sources of pain are everyday incidents. In a study on pain incidents during free play time in day–care it was found that preschool children have one painful incident about every 3 hours due to: falling, bumping into things or interactions with others (Fearon et al., 1996). Thereby making personal experience (e.g., stumble and fall) the most common pathway in learning to cope with pain.

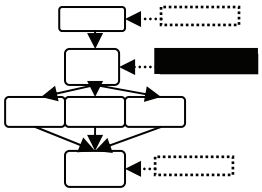
Children from 3 to 5 years old believe that the way they see things, or the way

they desire events to be, corresponds to the way things are. Children in this stage are assumed to describe pain in global, phenomenological terms and to start using descriptive adjectives and add associated emotions (e.g., 'sad', 'mad') (Craig & Grunau, 1991). Furthermore they tend to describe or attribute the cause of pain to external events that can be seen (McGrath & Pisterman, 1991).

School-age children (6-12 years old)

Having reached the school-age, children attribute pain to external concrete causes such as falls and needles. As a sign of their maturity, they begin to associate pain with non-visible physical and psychosocial variables. Children in this age group become able to take another's perspective, view multiple dimensions simultaneously or think in reverse and engage in logical reasoning (Gedaly-Duff, 1991). The development of the concept pain finishes when children understand why pain hurts and can explain its purpose (Harbeck & Peterson, 1992).

Person characteristics



Tissue damage (pain stimulus) initiates a sequence of neural events that may lead to pain perception, but many factors can intervene to alter the sequence of nociceptive transmission and thereby modify children's pain perception. Some characteristics are relatively stable for children, such as age, gender, temperament, previous pain experience, and cultural background. In contrast, cognitive factors, what children understand of pain, behaviour factors, what children do, and emotional factors, what children feel, are not stable. All these factors can influence the causal relationship between injury and pain (McGrath & Hillier, 2003). In the next part the influence of the characteristics dental anxiety and coping abilities will be discussed in more detail.

Dental Anxiety

Besides pain, an injection can also provoke anxiety, particularly in children. Research shows that about 14% of the 4-11 year old Dutch children are dentally anxious (ten Berge et al., 2002) and the strongest fears are associated with injections (Locker et al., 1999). Also, the situation in which pain is experienced, for instance the dental office, may cause anxiety due to negative associations related to the situation. While patients' fears may be acquired through vicarious experiences and threatening information, direct experience is the most common source of dental fear (Rachman, 1977). Four aspects of fear for the dental injection were identified

in a study by Milgrom and colleagues (1997): 1-general fear of injections, including pain of injection; 2-fears related to local anaesthetic (fear of the numb sensation); 3-fear of acquired disease; 4- fear of physical injury (fear the needle will break).

Anxiety is often accompanied by heightened metabolic state (arousal). From a clinical perspective it is often assumed that anxiety increases pain impact. A study showed that high anxiety subjects tended to over predict their experienced pain and anxiety during treatment. As a result they expect more pain and feel more anxious during subsequent treatment (Arntz et al., 1990; van Wijk, 2006). This was also shown by a study on lumbar punctures, children who displayed greater distress at the first treatment remembered fewer details of it one week later (Weisman et al., 1998). It was found that greater exaggeration in children's memories of anxiety and pain over the treatments was associated with higher distress during the subsequent treatment. However, empirical evidence is inconclusive. A study showed that when anxiety takes attention away from the pain this may lead to reduction in pain and when anxiety draws attention toward the pain, the pain impact may be increased (Arntz et al., 1994).

Coping abilities

Coping is defined as a process that involves cognitive and behavioural efforts to manage external or internal stimuli that are judged painful (nociceptive) and that exceed the established resources of the child. (Gedaly-Duff, 1991). Similar to children's understanding of pain their capacity to react appropriately to painful external or internal stimuli (e.g., invasive medical procedures) changes with increasing age in a developmental pattern.

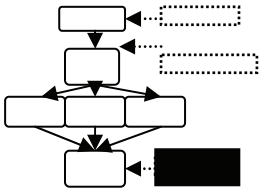
Coping is first observed as a reflexive action in infancy. Children as young as 18 months of age demonstrate the use of coping strategies, by seeking hugs and kisses and asking for medicine after a painful incident. In toddlers and preschoolers coping changes into primitive behavioural actions such as purposeful running away or fighting. The children in this age group spontaneously use distraction and will say that playing makes them feel better. Although they may use these techniques spontaneously, it is suggested that children cannot deliberately distract themselves or use other self-initiated cognitive strategies to reduce pain before the age of about 5-years (McGrath & McAlpine, 1993).

In a study of 6-, 9- and 12-year old children it was found that as the child's age increased, the self-reports of primary coping (trying to change the stressful circumstances) decreased and the self-reports of secondary coping (trying to adjust to circumstances) increased and thereby the use of more of cognitive mechanisms.

When coping with medical stressors children most often described secondary control approaches, approaches aimed at controlling the psychological impact of stressful events without changing the events as such, for example, thinking happy thoughts to distract oneself from the pain of getting an injection (Weisz et al., 1994). In addition to age and cognitive development, the use of specific coping strategies is also influenced by characteristics such as emotional responses, age-specific behavioural competence, communication skills and physical maturity (McGrath & Craig, 1989).

Besides the spontaneous use of coping strategies, investigations have provided evidence that children can be taught specific cognitive and behavioural strategies to reduce their experience of pain during medical procedures. Children undergoing lumbar punctures, for instance, were more likely to show coping behaviour when the medical staff or their parents made statements promoting coping (Blount et al., 1991).

Pain assessment Methods



The last stage of the pain assessment model is the assessment and interpretation. The simplest method of assessing children's pain is to ask them about it. However, relationships between feeling pain and reporting pain are context dependent and depend upon the methods used to assess, who is eliciting the self-report, the underlying reasons for eliciting the self-report and the person's perception of the consequences of reporting pain (Anand & Craig, 1996). Besides self-report, there are two other techniques to measure pain: physiological measures and behavioural measures. Each type is more or less reliable to measure pain in children and more or less suitable for different age groups (for a review see e.g., Blount et al., 2006).

Physiological measures

There are a number of physiological measures for pediatric procedural pain: for example, heart rate, sweating, and blood pressure. Despite the lack of response bias and the apparent objectivity, no single physiological index has been shown to be ideal. In fact, many physical measures vary not only according to pain but also to emotional states, temperature in the environment and body movement. Furthermore, there is a great interpersonal variability on how they respond to pain physiologically. Taken together, physiological measures simply cannot discriminate well between the responses to pain and other forms of stress to the body.

Behavioural measures

One can assess pain by observing specific types of distress behaviours (e.g., vocalization, facial expression, and body movement) which have been associated with pain and are helpful in evaluating pain in children with limited communication skills. However, again, it may be difficult to discriminate between pain behaviours and behaviour resulting from other sources of distress such as anxiety (Gaffney et al., 2003).

An other alternative to assess pain is by observing facial expressions. Facial actions as brow bulge, eye squeeze, and open lips are found to be specific indicators of acute and postoperative pain (Peters et al., 2003). Furthermore, infants' facial expressions are relatively free of learning biases. However, in dentistry not all of these indicative behaviours are easily visible for observers as the action or tools of the dentist often block the view.

Based on the observational methods just described many observational measures for pediatric procedural pain are developed (for a review see von Baeyer & Spagrud, 2006). The behavioural response to pain of children in dentistry is often a mixture of anxiety and pain, and because these two concepts are difficult to separate often the term distress is used. One of those measures, based on overt behaviours, is the Procedural Behavioural Rating Scale (PBRS, Katz et al., 1980). With the PBRS the occurrence or non-occurrence of 11 behaviours indicative of behavioural distress can be recorded during the anticipatory, encounter, and recovery phases of medical procedures. Based in part on the PBRS, the Observational Scale of Behavioural Distress was developed (OSBD, Elliot et al., 1987). With the OSBD, 11 distress behaviours are coded as occurring or not occurring during 15-second intervals. Also for very young children there are observational measures such as the Comfort scale (van Dijk et al., 2000), a scale to measure postoperative discomfort in children 0-3 years of age. The comfort 'behaviour' score consists of the summation of six behavioural items: Alertness, calmness, muscle tone, movement, facial tension, and respiratory response or crying. To measure the distress behaviour of children in dentistry the Venham scale was developed. The scale consists of 6 points: 1) relaxed, 2) uneasy, 3) tense, 4) reluctant, 5) resistance, and 6) out of contact or untreatable (Venham et al., 1980; Veerkamp et al., 1993).

Self-report measures

As mentioned earlier, since pain and distress are personal and subjective events, self-report has been described as the gold standard of pediatric pain assessment. Although using self-report to evaluate procedural pain in adults seems logical, this approach quickly becomes complicated when working with children, particularly when children are 5 to 6 years and younger. Children under 3 years of age present a particular challenge in terms of pain measurement, besides limited cognitive, linguistic, and social competencies, when toddlers are in pain or ill, it is difficult to engage them in tasks that do not fall in the range of activities that would normally interest them, increasing the difficulties to assess pain adequately.

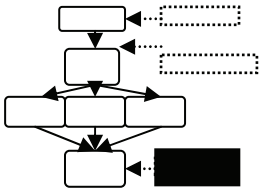
As a result, young children might not be as accurate in their estimates of pain: they may be more susceptible to response bias and situational demands, less able to separate pain from other unpleasant emotions, such as fear, anger, sadness, and anxiety and have fewer painful experiences with which they can compare the current event. In addition, developmental patterns in cognitive competencies such as children's understanding of measurement and numbers are also relevant to the self-report of pain since variations in children's cognitive competencies mediate how they perceive, understand, remember, and report pain (Gaffney et al., 2003).

In spite of these considerations, there are various pediatric self-report instruments. The most widely used child self-report scales are pictorial ones, usually with either photographed or cartoon faces ranging in expression from positive or neutral to negative. These pictorial scales are most often used with preschool-age and older children. For example the Oucher scale which depicts six photographs of children's faces spanning from a neutral expression to one of apparent pain, with a corresponding number scale from 0 to 100 for older children (Beyer et al., 1992). Another variation of this type of scale is the Faces Pain Scale-Revised (Hicks et al., 2001). In older children we can rely primarily on verbal reports with the use of, e.g., a 0 to 10 verbal rating scale (VRS) (Franck et al., 2000).

The choice of specific measures should be determined in relation to the children's developmental level, the nature of the setting and whether assessment is for research or clinical purposes. The reliability of various external signs as an indication for pain differs from situation to situation and from patient to patient. Thus, it is recommended that a range of assessment instruments be administered to attain a comprehensive evaluation of the experience. The idea is that different measurement techniques may illuminate different aspects of the painful experience. Specifically, observational scales can quantify children's overt behavioural

manifestations, parent- and staff-ratings can highlight adults' perceptions of children's pain, and self-report can record children's perceptions of their pain.

Rater



Besides the assessment method, the rater also has an influence on the assessment and interpretation of pediatric pain. Given that parents are often required to advocate for their children's medical needs, and medical staff makes the majority of decisions regarding diagnosis and treatment, their perspectives are important to consider too. However, it seems of great relevance to consider who rates the pain or asks about it. Whether ratings are provided by proxy raters (parents, medical staff nurse), self-report, and/or trained observers there is a poor agreement in the results. Various factors contribute to differences between ratings. For example, parents' ratings of a child's pain seem strongly influenced by their pre-procedural expectations of how much pain the child would experience. Nurses' ratings of acute pain reflect the overt distress behaviours exhibited by a child during the procedure. In all likelihood, the ratings made by direct caregivers are said to be the most closely approximating objective assessment of pain and distress (Manne et al., 1992).

Literature shows that there is a fairly pervasive and systematic tendency for proxy judgments to underestimate the pain experience of others (AAP, 2001). Healthcare professionals who often work with painful procedures can develop "pain blindness", leading them to underestimate the extent of pain experienced by children (Murtomaa et al., 1996). A study by Singer et al. (2002), on the correlation between scores given by different pain observers has shown that the correlation between the parents' and the children's pain ratings is larger than between the practitioner's and the children's pain rating, suggesting that a parent might be a better assessor of a child's pain. Although children often rate their experience as more distressing than observers, it is unclear whether the children are overestimating or the observer is underestimating child distress (Cohen et al., 2004).

Aims and thesis structure

The overall aim of this thesis is to study assessment of pain behaviour of children in dentistry. Three different aspects are covered. First, the possibility to recognize toothache in young children by means of their behaviour was studied (chapter 2-6). Second, the pain report and pain behaviour of children receiving a local anaesthesia injection was studied and in addition these responses were used to compare two different injection devices (chapter 7-10). Third, the coping strategies used by 11-year old children when in pain were examined (chapter 11-12).

Chapter 2 describes and analyses the Dental Discomfort Questionnaire (DDQ), a 9-question instrument to assess dental pain-related behaviours in very young children. Furthermore the possible differences in pain-related behaviours displayed by children with or without reported toothache, and by children with or without decayed teeth are assessed. In chapter 3 the value of the DDQ in predicting toothache in young children is analysed. Chapters 4 and 5 describe two studies in which the effect of dental treatment on the pain-related behaviours from the DDQ is assessed with different follow-up times. Chapter 6 examines whether children with learning difficulties, having an inability to express pain verbally, display the same toothache related behaviour as young children do and whether toothache can be identified based on these specific behaviours.

In chapter 7 the assessment of pain and distress during a dental injection by different raters, the child, the dentist and independent observers, is described and the relationship between the different assessments is explained. Chapter 8 and 9 study the advantages and disadvantages of a computerized anaesthesia delivery system (Wand®) versus the traditional syringe when administering a local anaesthesia injection. Chapter 10 deals with the influence of sequential treatments on the pain behaviour during a local anaesthesia injection.

Chapter 11 and 12 describe and analyse the Dental Cope Questionnaire, a 15-question instrument to assess the coping strategies of eleven-year-old children when dealing with pain at the dentist.

Finally, in chapter 13 the findings reported in the preceding chapters will be summarized and discussed.

Given that most chapters are based on separate publications inevitably some overlap between the chapters does exist. It should also be noted that terminology used in chapters varies due to different journal requirements. In addition, the chapters in this thesis are not arranged chronologically for editorial reasons.

Chapter 2

Dental Discomfort Questionnaire: assessment of dental discomfort and/or pain in very young children

Versloot J, Veerkamp JSJ, Hoogstraten J. Dental Discomfort Questionnaire: assessment of dental discomfort and/or pain in very young children. Community Dentistry and Oral Epidemiology 2006;34:47-52.

Abstract

Objectives: To present and analyse the Dental Discomfort Questionnaire (DDQ) for very young children and to assess the possible differences in pain-related behaviours displayed by children with or without reported toothache, and by children with or without decayed teeth.

Methods: Based on parental interviews of toddlers referred to a dental care practice twelve pain-related behaviours were identified which formed the Dental Discomfort Questionnaire (DDQ). The DDQ was filled out by parents on behalf of their children (N=146; mean age 47 months). Two third (n=94) of the children were referred to a special dental care centre and one third (n=52) were controls from a day care centre.

Results: The results show that the 12 items of the DDQ seem to measure one dimension. However, four items do not correlate with the presence of reported toothache, when these items are removed the DDQ-8 has a satisfactory reliability. All eight behaviours from the DDQ-8 occur significantly more often in children with decayed teeth and toothache than in children without decayed teeth or toothache. Especially behaviours concerning eating or brushing teeth are found to be more often present in children with decayed teeth and toothache.

Conclusions: It seems useful to take the child behaviour into account in assessing toothache. The DDQ has shown to be a reliable instrument, which could be helpful in the future for both parents and dentists in identifying toothache in young children.

Introduction

Pain is a complex, multidimensional phenomenon and the objective assessment of children's pain constitutes a challenge for health professionals (Frank et al., 2000). Whereas an adult is usually able to verbalize feelings of pain, children often are unable to do so. Moreover, variations in children's cognitive abilities affect how they perceive, understand, remember, and report pain. Their understanding of pain is hypothesized to follow a sequence of stages similar to the general cognitive sequence described by Piaget (Harbeck & Peterson, 1992). This sequence begins with the preoperational stage (3-6 years), children in this stage are assumed to describe pain in global, phenomenological terms and to start using descriptive adjectives and attach associated emotions (e.g., 'sad', 'mad'). Having passed several stages in which children gradually improve their understanding of pain (6-11 years), the cognitive sequence ends in the formal operational stage in which children (12 years and older) use sophisticated psycho-physiological concepts to describe pain. These children generally understand why pain hurts and can explain its value (Harbeck & Peterson, 1992).

In line with these assumptions, specific pain assessment tools were developed for different age groups. In neonates and infants we are forced to use behavioural and physiological variables to assess pain. Children between 4-7 years of age often can provide self-report assessment of their pain using a "facial" scale, although the validity and reliability is limited (Reid et al., 1995). In older children we can rely primarily on verbal reports using a e.g., 0 to 10 verbal rating scale (VRS) (Frank et al., 2000).

Pain is always a subjective experience, therefore self-report pain measures represent the gold standard for assessing children's perceptual or psychological experience of pain. As explained, in young children this is not an option. In case of young children, parents are an important source of information for the assessment of pain. Some research has been done to see which cues parents use to assess pain in their children (Reid et al., 1995). Based on these cues, a list of specific behaviours children exhibit following surgery was constructed. These behaviours are considered easily identifiable and can assist parents in the assessment of their children's postoperative pain (Chambers et al., 1996). Based on these and other behavioural variables several behavioural measures of pain have been developed to be used by health professionals and trained coders, for example, the COMFORT scale and the Toddler-Preschooler Postoperative Pain scale (TPPPS). The COMFORT scale consists of nine behaviours that have been found to occur in young children with

bodily pain (e.g., cry, body movement, or muscle tension) (van Dijk et al., 2000). The TPPPS is a scale developed as a clinical measure of postoperative pain in children which consists of seven items divided over three pain behaviour categories: vocal pain expression, facial pain expression and bodily pain expression. The items were derived from observational studies on children's pain behaviour (Tarbell et al., 1992).

Pain caused by decayed teeth can manifest itself in different ways: children may eat less, sleep less, and/or exhibit negative behaviour. One treatment session under general anaesthesia allowing complete elimination of the caries and return of the oral cavity into good health showed subsequent improvement in the quality of life in children (e.g., eating, sleeping, pain) as reported by their parents (Thomas & Primosch, 2002). Yet some children do not appear to complain verbally at all, even with rampant caries. In pediatric dentistry this makes the recognition of toothache in pre-verbal children, toddlers and pre-schoolers very difficult. A study on the effects of dental caries on the quality of life in children (mean age 44 months) showed that only 48% of the children with carious lesions indicated that they had pain or discomfort; however they did manifest effects of pain by changing their eating and sleep habits (Low et al., 1999). One of the possible reasons of the limited prevalence figures might be that parents are likely to look for other causes when toddlers are demonstrating signs of pain in the area of the head and mid-face.

In the Netherlands sound teeth are not normative for 5-year-old children, in fact only half of them still have a caries free dentition (Kalsbeek et al., 2002). Dental caries experience at a young age is said to be predictive for caries development later in the permanent dentition (Vanobbergen et al., 2001).

Furthermore, retrospective research on a pain prediction model for un-restored carious deciduous teeth showed a higher risk of subsequent pain or infection when the caries developed in patients at younger age (Davey, 1989). An early recognition of toothache can be helpful in a preventive and restorative climate. Through the recognition of toothache, caries can possibly be detected at an earlier stage, before more teeth have been affected. This could prevent an invasive treatment or the use of general anaesthesia; which, in turn, could possibly reduce the chance of fear acquisition. Children who experience a painful treatment at an early age have a higher risk to develop dental anxiety compared with children who have a history of positive or neutral dental experience before their first painful treatment (Levine et al., 2003; ten Berge et al., 2002a).

For that reason, indirect ways of assessing pain, through habits or behaviour are of great importance. The use of an instrument to recognize behaviour indicative for

toothache in toddlers is needed to underline the importance of prompt treatment of this group of children.

The aim of the present study is first to present and analyse the Dental Discomfort Questionnaire (DDQ) for very young children and second to assess the possible differences in pain-related behaviours displayed by children with or without toothache, and by children with or without decayed teeth.

Materials and methods

Participants

This study was conducted among 146 children (47% girls) between 30 and 59 months of age (mean 46.8, SD 8.3). The study population consisted of two groups, 94 children (51% girls) who were referred to a special dental care centre (SBT) in Amsterdam or to a similar private dental clinic specialized in treating children. All these children had decayed teeth. The control group consisted of 52 children (41% girls) from a day-care centre. Only subjects without active and untreated deceased teeth could participate in this control group.

Dental Discomfort Questionnaire

Based on extensive interviews with parents of referred toddlers, a group of experienced dentists specialized in treating children generated a list of behaviours that occur in young children with caries and toothache. The information gathered resulted in the DDQ (see Table 1). The children in our study are very young, therefore the parents were asked to fill out the DDQ on behalf of their children.

The questionnaire consists of two parts. The first part includes a question concerning the occurrence of toothache. The parent is asked if he/she ever noticed that the child had toothache, this question could be answered with: 'never', 'sometimes', 'often' or 'I do not know'. If the parent answered 'sometimes' or 'often', they were asked when: either during meals, during daytime or nighttimes (several alternatives possible). The second part of the DDQ consists of 12 questions about different behaviours possibly associated with toothache or discomfort due to caries (e.g., crying during meals or chewing problems). For each item the parent was asked to rate how often their child showed a given specific behaviour. The questions could be answered on a 3-point scale: 0 "never", 1 "sometimes", and 2 "often". Total scores ranged from 0 to 24.

Dental history

The children were examined following diagnostic criteria recommended by the World Health Organisation (WHO, 1997) to asses the occurrence of dental caries.

Statistical analysis

The reliability (internal consistency) of the DDQ was assessed by Cronbach's alpha. Chi-square tests were conducted to compare our samples with regard to the reported occurrence of the 12 different pain associated behaviours. Furthermore, predictors of toothache were determined using a binary logistic regression analysis.

Results

Subjects that participated in this study were divided into four groups according to reported toothache (never versus sometimes or often) and presence of decayed teeth (yes versus no). The frequencies of the different groups are shown in Table 1.

Table 1. Occurrence of decayed teeth and reported prevalence of toothache.

N=146 (%)	Toothache	No toothache	Total
Decayed teeth	50 (53%)	44 (47%)	94 (100%)
No decayed teeth	3 (6%)	49 (94%)	52 (100%)

According to their parents children with decayed teeth have clearly more often toothache than children without decayed teeth (53% versus 6%). In case of decayed teeth the proportion of children with toothache equals the proportion of children without toothache (53% versus 47%). In case of toothache, parents indicate that 79% has toothache during the day, 43% during the night and 80% during eating.

Psychometric analysis

A psychometric analysis was performed on the 12 items of the DDQ to examine the reliability of the questionnaire (Table 2). The table shows that all corrected item-total correlations are positive and the alpha is satisfactory (alpha .74). Results indicate that the DDQ can be seen as a one-dimensional scale. The mean total DDQ score was 3.53 (SD 3.07). No significant difference was found between boys and girls on the mean DDQ score (3.71 versus 3.33) and there was no association between age and the mean total DDQ score. Furthermore, most DDQ items have a positive correlation with toothache (never, sometimes, often), except for the items 8, 10-12.

Table 2. Psychometric analysis DDQ.

DDQ item (N=134*)	never	Corrected Item-Total Correlation	Alpha if Item Deleted	Correlation Toothache (r)
1. Problems with brushing upper teeth	71 (49%)	0.62	0.69	0.33**
2. Puts away something sweet to eat	96 (66%)	0.47	0.71	0.42**
3. Problems with brushing lower teeth	80 (58%)	0.36	0.73	0.28**
4. Bites with molar instead of front teeth	87 (60%)	0.20	0.76	0.21**
5. Chewing at one side	107 (75%)	0.60	0.69	0.48**
6. Problems chewing	117 (81%)	0.45	0.72	0.39**
7. Reaching for the cheek while eating	123 (85%)	0.58	0.70	0.50**
8. Suddenly crying at night	99 (68%)	0.38	0.73	0.11
9. Crying during meals	125 (86%)	0.45	0.72	0.42**
10. Earache at night	121 (88%)	0.07	0.75	-0.11
11. Earache at daytime	124 (93%)	0.09	0.75	0.00
12. Earache during eating	131 (97%)	0.21	0.74	-0.05
Total DDQ-score	-	-	0.74	0.50**

*Not all items were always completed; **significant correlation $p<0.01$.

Table 3 shows the number of children from the different groups: 1) children with decayed teeth and toothache, 2) children with decayed teeth but without toothache, and 4) children without decayed teeth or toothache, who demonstrate a specific DDQ behaviour ('sometimes' or 'often'). Group 3, children without decayed teeth but with toothache, is considered too small to be included in further analysis.

Table 3. Children from the different groups who demonstrate the specific behaviours.

Behaviours from the DDQ ('sometimes' or 'often') n (%)	Children with decayed teeth and toothache (1) n=50	Children with decayed teeth without toothache (2) n=44	Children without decayed teeth or toothache (4) n=49	Total **
1. Problems with brushing upper teeth	37 (74%) ‡*	20 (47%)	15 (31%)	142
2. Puts away something sweet to eat	30 (60%) ‡*	9 (21%)	8 (16%)	143
3. Problems with brushing lower teeth	28 (60%) *	16 (39%)	14 (30%)	135
4. Bites with molar instead of front teeth	26 (52%) *	18 (42%)	13 (27%)	142
5. Chewing at one side	25 (53%) ‡*	7 (16%)	3 (6%)	139
6. Problems chewing	20 (40%) ‡*	5 (12%)	3 (6%)	142
7. Reaching for the cheek while eating	19 (38%) ‡*	2 (5%)	1 (2%)	143
8. Suddenly crying at night	18 (36%)	9 (21%)	18 (37%)	142
9. Crying during meals	15 (30%) ‡*	4 (9%)	1 (2%)	143
10. Earache at night	4 (8%)	6 (15%)	7 (15%)	134
11. Earache at daytime	3 (6%)	2 (5%)	4 (9%)	130
12. Earache during eating	1 (2%)	1 (3%)	2 (4%)	131
Mean DDQ score (SD)	5.73 (3.41) ‡*	2.93 (2.37)	1.93 (1.82)	144
Proportion of children with a score 4 or higher on the DDQ	35 (70%)‡*	15 (34%)	9 (18%)	144

(1), (2), and (4) refers to group 1, 2, and 4 respectively, group 3 was excluded because of low numbers; ‡ Significant difference between group 1 and 2 ($0.001 < p < 0.012$); * Significant difference between group 1 and 4 ($0.001 < p < 0.010$); **not all questionnaires were completed fully.

The behaviours 1-7 and 9, displayed in Table 3, appear to be more often present in children from group 1 than in children from group 4. The behaviours 1,2,5,6,7 and 9 appear to be more often present in children from group 1 than in children from group 2. In line with these results, the children from group 1 (mean total score of 5.73) display on average more behaviours than the children from group 2 or 4 (mean 2.93 and 1.93; $F(2.140) = 27.64$, $p<0.001$).

Between group 2 and 4 (Table 3) there was no significant difference in the mean total DDQ score. However, the mean total DDQ score of group 2 is somewhat higher and includes more children with a relative high score of 4 or higher than group 4 (34% versus 18%).

Combining the results presented in Tables 2 and 3 it is clear that the items considering earache and suddenly crying at night are outliers. These behaviours have a relatively low corrected item-total correlation and/or no significant correlation with reported toothache. When these four items are deleted the DDQ, left with eight items (DDQ-8), has an alpha of 0.75 and the total score ranges from 0-16.

Regression analysis

The DDQ-8 total score explained 41% of the variance in toothache ($F(1,141)=107.84$, $p<0.001$). To see which DDQ-8 items contribute significantly to the prediction of toothache, a binary logistic regression analysis was performed. The analysis revealed that three of the eight behaviours are positive predictors of toothache: puts away something sweet to eat, chewing at one side, and reaching for the cheek while eating. The results are given in Table 4.

Table 4. Results of binary logistic regression analysis.

	OR	Wald	p
1. Problems with brushing upper teeth	1.00	0.00	.992
2. Puts away something sweet to eat	2.89	5.37	.020*
3. Problems with brushing lower teeth	1.80	1.05	.305
4. Bites with molar instead of front teeth	1.65	2.16	.142
5. Chewing at one side	2.81	3.79	.051
6. Problems chewing	1.42	0.28	.595
7. Reaching for the cheek while eating	9.05	4.78	.029*
9. Crying during meals	0.51	0.43	.511
All items DDQ-8	$R^2=0.43$		

*significant at $p<0.05$.

Discussion

The results of the present study show that the 12 items of the Dental Discomfort Questionnaire (DDQ) seem to measure one dimension. However, four items do not correlate with the presence of toothache and with these items removed the DDQ-8 has a satisfactory reliability.

Furthermore, most of the behaviours from the DDQ-8 occur significantly more often in children with decayed teeth and toothache than in children without toothache with or without decayed teeth.

Altogether, these findings give a preliminary validation of the questionnaire and show we might better continue with 8 of the total 12 items. Especially behaviours concerning eating or brushing teeth are found to be more often present in children with decayed teeth and toothache. In other studies also, problems eating were reported as a consequence of the presence of carious lesions or toothache (Thomas & Primosch, 2002; Low et al., 1999).

The result of the present study shows that 53% of the children with decayed teeth suffer from toothache according to the parent. This is in line with the 48% found in an earlier study where a parental questionnaire was used (Low et al., 1999). As a consequence of using a parental report this percentage might be an underestimation of the actual proportion of young children who suffer from toothache. One third of children with decayed teeth without toothache according to the parent had a relative high score on the DDQ, suggesting there might be children in this sub sample with unrecognised toothache. This in contrast with children without decayed teeth or toothache of whom only 18% had a relatively high score.

Toddlers with dental disease do not necessarily complain of pain, in part because they do not have a full concept of toothache, however they do manifest behavioural effects of pain by changes in their eating and sleep habits. Very young children depend for a great part on behavioural cues in their communication. Possibly parents with young children do not expect their child to have toothache and therefore might overlook, in their communication, the cues indicative for the presence of toothache. This study shows that the behaviours: puts away something sweet to eat, chewing at one side, and reaching for the cheek while eating are predictive for the presence of toothache. These three behaviours could possibly be used as cues by the parent, caregiver or teacher to help them recognize toothache in young children.

Furthermore, identifying and treating young children with decayed teeth is of great importance because these children are at risk of getting further toothache.

When decay is left unrestored and it is presented before 4 years and the worst tooth is affected at multiple surfaces 21% of these children reported pain within one year and 67% reported pain in any tooth before exfoliation (Levine et al., 2003). It seems however important to avoid children from having a period of life that is punctuated by pain and inability to eat. Some research even suggests that caries can lead to retardation in growth (Acs et al., 1992).

The limitation of this study that our samples were referred samples needs to be acknowledged. In future research a confirmative study in a larger sample from the general population seems advisable.

In conclusion, the DDQ has shown to be a reliable instrument, which could be helpful in the future for parents, non-dental health care workers, dentists and researchers in identifying toothache in young children. It seems useful to take the child's behaviour into account in assessing toothache and to inform parents, and non-dental healthcare workers about which behaviours to look for so they can recognize when a child has toothache.

Chapter 3

Dental Discomfort Questionnaire: predicting toothache in preverbal children

Versloot J, Veerkamp JSJ, Hoogstraten J. Dental Discomfort Questionnaire: predicting toothache in preverbal children. European Journal of Paediatric Dentistry 2004;3:170-173.

Abstract

Objectives: In the present study the value of the Dental Discomfort Questionnaire in predicting toothache in young children is analysed.

Methods: The Dental Discomfort Questionnaire (DDQ-8; Cronbach's alpha 0.75) was completed by parents on behalf of their children (N=99; mean age 47 months). Half of the children were referred to a special dental care centre and the other half were controls from a day care centre.

Results: The behaviours from the DDQ-8 appeared to be more often present in those children with decayed teeth and toothache than in those without decayed teeth or toothache. A score of 3 or higher on the DDQ-8 seemed the best cut-off point to predict toothache in children. The Receiver Operating Characteristic Curve (ROC area) showed that the DDQ-8 has predictive value for toothache.

Statistics: The validity of the DDQ-8 was expressed as sensitivity, specificity and positive predictive value and negative predictive value. The DDQ's ability to discriminate between patients with and without toothache was estimated by the area under the ROC curve of the questionnaire.

Conclusions: The DDQ-8 could be helpful for parents, non-dental healthcare workers and researchers in predicting the presence of toothache in preverbal children.

Introduction

The recently developed Dental Discomfort Questionnaire (DDQ) is an instrument to identify toothache related behaviours in young children. Pain caused by decayed teeth can manifest itself in different ways: children may eat less, sleep less, and/or exhibit negative behaviour (Thomas & Primosch, 2002). Yet preschool children with dental disease do not necessarily complain of pain. Very young children do not yet have the cognitive maturation to understand, remember, and report pain (Frank et al., 2000; Harbeck & Peterson, 1992). In pediatric dentistry this complicates the recognition of toothache in pre-verbal children, toddlers and pre-schoolers. A study on the effects of dental caries on the quality of life in children showed that only 48% of the children with carious lesions indicated that they had pain or discomfort. However, they did manifest effects of pain by changing their eating and sleep habits (Low et al., 1999). One of the possible reasons of the limited prevalence of pain in these very young children might be that parents are likely to look for other causes when children are demonstrating signs of pain in the area of the head and mid-face. For that reason, indirect ways of assessing pain, through habits or behaviour are of great importance to avoid children from having a period of life that is disturbed by pain.

In the present study the value of the Dental Discomfort Questionnaire in predicting toothache in young children was assessed and analysed.

Materials and methods

Participants

This study was conducted among 99 children (48% girls) between the ages of 30 and 59 months (mean 47.0, SD 8.2) who were selected from a cohort of 165 children derived from an earlier study. The study population consisted of 50 children (54% girls) who had been referred either to a special dental care centre (SBT) in Amsterdam or to a comparable private dental clinic specialized in treating children referred from general dental practitioners. All these children had decayed teeth and toothache. The control group consisted of 49 children (41% girls) recruited from a day-care centre. Only subjects without decayed teeth and toothache could participate in this control group.

Dental Discomfort Questionnaire

Based on earlier research of 'unpublished data' and interviews with parents of

referred toddlers, behaviours occurring in young children with caries and toothache were identified. The information gathered resulted in the Dental Discomfort Questionnaire (DDQ-8; Cronbach's alpha 0.75), an instrument to identify behaviours related to toothache. The children in our study were very young and, therefore, the parents were asked to fill out the DDQ on behalf of their children. The questionnaire consisted of two parts. The first part included a question concerning the occurrence of episodes of toothache. The parent was asked if he/she had ever noticed that their child had toothache. The possible answers were: 'never', 'sometimes', 'often' or 'I do not know'. The second part of the DDQ consisted of 8 questions about different behaviours that are associated with toothache, such as crying during meals or chewing or eating problems. For each item the parent was asked to rate how often their child showed a given specific behaviour. The questions could be answered on a 3-point scale: 0 "never", 1 "sometimes", and 2 "often". Total scores ranged from 0 to 16.

Statistical analysis

The validity of the DDQ-8 was expressed as sensitivity, specificity and positive predictive value and negative predictive value. The sensitivity reflects the chance of getting a high score on the DDQ when a child has toothache. The specificity reflects the chance of getting a low score on the DDQ when a child has no toothache. The positive predictive value is the chance that a child with a high score actually has toothache. The negative predictive value is the chance that a child with a low score actually has no toothache. For maximal validity of a test sensitivity and specificity both should be 100%. The DDQ's ability to discriminate between children with and without toothache was estimated by the area under the receiver operating characteristic curve (ROC area) of the questionnaire.

Results

The behaviours displayed in Table 1, appear to be more often present in children with decayed teeth and toothache (group 1) than in children without decayed teeth or toothache (group 2). In line with these results, the children from group 1 (mean score 5.10) displayed on average more behaviours than the children from group 2 (mean score 1.25; $t(97)=8.08$, $p<0.001$).

Table 2 shows the different cut-off points and the corresponding sensitivity, specificity, positive and negative predictive values. A score of 3 or higher seemed the best cut-off point, which would yield a sensitivity of 0.78 and a specificity of 0.82, a positive predictive value of 0.81 and a negative predictive value of 0.78. This

means that when a child has toothache he or she has a 78% chance of getting a positive test result and when a child has no toothache he or she has an 82% chance of getting a negative test result. When a child has a positive test result it means that he or she has an 81% chance of having toothache and when a child has a negative test result he or she has a 78% chance of not having toothache.

Table 1. Children from two different groups, with or without toothache whose parents reported specific behaviours.

Behaviours from the DDQ-8 ('sometimes' or 'often') n (%)	Children with decayed teeth and toothache n=50 (1)	Children without decayed teeth or toothache n=49 (2)	N
1. Problems with brushing upper teeth	37 (74%)	15 (31%)*	99
2. Puts away something sweet to eat	30 (60%)	8 (16%)*	99
3. Problems with brushing lower teeth	28 (60%)	14 (30%)*	94
4. Bites with molar instead of front teeth	26 (52%)	13 (27%)**	99
5. Chewing at one side	25 (53%)	3 (6%)*	96
6. Problems chewing	20 (40%)	3 (6%)*	99
7. Reaching for the cheek while eating	19 (38%)	1 (2%)*	99
8. Crying during meals	15 (30%)	1 (2%)*	99
Mean total DDQ-8 score (SD)	5.10 (2.99)	1.25 (1.50)*	99

* Significant difference between group 1 and 2 $p<0.005$; ** Significant difference between group 1 and 2 $p<0.01$

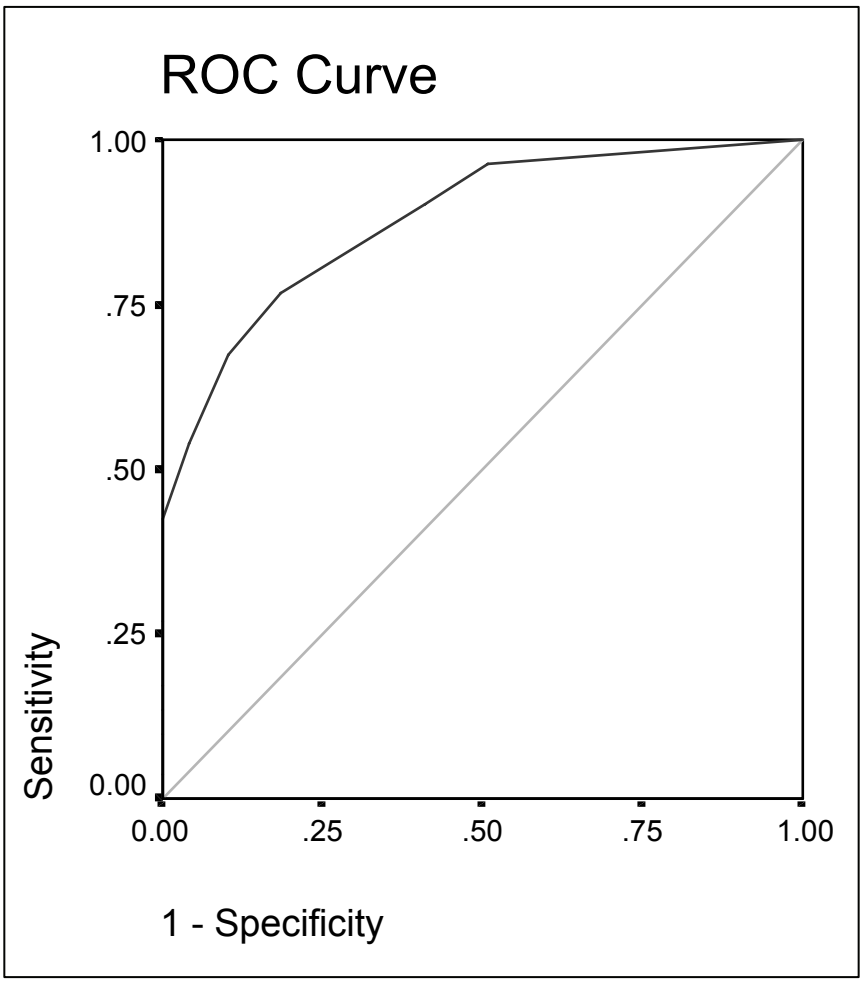
Table 2. Different cut-off points with sensitivity and specificity, PPV and NPV on reported toothache in very young children with and without dental caries.

Positive if greater than or equal to	Sensitivity	Specificity	PPV	NPV
0	1.00	0.00	0.51	1.00
1	0.98	0.49	0.66	0.96
2	0.92	0.59	0.70	0.88
3	**0.78**	**0.82**	**0.81**	**0.78**
4	0.68	0.88	0.87	0.73
5	0.54	0.96	0.93	0.67
6	0.42	1.00	1.00	0.63

PPV= Positive Predictive Value; NPV= Negative Predictive Value

The models' ability to discriminate between patients with and without toothache was estimated by using the area under the receiver operating characteristic curve (ROC area) of the model. The ROC curve for the data, shown in figure 1, demonstrates an area under the curve of 0.88, with a 95% confidence interval (CI) from 0.81 to 0.94.

Figure 1. Graph showing a models' ability to discriminate between very young children with and without toothache.



Discussion

The value of the Dental Discomfort Questionnaire in predicting toothache in young children was found to be reasonable. All 8 behaviours we used for the prediction were found to occur more often in children with toothache than in those without. The ROC curve showed that the DDQ has a good predictive value. Finally, with the DDQ it is possible to identify 78% of those children with

toothache and of the group of children we identified 81% had toothache.

In considering these findings, a limitation of this study needs to be acknowledged. The presence of toothache in a child is based on the report of the parent. Indeed, it can never be 100% sure that a child actually has a toothache. In an attempt to minimise this influence only children with both reported toothache and decayed teeth were included in this study. The presence of decayed teeth raises the likelihood of the presence of toothache and can be determined with a great deal of certainty. We might add that the parents were asked first if they noticed that their child had experienced toothache. Then, they were asked about their child's eating behaviours. It would be an interesting question for future research to see whether the reported toothache is associated with the responses of the parents to the questions concerning the child's behaviour. However, this does demand a different research design with varying conditions.

Unfortunately we cannot use children's own self-report of toothache within the present age group. Development of communicative skills in children is a continuous process, starting with behavioural expressions in infants and shifting slowly to a more verbal approach at preschool age. During this process a combined approach might be helpful, such as observing a child's behaviour and combining this with a verbal response. The acquired verbal language skills are highly heterogeneous among very young children. Infants and young children only slowly acquire the neurophysiologic maturity and cognitive capabilities that enable them to encode pain messages in language. Until language is fully available, a proces that may take the first four to seven years of life, nonverbal approaches remain the primary mode of pain assessment (Hdjistavropoulos & Craig, 2002).

The diagnosis as to whether a child has toothache or not, is important. This is because it indicates, to some degree, the status of the pulp tissue in a decayed tooth that is suspected of causing the toothache. This may affect the treatment possibilities for primary teeth involved. There are various options in treating a decayed tooth, from minor restoration through to pulpectomy and coronal coverage. An accurate diagnosis of pulp vitality therefore becomes crucial and is related to the presence or absence of toothache.

In future research it could be useful to search for more behavioural indicators of toothache. Possible indicators might be when a child exhibits negative behaviour or is more withdrawn than usually. Adding extra items to the DDQ can possibly raise the sensitivity, which will further improve its predictive value.

Conclusion

Pain is a complex, multidimensional phenomenon and the objective assessment of young children's pain constitutes a challenge for health professionals. It is to be hoped that by using the DDQ, identifying toothache in very young children can become a smaller challenge.

Chapter 4

Dental Discomfort Questionnaire for young children before and after treatment

Versloot J, Veerkamp JSJ, Hoogstraten J. Dental Discomfort Questionnaire for young children before and after treatment. Acta Odontologica Scandinavica 2005;63:1-4.

Abstract

Objectives: To present a follow-up using the Dental Discomfort Questionnaire (DDQ) before and after the treatment of children under the assumption that the number of toothache related behaviours diminishes as a result of treatment and to see whether this effect is related to the site of the carious teeth or to the treatment itself.

Methods: Sixty-one parents completed the DDQ before and after the treatment of their child, aged between 30 and 59 months. The available dental records were used to assess the status of the caries and the consecutive treatment.

Results: Overall, there was a significant decrease in the average number of post treatment behaviours displayed by children. However, children with extractions during treatment or children with caries in their front teeth did not change their behaviour. These children continued to have difficulty with chewing and biting.

Conclusions: The dental treatment of children leads to reduced toothache related behaviours. Our study showed the DDQ to be a useful instrument for acquiring insight into the behavioural aspects of young children as a consequence of toothache or dental treatment thereby underlining the importance of a behavioural approach in young children.

Introduction

In The Netherlands, sound teeth are no longer the norm for 5-year-old children, in fact only half still have caries-free dentition (Kalsbeek et al., 1996)). Many of these children have several carious lesions, which may have a significant impact on their quality of life; they eat less, sleep less, and experience pain (Thomas & Primosch, 2002). Furthermore, dental caries experienced at a young age is said to be predictive of caries development later in the permanent dentition (Vanobbergen et al., 2001) and when left un-restored there is a risk of subsequent pain and dental anxiety (ten Berge et al., 2002a; Davey, 1989).

Pain in young children is not always recognized. As a result of cognitive immaturity, and perhaps, the consistency of the pain over a long period young children with dental caries or even rampant caries do not always verbalize feelings of pain. A study by Thomas and Primosch (2002) on the effects of dental caries on the quality of life in children (mean age 44 months) showed that only 48% of parents reported that their children with carious lesions had pain or discomfort. However, these children did manifest effects in other aspects of their daily living, especially with eating, sleeping and agitated behaviour.

A single treatment session under general anaesthesia allowing complete elimination of the caries and rehabilitation of the teeth showed subsequent improvement in the quality of life of young children (e.g., eating, sleeping, pain) as reported by the parents (Anderson et al., 2004; Low et al., 1999). Besides physical improvement after treatment, research also found improvement in social quality of life (e.g., more smiling, improved school performance, and increased social interaction) (White et al., 2003).

It seems toothache can be recognized through the behaviour of young children (i.e., their eating, sleeping and other pain-related behaviours), based on this knowledge the Dental Discomfort Questionnaire (DDQ) was developed. This is a questionnaire that can be used to identify toothache in young children (2-4 years of age) by their specific behaviours. The DDQ has been developed based on descriptions of behaviours associated with toothache according to the parents of referred children with caries and toothache. A strong association is shown between the behaviours of the DDQ and toothache in young children as reported by the parent. Furthermore, it has been found that the DDQ has a good predictive value for the presence of toothache (Versloot et al., 2004c).

The aim of the present study was to present a follow-up using the DDQ before and after the children are treated, under the assumption that the number of

toothache related behaviours diminishes as a result of treatment, thereby testing its clinical use as a pain assessment tool. A second aim was to see whether this effect is related to the site of the carious teeth or the treatment content.

Materials and methods

Participants

Both before and after all dental disease was treated, questionnaires were sent to 109 parents of whom 61 (59%) replied both times. On average, there was a period of 7.7 months (SD 1.95) between the two measurements. The children were aged between 30 and 59 months (mean 49.0, SD 8.05) and the study population consisted of a convenience sample of children treated at a special dental care centre (SBT) in Amsterdam or at a comparable secondary dental care clinic specialized in treating referred children. The Netherlands Institute of Dental Sciences (IOT) at the Academic Centre of Dentistry Amsterdam approved the study. Parental consent was obtained.

Measures

Owing to the age of the children, the parents were asked to fill out the DDQ on their behalf. The list consists of two parts. The first part includes a question concerning the occurrence of toothache. The parent is asked if he/she noticed that their child had toothache, this question can be answered with: 'never', 'sometimes', 'often' or 'I do not know'. The second part of the DDQ consists of eight questions regarding different behaviours associated with toothache or caries, e.g., crying during meals or chewing problems. For each item, the parent is asked to rate how often their child shows that specific behaviour. The questions can be answered on a 3-point scale: 0 "never", 1 "sometimes", and 2 "often". Sum scores thus range from 0 to 16. The sum score of the DDQ is based on the questionnaires in which at least 6 out of 8 questions are answered. The missing values are calculated by "series mean", a technique where the missing value is replaced with the subject's mean for the filled out items.

Dental history - The available dental records are used to assess the status of the caries and the consecutive treatment.

Statistical analyses

McNemar tests to compare paired proportions were conducted to compare the DDQ-items before and after treatment (Altman, 1991). For this analysis the

response categories were dichotomised into "0" never versus "1" sometimes and often. Wilcoxon tests, a non-parametric equivalent to the t-test, were conducted to compare the mean DDQ-scores before and after treatment for different independent variables i.e. toothache before treatment (yes/no), extractions as treatment (yes/no), and front caries (yes/no). Mann-Whitney U tests, a nonparametric equivalent to the t-test, were used to compare children with or without toothache, extractions as treatment or front caries. To minimize the probability of a type-I error, the p-value was adjusted according to the Bonferroni correction, the maximum number of tests was seven, the p-value was therefore set on p=0.007. The tests were one-tailed unless otherwise indicated.

Results

Table 1. Percentage of children that displayed a specific behaviour before and after treatment.

Behaviour items DDQ	N*	Before treatment	After treatment	p
1. Problems with brushing upper teeth	59	54%	41%	.077
2. Puts away something sweet to eat	60	40%	32%	.359
3. Problems with brushing lower teeth	55	44%	27%	.022
4. Bite with molar instead of front teeth	59	44%	46%	1.00
5. Chewing at one side	54	32%	30%	1.00
6. Problems chewing	60	22%	17%	.648
7. Reaching for the cheek while eating	60	17%	7%	.109
8. Crying during meals	58	16%	7%	.125

*Not all items were always completed

Before treatment 51% of the parents reported that their child had toothache. Overall, there was a significant decrease in the mean DDQ-score for children after they had been treated (mean 3.40 versus 2.44; Z=-2,598, p=0.0045). Taking the items separately, it was found that after treatment fewer children had problems with, for example, brushing the lower teeth (44% versus 27%), brushing the upper teeth (54% versus 41%), puts away something sweet to eat (40% versus 32%), reaching for the cheek while eating (17% versus 7%), and crying during meals (16% versus 7%) although these differences did not reach significance (Table 1).

In the current study, 59% of the parents responded to both questionnaires. Further analysis showed that after treatment the non-responders had a higher initial DDQ score than the responders (5.10 versus 3.27, Z=-2.79 p=0.002).

Toothache versus no toothache

Before treatment, children with reported toothache had a significantly higher DDQ-score than children without reported toothache (mean 4.42 versus2.24; Z=-2.85, p=0.002). Children with toothache showed a significant decrease in DDQ-score after treatment (mean 4.42 versus 2.90; Z=2.56, p=0.005) this not being the case for children without toothache (mean before 2.24, mean after 1.93) (Table 2 and 3).

Table 2. Mean DDQ-score (M) and standard deviations (SD) of children before and after treatment divided for prevalence of toothache.

	Toothache before treatment					
	N=60		No (n=26)		Yes (n=30)	
	M	SD	M	SD	M	SD
Before treatment	3.40*	2.84	2.24†	2.16	4.42*†	3.00
After treatment	2.44*	1.98	1.93	1.76	2.90*	2.14

* Significant difference before and after treatment p<0.007;

†Significant difference before treatment p<0.007;

Table 3. Mean DDQ-score (M) and standard deviations (SD) of children before and after treatment divided for prevalence of extractions and front caries.

	Extractions				Caries in front			
	No (n=21)		Yes (n=36)		No (n=32)		Yes (n=24)	
	M	SD	M	SD	M	SD	M	SD
Before treatment	2.73*	1.61	4.02	3.27	3.01*	2.47	4.32	3.18
After treatment	1.53*‡	1.36	3.14‡	2.03	1.71*‡	1.72	3.67‡	1.71

* Significant difference before and after treatment p<0.007;

‡Significant difference after treatment p<0.007.

Extractions versus no extractions

Children without extractions during their treatment had a significantly lower DDQ-score after treatment (mean 1.53) than before (mean 2.73; Z=-317, p=0.001); they also had significantly lower DDQ scores after treatment compared

with children who did have extractions (mean 1.53 versus 3.14; Z=-3.12 p=0.001) (Table 3). In detail, it was found that behaviours such as puts away something sweet to eat (44% versus 14%) and chewing on one side (43% versus 10%) were displayed significantly less often by children who did not have extractions during treatment than by children who did have treatment including extractions.

Caries in front teeth versus no caries in the front teeth

Differences in pain-related behaviours were also found between children with caries in their front teeth and children with caries elsewhere. Children with caries elsewhere had a significantly lower DDQ-score after treatment than before treatment (mean 1.71 versus3.01, Z=-3.00 p=0.002) and also a significantly lower DDQ-score after treatment than children who had caries in their front teeth (mean 1.71 versus 3.67, Z=-4.30 p<0.001). This latter group did not have a significant reduction in DDQ-scores before and after treatment (see Table 2). When the behaviour items were compared independently it appeared that after treatment the behaviours: 'bites with molar instead of front teeth' (80% versus 23%), 'chewing at one side' (44% versus 19%) and 'problems chewing' (32% versus 6%), were displayed more often by children who had caries in their front than by children who had caries elsewhere. Before treatment only 'bites with molar instead of front teeth' (71% versus 25%) was done more often by children who had caries in their front teeth.

Discussion

In line with our hypotheses the mean number of behaviours displayed by the children decreased significantly after treatment. The children showed fewer problems on seven items, although none reached significance. However, the behaviour of children with extractions as treatment or front teeth caries did not change much after treatment. Children who had extractions continued having problems with eating sweet things and continued to chew on one side. A comparable effect is seen in children who had caries in their front teeth; they continued to have difficulty with chewing and they bit off things with their molars instead of with their front teeth. The underlying problem here seems to be connected with extraction since a great number of children with caries in their front teeth need extraction treatment, 83% in our sample. When the front teeth are affected, children are more likely to bite with their molars rather than with their front teeth and to continue with this behaviour after treatment because of the absence of the teeth. Another possible explanation is that these behaviours become

a habit for these children because they have deceased teeth for an extended period of time. In this specific situation it seems that the pain experience has merely changed into a discomfort attitude. Finally, the group not responding to the follow-up had significantly more pain-related behaviours before treatment. If data had been obtained from this group these might have strengthened the results. Further studies to support this hypothesis and to assess test-retest reliability are mandatory.

To conclude, dental treatment of children leads to reduced toothache related behaviours. Our study showed the DDQ to be a useful instrument for gaining insight into the behavioural aspects of young children as a consequence of toothache or dental treatment thereby underlining the importance of a behavioural approach in young children.

Chapter 5

Follow-up with the Dental Discomfort Questionnaire for young Children

Versloot J, Veerkamp JSJ, Hoogstraten J. Follow-up with the Dental Discomfort Questionnaire for young children following full mouth rehabilitation under general anesthesia. European Archives of Paediatric Dentistry 2006;7:126-129.

Abstract

Objectives: The aim of the present study was firstly to assess the persistence of pain-related behaviours of the Dental Discomfort Questionnaire (DDQ) and secondly to complete a follow-up study to assess the effect of dental treatment on pain-related behaviours in preschool children.

Methods: The 9-question DDQ was used to assess dental pain-related behaviours in a group of preverbal children. For the test-retest analysis the questionnaire was filled out twice by 44 parents on behalf of their referred child. For the follow-up study the questionnaire was filled out by 71 parents before and after all dental disease was treated.

Results: A strong correlation for the test-retest was found over a 2 month period before treatment. When the behaviour items were compared independently before and after treatment it appeared that after treatment all but one behaviour (i.e. bites with molar instead of front teeth) was displayed less often. Overall, after treatment all children had a lower mean DDQ score.

Conclusions: Dental treatment of children leads to reduced toothache related behaviours and subsequently to a better quality of life. The DDQ is a sensitive instrument to measure dental discomfort before and after restorative treatment if and when the follow-up period is short. The DDQ can possibly support healthcare providers, teachers and parents in their assessment of toothache in young children.

Introduction

In the Western world sound teeth are not normative anymore for many 5-year-old children (Pitts et al., 2005), in fact in The Netherlands only half of them still have a caries free dentitions (Kalsbeek et al., 1996). In the USA as many as 2.5 million children between 2 to 5 years of age have untreated tooth decay (Vargas et al., 1998). Decayed teeth may cause pain or discomfort which can manifest itself in different ways: children may eat less, sleep less, and/or exhibit negative behaviours. A single treatment session under general anaesthesia (GA) allowing complete elimination of the caries and rehabilitation of the teeth has been shown to lead to subsequent improvements in the quality of life in young children (e.g., eating, sleeping, pain) as reported by the parents (Anderson et al., 2004; Low et al., 1999). Besides physical improvement after treatment, research has also found improvements in social quality of life, such as more smiling, improved school performance, and increased social interaction (White et al., 2003).

Another study on the effects of dental caries on the quality of life in children (mean age 44 months) showed that only 48% of the parents reported that their children with carious lesions had pain or discomfort. However, these children did manifest effects in other aspects of their daily life, especially while eating, sleeping and with agitated behaviour (Thomas & Primosch, 2002).

In very young children pain is not always recognized (Howard, 2003). Toddlers with dental caries or even rampant caries do not always verbalize feelings of pain, possibly as a result of their cognitive immaturity and perhaps, the presence of the pain over a long period. This makes the recognition of toothache in pre-verbal children, toddlers and pre-scholars very difficult.

However, if pain and discomfort caused by decayed teeth can change certain behaviours, these behaviours may well be used to indicate toothache in young children. For this purpose the Dental Discomfort Questionnaire (DDQ) was developed which consists of questions regarding to toothache related behaviours, based on extensive interviews with parents of referred toddlers, 2-4 years of age, with caries and toothache. A strong association was shown between the behaviours of the DDQ and toothache in very young children as reported by their parent. Furthermore it was found that the DDQ had a good predictive value for the incidence of toothache (Versloot et al., 2004c).

In an earlier study an overall decrease in toothache related behaviours was found after treatment of all dental disease. Surprisingly no improvement was found on the individual behaviours although all caries was treated. The post treatment

results were collected after on average 7.7 months (Versloot et al., 2005b). Possibly these children developed new carious lesions or a part of the restorative treatment failed before parents filled out the follow-up questionnaire. In a prospective study on relapse of caries lesions, a relapse rate of 37% was found for new caries lesions at 6 months post dental surgery (Chase et al., 2004). In other retrospective studies relapse rates between 23% and 57% were found after 6-24 months (Almeida et al., 2000; Eidelman et al., 2000; Sheehy et al., 1994).

The aim of the present study was, therefore, twofold. Firstly to assess the persistence of pain-related behaviours of the DDQ. Secondly, to assess the effect of dental treatment on pain-related behaviour in preschool children, this after with a shorter follow-up period.

Material and methods

Both the study populations consisted of convenience samples of children who were treated at a special dental care centre (SBT) in Amsterdam or at a comparable secondary dental care clinic specialized in treating children. The Netherlands Institute of Dental Sciences (IOT) at the Academic Centre of Dentistry Amsterdam approved the study. Informed parental consent was obtained.

A total of 190 parents were asked to participate in the study and 115 could be included, 75 dropped out for different reasons: 60 parents were never reached by phone, 9 did not speak Dutch, 3 refused participation and for 3 not all information could be obtained. The 115 children were randomly allocated to the test-retest or follow-up groups. However, only 45 children in the test-retest group were reached twice before treatment took place. Children who could not be reached a second time before treatment were included in the follow-up group.

Subjects: Test-retest

For the test-retest analysis the parents were interviewed twice by the telephone. The first time (T1) was shortly after the first consultation and the second time just before treatment (T2). The time between T1 and T2 was needed to get permission for the treatment from the relevant dental insurance company and to allow children to be medically checked. To avoid response bias both at T1 and T2 the parents were interviewed over the telephone and the average number of weeks between first and second phone call was 8.7 weeks (SD 4.3). There were 45 children (56% girls, n=25) included, with a mean age 43.1 months (SD 9.0).

Subjects: Follow-up

For the follow-up study the parents were also interviewed twice over the telephone. The first time (T1) was shortly after the first consultation and the second time after all dental disease had been treated and the child had had time for general healing (T3). The treatments were done under GA and included full restoration by means of restorations, performed metal crowns, extractions and pulpotomies. The average number of weeks between the initial and follow-up telephone call was 11.2 weeks (SD 6.6). A total of 70 children, mean age 43.5 months (SD 9.1), 43% girls (n=30) took part in this study.

No difference was found between the two research groups concerning age or gender. Also no difference was found between the research groups and the non-responders concerning age, gender, and caries location.

Measures

Dental Discomfort Questionnaire - Due to their children's age, the parents were asked to fill out the DDQ (Versloot et al., 2006) on their behalf. The list consists of two parts. The first part includes a question concerning the occurrence of toothache. The parent is asked if he/she noticed that their child had toothache, this question could be answered with: 'never', 'sometimes', 'often' or 'I do not know'. The second part of the DDQ consists of 9 questions regarding different behaviours associated with toothache or caries e.g., crying during meals or problems chewing. For each item the parent was asked to rate the occurrence of their child's specific behaviour. The questions could be answered on a 3-point scale: 0 "never", 1 "sometimes", and 2 "often". Summation of the scores thus ranged from 0 to 18. The sum score of the DDQ is based on the questionnaires in which at least 6 out of 9 questions were answered. The missing values were calculated by "series mean", a technique where the missing value is replaced with the subject's mean for the filled out items.

Dental history - The available dental records were used to assess the status of the caries and the consecutive treatment.

Statistical analysis

Pearson's correlation was used to calculate the relation between the behaviours displayed at T1 and T2. The paired t-test and independent t-test were used to compare the DDQ-means and the McNemar test was used to calculate the difference before and after treatment of the individual items. Finally a univariate

analysis was carried out using the mean-DDQ score as dependent and toothache, caries in front teeth and extractions during treatment respectively as independent variables.

Results

Test-retest

A strong correlation was found, R=0.72, between the behaviours displayed at T1 and T2. Furthermore no difference was found between the mean DDQ score at the start (T1) (mean 5.6, SD 4.7) and at the end of the waiting time (T2) (mean 4.9, SD 5.0). Per item on average 75% of the children did not change their behaviour over the waiting time period. At the beginning (T1) 66% of the parents reported their child had toothache and at the end of the waiting time (T2) this was 58%.

Follow-up

Table 1. Percentage of a population of Dutch children that displayed a specific behaviour before and after treatment.

	N*	T1	T3	p
Reported Toothache	67	66%	3%	<.001
Behaviour items DDQ:				
1. Problems with brushing upper teeth	69	59%	29%	.001
2. Puts away something sweet to eat	69	57%	19%	<.001
3. Problems with brushing lower teeth	65	45%	26%	.029
4. Bites with molar instead of front teeth	59	33%	26%	Ns.
5. Chewing at one side	58	45%	17%	.006
6. Problems chewing	68	38%	9%	<.001
7. Reaching for the cheek while eating	68	41%	6%	<.001
8. Crying during meals	69	38%	6%	<.001
9. Suddenly crying at night	69	38%	9%	<.001

*Not all items were always completed;

When scores on the behaviour items are compared independently it appeared that after treatment all but one behaviour (i.e. bites with molars instead of front teeth) was displayed less often. After treatment behaviours like: 'problems chewing', 'reaching for the cheek while eating', crying during meals', 'suddenly starts to cry at night, were shown by less than 10% of the children. Behaviours such as 'problem brushing upper and or lower teeth', however, were still shown by

approximately 30% of the children after treatment (Table 1).

An analysis of variance with toothache (no, yes), caries in the front (no, yes), and scheduled extractions in the treatment (no, yes), as independent variables and total DDQ-score before treatment as dependent was performed. A univariate main effect for toothache was found ($F(1,56)=18.55$, $p<0.001$) resulting from a higher mean DDQ-score of children with toothache. When the same analysis was done for the mean DDQ-score after treatment no significant difference was found (Table 2).

Table 2. Mean DDQ-score and standard deviations for a population of Dutch children before and after treatment divided for prevalence of toothache, caries in the front and extractions.

	N	T1	T3	T p
Total	69	5.6 (4.5)	1.9 (2.0)	T(68)=6.91, p< .001
Toothache*				
No	22	2.1 (2.2)**	1.5 (1.6)	T(21)=1.09, p=.290
Yes	46	7.1 (4.2)**	2.0 (2.1)	T(45)=7.80, p<.001
Caries in front				
No	25	3.9 (3.5)	1.9 (2.1)	T(24)=-2.91, p=.008
Yes	44	6.6 (4.7)	1.9 (1.9)	T(43)=6.58, p< .001
Extractions				
No	29	3.6 (3.1)	1.5 (1.6)	T(28)=3.74, p=.001
Yes	36	6.9 (4.8)	2.1 (2.1)	T(35)=5.62, p<.001

*Measured before treatment; ** significantly different $p<0.01$.

Finally, a paired t-test showed a significant decrease in mean DDQ-score between T1, before treatment (mean 5.6, SD 4.5) and T3, after treatment (mean 1.9, SD 2.0). Comparing the difference between T1 and T3 for the groups with or without: toothache, caries in the front or scheduled extractions, it was found that only children without toothache did not show a decrease in the mean DDQ-score. However, before treatment this group already had a low mean DDQ-score (Table 2).

Discussion

The test-retest analysis over a period of two months showed that the pain-related behaviours included in the DDQ were very persistent. Children displayed the same

number of behaviours at the beginning of the waiting list period as at the end. This highlights the importance for treatment of caries in this group of children. Without treatment these children continue to show pain-related behaviours.

Children with toothache demonstrated more pain-related behaviours before treatment than children without so it seems that children with the most severe caries also displayed the most pain-related behaviours which supports the validity of the DDQ. In line with our hypotheses the mean number of behaviours displayed by the children decreased significantly after treatment. Children showed fewer problems on 8 items. Only 'biting things off with molars instead of their front teeth', seems to be a persistent behaviour. This can be explained plausibly as children with caries in their front teeth often have them extracted which forces them to continue biting food with their molars after treatment. This supports the robustness of the DDQ and is in line with results found in an earlier study (Versloot et al., 2006). The explanation that these behaviours persisted because they become a habit for these children, as they had carious teeth for an extended period of time, could not be supported by the results in the current study. Based on the results reported herein, it seems that newly developed caries could be the reason why in the previous study the behaviours were still demonstrated by the children at the follow-up measurement. Due to the long follow-up time in that study (almost 8 months) between the first and second measurement new caries could have developed. Furthermore, as said earlier failure of restorative treatment could also be a reason that the behaviours occurred in children eighth months after treatment.

In the present study it was found that a few behaviours, 'problems chewing', 'reaching for the cheek while eating', crying during meals' and 'suddenly starts to cry at night', were hardly displayed anymore after treatment, indicating that these behaviours are likely to be caused by the presence of caries and toothache. In an earlier study (Versloot et al., 2006) it was also shown that these behaviours, except for 'suddenly starts to cry at night', are hardly displayed by children from the control group without toothache and caries. Therefore, it seems of interest when looking for indicators of toothache to check for these behaviours in particular.

To conclude, comprehensive dental treatment of children leads to reduced toothache related behaviours and subsequently to a better quality of life. Although studies have shown high relapse of the caries in this group of children, the DDQ is a sensitive instrument to measure improvement in dental discomfort after restorative treatment if and when the follow-up period is short. The DDQ can possibly support healthcare providers, teachers and parents in their assessment of toothache in young children.

Chapter 6

The Dental Discomfort Questionnaire: its use with mentally disabled children

(Submitted)

Abstract

Objectives: First to examine whether the behaviors from the DDQ occur more often in mentally disabled children with caries and toothache than in children without caries and toothache; second to examined whether two additional items increase the specificity and sensitivity of the DDQ to recognize toothache in this particular population of children.
Methods: The Dental Discomfort Questionnaire (DDQ+) was completed by a convenience sample of 58 parents on behalf of their children: 31% girls, aged between 6 and 13 years (mean 7.5, SD 2.7).
Results: Of the total group 26% (n=15) suffered from toothache and 43% (n=25) had decayed teeth. Children with caries and toothache had a significant higher mean DDQ total score and displayed more toothache-related behaviors (e.g. Problems chewing, problems brushing teeth) than children without caries or toothache.
Conclusions: The DDQ seems to be a functional and easy to use instrument for parents, teachers and healthcare providers to alert them to the possible presence of toothache in this specific group of children.

Introduction

The assessment of dental pain in children is a challenge especially in children with special needs (Franck et al., 2000). For the reason that, childhood developmental disabilities are associated with a variety of motor, cognitive, language, and social barriers that limit effective and timely communication of pain and distress. The ability to communicate pain and distress, however, is fundamental to seeking and obtaining care (Oberlander & Craig, 2003).

As a consequence of possible limited communication abilities some children with developmental disabilities depend on their parents for the recognition of their pain. A study on the ability of parents' to perceive pain experienced by their offspring with Down syndrome found that parents have more difficulty with discerning if and where their child with Down Syndrome has pain than with their child without Down Syndrome (Hennequin et al., 2003).

Children with a mental disability tend to have poorer oral hygiene compared to children without a mental disability and have a low restorative index. In addition, dental attendance of these children is less regular and they attend at a later age, often experiencing symptoms of acute dental pain (e.g. swelling) (Owens et al., 2006; Gizani et al., 1997). As a result, toothache is often noticed too late, when symptoms are already severe.

The important aspect of early dental care is preventing children from having pain and infection. Research indicates that dental caries at a young age is predictive of caries in the permanent dentition (Vanobbergen et al., 2001). In addition, prolonged dental caries can affect the child's oral health related quality of life (Humphris et al., 2005). Pain due to dental caries can cause children to eat less, sleep worse or can cause the child to exhibit negative behaviour (Thomas & Primosch, 2002; Low et al., 1999).

Earlier research with toddlers and preschoolers has shown a relation between certain pain associated behaviors e.g. crying during meals, chewing at one site or problems with brushing teeth, and the presence of toothache and caries. Children with caries and toothache tend to display these behaviors more often. (Versloot et al., 2006). The recently developed Dental Discomfort Questionnaire (DDQ) is an instrument to identify toothache in young (preverbal) children based on their behaviour (Versloot et al., 2004c). Until recently, there has been no published work addressing assessment of toothache in children with developmental disabilities.

As said before, children with developmental disabilities can experience cognitive, language and social barriers in their communication of pain. It could therefore be

helpful to use behavioural clues as indicators for the presence of pain. So, the objective of the current study is to see whether the behaviors from the DDQ can help to identify toothache in mentally disabled children with a limited capacity for self-report.

Two aims are formulated: first to examine whether the behaviors from the DDQ occur more often in mentally disabled children with caries and toothache than in children without caries and toothache; second to examine whether two additional items increase the specificity and sensitivity of the DDQ to recognize toothache in this particular population of children.

Materials and methods

Participants

This study was conducted among 58 children (31% girls) between 6 and 13 years of age (mean 7.5, SD 2.7). The study population attended a school for children with learning difficulties. The school accepts pupils between the ages of 4 and 19. There are currently 108 pupils registered. Children who were younger than 6 and older than 13 were excluded from the study. Of the remaining 60 children, 2 were excluded from the study because they were peg-fed. The children exhibit a wide range of learning disabilities including autistic traits, Down's syndrome, cerebral palsy and other conditions with features behaviour difficulties and IQ below 50.

An experienced Dental Officer from the Community Dental Service (CDS) assesses 70% of the children's dental status annually. A further 10% are seen on a regular basis within the CDS and the remainders are registered with their family General Dental Practitioner.

The study was approved by the Queen's University of Belfast, Ethical Committee and all parents gave informed consent.

Caries status

Obvious decay experience (Dcv3MFT/dcv3mft) was assessed using the British Association for the Study of Community Dentistry (BASCD) guidelines standardized for the collection of epidemiological data throughout the UK (Mitropoulos et al., 1992). The protocol used recognizes decay, which extends into the dentine on the basis of a clinical examination conducted without the use of probes (Dcv3/dcv3). The full examination was conducted under standardized conditions observing normal infection control protocols. A single, independent, BASCD calibrated community dentist (EHS) examined all children taking part in the

study. Missing deciduous teeth, except incisors, were assumed to have been extracted as a result of caries.

Intra-examiner reliability was measured by re-examining a 10 percent random sample of all children. Two dental examinations were conducted for each of the selected children. Intra-examiner consistency can be assessed in a variety of ways from percentage agreement to the use of the Kappa statistic. In this study the Kappa statistic was used to give an accurate measure of reproducibility.

Dental Discomfort Questionnaire

Based on extensive interviews with parents of referred toddlers, a group of experienced dentists specialized in treating children generated a list of behaviours that occur in young children with caries and toothache. The information gathered resulted in the Dental Discomfort Questionnaire (DDQ). Due to their children's limited abilities, the parents were asked to fill out the DDQ on their behalf. The list consists of two parts. The first part includes a question concerning the occurrence of toothache. The parent is asked if he/she noticed that their child had toothache, this question could be answered with: 'never', 'sometimes', 'often' or 'I do not know'.

The second part of the DDQ consists of 9 questions regarding different behaviours associated with toothache or caries e.g., crying during meals or problems chewing. For each item the parent was asked to rate the occurrence of their child's specific behaviour. The questions could be answered on a 3-point scale: 0 "never", 1 "sometimes", and 2 "often". The total score is calculated by summing the answers, thus the total score ranges from 0-18. For the current study population two questions were added. These were "Is your child producing more saliva?" and "Is your child putting her/his hands in their mouth?" These additional items were based on observations made by the dentists experienced in treating children with special needs. The DDQ with the additional items is named the DDQ+ and the total score ranges from 0-22.

Statistical analysis

Chi-square tests were conducted to compare the occurrence of the 11 different pain associated behaviours between children with and without toothache or caries. Due to chance capitalization only differences with $p<0.01$ are taken into account. Independent t-tests were used to compare the mean total DDQ-score and DDQ+-score between the different groups.

The DDQ's ability to discriminate between children with and without toothache

is estimated by the area under the receiver operating characteristic curve (ROC area) of the questionnaire. Furthermore the sensitivity and specificity is estimated for different break points of the DDQ-total score. The sensitivity reflects the chance of getting a high score on the DDQ in case of toothache. The specificity reflects the chance of getting a low score on the DDQ when a child has no toothache. For a maximal validity of a test sensitivity and specificity both should be 100%.

Results

Caries status and toothache

Due to the age group in this study sample (6-13 years) dmft as well as DMFT were recorded. Since the presence of deciduous teeth normally excludes the presence of its successor, in the data file the dmft and DMFT were combined to provide an overall score for obvious decay experience. The mean score for the number of teeth with decay into dentine was 2.24 (SD 3.54). Of the children 43% (n=25) had at least one tooth with decay into dentine and their mean number of teeth with decay into dentine for these children was 5.2 (SD 3.71). In addition 52% (n=30) of the children had no obvious caries experience, 9% (n=5) had filled teeth with only 5% (n=3) having missing teeth.

Of the total group of children 26% (n=15) suffered from toothache, as reported by the parents. Significantly larger proportions of children with decay into dentine had toothache (44%) compared with those without decayed teeth (12%) (X2= 3.59, p=0.058). One third (n=11) of the parents were not sure if their child had toothache but they were found to have no decayed teeth (Table 1).

Table 1. Percentage of children with toothache.

N=58	No decayed N (%)	Decayed n (%)	Total n (%)
No toothache	18 (55%)	14 (56%)	32 (55%)
Yes toothache	4 (12%)	11 (44%)	15 (26%)
Uncertain toothache*	11 (33%)	0	11 (19%)

*11 parents of children without decayed teeth were not sure if their child had toothache.

Dental Discomfort Questionnaire

Table 2. Percentage of children displaying specific behaviours sometimes or often.

	Caries free no toothache (control) N=18	Caries free don't know tooth-ache N=10	Caries but no tooth-ache N=14	Both caries and tooth-ache N=11
Biting things off with their molars instead of their front teeth	11	30	50	55
Putting sweets away just after starting eating	6	18	21	82*
Starting to cry during meals	6	10	21	27
Having problems with brushing upper teeth	11	28	79*	91*
Having problems with brushing lower teeth	11	27	79*	82*
Having problems chewing	6	28	29	73*
Chewing at one side	0	18	21	82*
Suddenly grabbing his/her cheek	0	36*	0	27
Suddenly crying at night	6	18	21	46*
Producing more saliva	6	64*	7	46*
Putting her/his hands in their mouth	0	64*	21	73*

*significant difference (at $p<0.01$) between that group and the control group (no obvious decay nor toothache)

Based on the presence of toothache and decayed teeth 5 different groups of children could be formed: the control group with no decayed teeth and no toothache, a group with decayed teeth but no toothache, a group without decayed teeth but with toothache, a group with decayed teeth and toothache. Furthermore there was a group without decayed teeth of whom the parents were not sure about

the presence of toothache. For each group separately (except the group without decayed teeth but with toothache, due to small numbers) the frequency of the DDQ+ items were calculated. Table 2 shows the percentage of children in these groups that displayed certain behaviours sometimes or often. All three groups were compared with the control group without decayed teeth and without toothache.

In comparison to the control group children without caries but whose parents were unsure if they suffered from toothache reported significantly more toothache-related behaviours: suddenly grabbing their cheek, produces more saliva and puts their hands in their mouth. Similarly, compared with controls, parents of children with caries reported significantly more toothache-related behaviours: has problems brushing upper or lower teeth; and parents of children with toothache and caries reported significantly more toothache-related behaviours: puts a sweet away, has problems brushing upper or lower teeth, has problems chewing, eats at one side, produces more saliva and puts their hands in their mouth in (Table 2).

When the mean DDQ and DDQ+ scores are compared it was found that children without caries or toothache had a significantly lower mean DDQ and DDQ+ total score than the children from the other three groups (DDQ, $F(3,50)=20.25$, $p<0.001$; DDQ+, $F(3,50)=18.29$, $p<0.001$). Furthermore, children with caries and toothache had a significant higher mean DDQ and DDQ+ total scores than the children from the other groups (Table 3).

Table 3. Mean total DDQ score and SD.

Mean (SD)	Caries free no toothache (control) N=18	Caries free don't know toothache N=10	Caries but no toothache N=14	Both caries and toothache N=11
Total DDQ	0.61 (1.38)*	3.09 (2.02)	4.36 (2.85)	7.45 (3.11)**
Total DDQ+	0.67 (1.57)*	5.09 (3.11)	4.64 (3.10)	9.18 (4.29)**

*significant difference between the group "Caries free and no toothache" (control) and the three other groups.

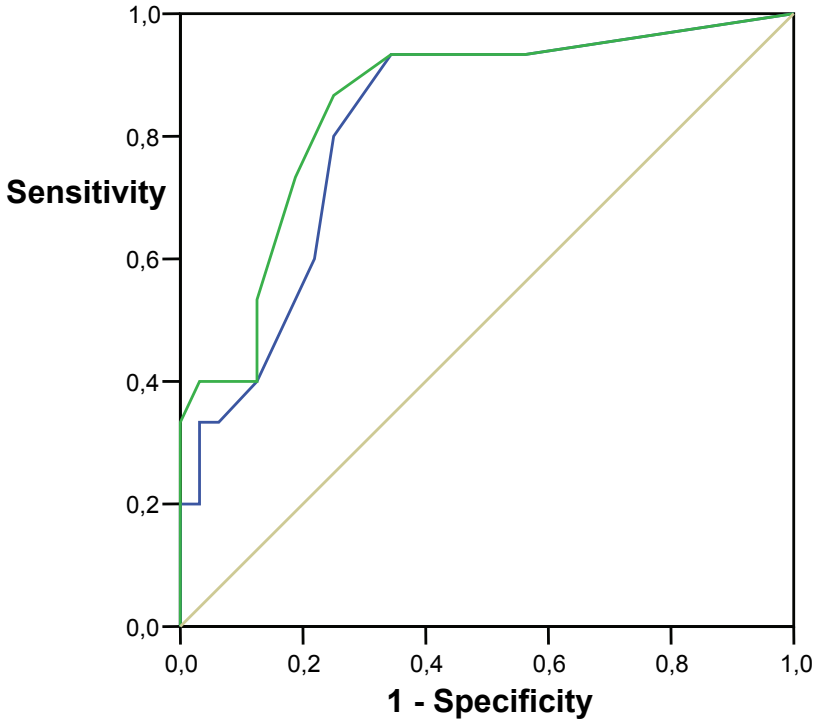
**significant difference between the group "Both caries and toothache" and the groups: "Caries free don't know toothache" and "Caries but no toothache".

In addition there was a significant correlation between the total DDQ score and dmft-DMFT $r=0.64$ and between the total DDQ+ score and dmft-DMFT $r=0.52$. No correlation between age and DDQ or DMFT was found.

Finally, the area under the ROC curve of total DDQ-score to predict toothache was 0.82 (0.69-0.95). The optimal break point, with the highest sensitivity (80%) and specificity (75%) was found to be greater than or equal to 4 (Figure 1).

The area under the curve of total DDQ+-score to predict toothache was 0.85 (0.73-0.97). The optimal break point, with the highest sensitivity (86%) and specificity (75%) was found to be greater than or equal to 4 (Figure 1).

Fig 1. ROC Curve



Upper line: DDQ+; Lower line DDQ

Discussion

The current study shows that children with mental disability display mostly the same toothache related behaviours as young children. Furthermore, these specific behaviours can be used to predict the presence of toothache.

In our study population 43% had decay into the dentine and 44% of these children suffered from toothache. Furthermore, children with caries and toothache had higher mean DDQ/DDQ+ scores than children who had no obvious decay experience or toothache. More specifically, children with caries and toothache

display eight out of the eleven behaviours more often than children without caries or toothache. In contrast, children with caries but without toothache display only two behaviours more often than children with no obvious decay or toothache experience, which supports the validity of the questionnaire.

The DDQ/DDQ+ were found to have a good association with the DMFT/dmft scores, indicating children who score high on the questionnaires often have a high DMFT/dmft score. Furthermore, the list has a good predictive value for toothache in this population, supporting its clinical use in this group. From the children who suffer from toothache, 80% or 86% could be identified using the DDQ or DDQ+ respectively with a cut-off score equal or higher than 4.

Almost 20% of the parents thought their child was suffering from toothache whereas the dentist could not identify caries. Almost two third of these children were found to display the two behaviours: produce more saliva and put their hands in their mouth, sometimes or often. Both aspects might be biased if it happens to be routine agitated behaviours as a result of tooth eruption which occurs between 6 and 13 years of age. Nevertheless the sensitivity of the DDQ+ suggested that for those children who displayed 4 or more toothache-related behaviours there was an 86% probability that they were experiencing dental pain. This finding suggests that the DDQ+ would be a useful instrument in assisting parents of children with mental disability to identify when their child is experiencing dental pain

Of course some limitations should be made. The numbers of children are limited and the parents might be biased already interpreting their children behaviours when assessing the occurrence of toothache. There is, however, evidence that the behaviour approach works in children of comparable developmental age (Versloot et al., 2004c; Versloot et al., 2006) and the correlations with obvious caries experience supports the initial findings in this study. Furthermore the specific study population must be taken into account when generalizing the results. Also, further studies are needed to see if treatment can reduce these behaviours and thereby improving the quality of life in these children.

Conclusions

This study gave a description of which behaviours can be indicative for the presence of toothache in children with a mental disability. The DDQ seems to be a functional and easy to use instrument in identifying toothache in this specific group of children. Furthermore, the specific behaviours from the DDQ seems to be particular helpful for parents, teachers and healthcare providers to alert them to the possible presence of toothache in this specific group.

Chapter 7

Assessment of pain by the child, the dentist and independent observers

Versloot J, Veerkamp JSJ, Hoogstraten J. Assessment of pain by the Child, Dentist, and Independent Observers. Pediatric Dentistry 2004;26:445-449.

Abstract

Objectives: To study the assessment of pain and distress by the child, dentist and independent observers during a dental injection and study the relationship between the different assessments.

Methods: The amount of pain experienced by the child during local anaesthesia was reported independently by the child to both the dentist and parent on a 4-point scale running from 'no pain' to 'a lot of pain'. The dentist and observers also gave a score for the pain experienced on a 4-point scale. The amount of distress experienced by the child during local anaesthesia was assessed by the dentist and observers using a 6-point scale (from 'relaxed' to 'out of contact).

Results: The dentists' pain assessment was the lowest. A substantial correlation was found between the child's self-reported pain and the pain as assessed by independent observers. There was a moderate correlation between the amount of distress and pain intensity as reported by the child during the anaesthesia phase.

Conclusions: Observation of a child in a videotaped procedure is apparently the most reliable method to accurately assess pain behaviour and to discriminate pain from distress. A combination of the child's report and video observation is advised to assess pain in young children.

Introduction

Pain and distress are terms used to describe pain and pain-related fear, anxiety, and agitated behaviour (Franck et al., 2000). Because pain and distress in children are correlated, they are difficult to assess independently (Litt, 1996; Humphrey et al., 1992). Since pain has sensory, emotional, cognitive, and behavioural components that are interrelated with environmental, developmental, socio-cultural, and contextual factors (AAP, 2001), it is a complex multidimensional concept that can vary in quality, intensity, duration, location and unpleasantness. Children may therefore experience different levels of pain from the same stimulus (e.g., a dental injection). Moreover, the concepts of pain applicable to children seem to differ from those applicable to adults, probably due to different levels of cognitive development (Franck et al., 2000). Toddlers and preschoolers are also unable to verbally describe their pain perception accurately.

Distress on the other hand can be defined as an occurrence of emotions felt or behaviour displayed during (dental) treatment caused by factors other than pain, for instance fear, anxiety, and anticipatory or situational stress. Furthermore, distress lacks the direct stimulus of physical damage.

Finding a gold standard for the objective assessment of pain in young children indeed is a challenging and critical task for health professionals. An accurate and reliable measurement of pain is necessary, both for diagnostic purposes and for evaluating pain behaviour. While pain can be assessed through self-report measures (e.g., facial scales, visual analogue scales), behavioural measures (facial expression, behavioural rating) and physiological measures (heart rate, sweating and EEG), the choice of the proper instrument depends on the nature of the painful stimulus (e.g., chronic or acute), the age of the child, and his or her communication capabilities (AAP, 2001; Matthews et al., 2003). In dentistry, behavioural ratings are often used for pain assessment in toddlers and preschoolers. For children between 4 and 6 years, an adapted self-report (facial scales) combined with some form of behavioural rating is the most common method. For children above 6 years, self-report is recommended (Hallonsten et al., 2001).

Pain measurement, however, is complicated by major methodological and developmental issues. For instance there is only a limited correlation between facial scales and behaviour ratings (Buchanan & Niven, 2003). In addition, whether ratings are provided by the parents, child, nurse, and/or trained observers there is a poor agreement in the outcome of behavioural pain measurement. Different factors contribute to differences between ratings (Manne et al., 1992). For example,

parents' ratings of child pain seem strongly influenced by their pre-procedural expectations of how much pain the child would experience. Nurses' ratings of acute pain reflect the overt distress behaviours exhibited by a child during the procedure. In all likelihood, the ratings made by direct caregivers most closely approximate objective assessment of pain and distress (Manne et al., 1992).

There is a fairly pervasive and systematic tendency, however, for proxy judgments to underestimate the pain experience of others (AAP, 2001). Healthcare professionals who often work with painful procedures can develop "pain blindness", leading them to underestimate the extent of pain experienced by children (Murtomaa et al., 1996). A study by Singer et al. (2002), on the correlation between different pain observers has shown that the correlation between parents' and children's pain ratings is larger than between practitioners' and children's pain rating, suggesting that a parent might be a better assessor of a child's pain. Because the former study used a variety of instruments to assess a wide range of pain types, however, a comparison between the pain scores was impossible.

Pain measurement complexity is exacerbated by the fact that it is difficult to distinguish between behaviour resulting purely from pain and behaviour resulting from fear and a mixture of other factors. While there are methods to assess distress, these measure overt behaviour without distinguishing between pain behaviour and distress behaviour. On the other hand, behaviour measurements for pain intensity may be influenced by behaviour resulting from distress. To this it should be added that there is sparse literature on the differences between pain and distress during dental treatment and the influence of one on the other.

The present study had a twofold aim. One, to determine whether assessments of pain severity by children aged 4-8 years correlate with similar assessments made by dentists and independent observers. Two, to assess the relation between pain and distress in young children, and analyze the extent to which the reported pain is influenced by anticipatory and situational distress. In this study the same type of pain measurement was used by observers, practitioners and patients. At the same time, a specific type of pain was studied (i.e. pain resulting from a dental injection). Because a topical anaesthetic was used the pain experience was softened. In an attempt to isolate the pain behaviour from the distress behaviour, patient behaviour was recorded on video during the painful stimulus. In addition the authors controlled for patient's levels of dental anxiety.

Materials and methods

Subjects, dentists, observers

This study was conducted among 50 children (31 girls) between 4 and 8 years of age (mean 5.6, SD 1.2), treated at a special dental care centre (SBT) in Amsterdam or in a private dental practice specialized in treating children. All children were referred because treatment by their regular dentist was considered unworkable. The treatment was performed in the absence of the parents, by five dentists experienced in treating children. All treatments were videotaped and analyzed by two specially trained advanced psychology students.

This study was approved by the Interuniversity Dentistry Research School (IOT) at the Academic Centre of Dentistry Amsterdam. Parental consent for all children was obtained.

Pain measurement

Pain was defined as a sudden behaviour change during or shortly after needle insertion. The pain during the dental injection (restricted to the PDL injections) was assessed in four different ways.

1. After the dental injection was applied the dentist rated the child's pain-associated behaviour.
2. After the dental injection, when the child was calm (e.g., after a sip of water), the dentist asked the child if he/she noticed it when his/her tooth was made to sleep.
3. After the treatment, when the child was reunited with the parent and the dentist had left, the parent asked the child the same question as the dentist.
4. Two independent observers rated the child's pain-associated behaviour based on a videotape of the dental injection.

Each dentist independently assessed the children they treated. All the pain measurements were rated on a 4-point scale 1) no pain; 2) a little pain; 3) modest pain; and 4) a lot of pain.

Distress measurement

Distress was defined as the stress behaviour displayed by a child which might not be the result of pain. For purposes of coding the child's distress behaviour, the first part of the treatment, including the local anaesthesia was divided into three non-overlapping phases: 1. period between the child's entry into the room and the application of the topical anaesthesia; 2. period from phase 1 until the dentist

picked up the local anaesthesia syringe; 3. period from phase 2 until the end of local anaesthesia. The child's behaviours were coded using a modified version of the Venham scale, i.e. a 6-point scale: 1) relaxed, 2) uneasy, 3) tense, 4) reluctant, 5) interference, and 6) out of contact or untreatable (Veerkamp et al., 1995). The dentist rated the amount of distress the children displayed during the treatment's three separate phases. The two observers gave a distress rating based on the videotapes of the treatment. The score was the peak amount of distress displayed by the child in that particular phase.

The Dental Subscale of the Children's Fear Survey Schedule (CFSS-DS)

Dental fear could influence a child's expressed behaviour during a dental injection. To assess the level of dental fear experienced by the subjects, the parent was asked to complete the CFSS-DS on behalf of his/her child. Since younger children are unable to complete the CFSS-DS on their own and to enable comparisons between different ages, it was decided to use the parent's version of the CFSS-DS. The CFSS-DS consists of 15 items, related to various aspects of dental treatment (e.g., "how afraid is your child of: the noise of the dentist drilling or having somebody examines your mouth"). Each item can be scored on a 5-point scale 1) "not afraid at all"; to 5) "very afraid". Thus total scores range from 15-75. Previous research has indicated scores below 32 as non-clinical, scores between 32-38 as 'borderline range', and scores of 39 and higher as 'clinical range' of dental fear. Children scoring in the 'non-clinical range' generally are non or less fearful, and are expected not to cause problems during treatment. Of the Dutch child population 14% suffers from some degree of dental fear (ten Berge et al., 2002b).

Behaviour ratings

On the basis of the videotapes, the observers, separately, rated the number of pain-associated behaviour and the distress behaviour each child experienced. To separate distress behaviour from pain behaviour, the observers studied the behavioural change at the moment the injection was given. Any change in behaviour (e.g., suddenly starting to cry, crying louder, closing eyes, or sudden body movements) was interpreted as pain behaviour. The two observers evaluated each child independently, comparing their score, and, in case of disagreement reaching a final rating by joint decision. They reached good agreement (intra class correlations 0.88-1.00). All dentists and observers were trained using videotapes not included in the study.

Statistical analysis

ANOVA for repeated measures was used to test for significant differences in distress assessment (between the dentist's three ratings and the observers' three ratings) and pain assessment (between the pain ratings of the child, dentist and observers). When a significant effect was found, a paired comparison was performed to identify specific differences. Spearman rank correlation coefficient was used to assess the relation between the different distress assessments and the different pain assessments.

Results

The mean total CFSS-DS score was 34.6 (SD 11.65), 59% had a score of 32 or higher. No significant differences in total CFSS-DS scores between boys and girls nor an association between the total scores and age or any of the pain or distress ratings were found. One CFSS-DS question, about fear for a dental injection had a significant ($p=0.005$), but modest correlation with the amount of distress displayed during the injection phase ($r=.39$).

Pain

Gender and age were not associated with any of the pain ratings. The different mean pain assessments were subjected to an analysis of variance (ANOVA) for repeated measures resulting in a significant effect. Subsequent paired comparison analysis showed that the dentists (Mean 1.46, SD 0.66) assessed the pain significantly lower than the observers (Mean 2.04, SD 0.75, $p<0.01$), lower than the child to the dentist (Mean 2.16, SD 0.96, $p<0.01$) and lower than the child to the parent (Mean 2.44, SD 1.13, $p<0.01$). The observers (Mean 2.04, SD 0.75) assessed the pain significantly lower than the child to the parent (Mean 2.44, SD 1.13, $p<0.01$). The means are presented in Table 1.

The two pain reports of the child -to the dentist and parent- showed a good correlation ($r=.65$, $p<0.01$) (Table 1). When the two pain reports were compared, however, it was found that 12% of the children reported more pain to the dentist and 28% reported more pain to the parent.

Substantial correlations were found between the: 1) observers' pain assessment and child's report to the dentist ($r=.57$, $p<0.01$), 2) observers and the dentist ($r=.41$, $p<0.01$) and 3) observers and the child's report to the parent ($r=.41$, $p<0.01$). A low correlation was found between pain assessed by the dentist and the child's report to the dentist ($r=.36$, $p<0.01$). No significant correlation was found

between pain assessed by the dentist and child's report to the parent (r=.18).

Table 1 Pain assessments during the local anaesthesia; means, standard deviations and correlations.

Variable N=50	Mean	SD	Observer (r)	Child to dentist (r)	Child to parent (r)
Dentist ratings	1.64*	0.66	.41**	.36**	.18
Observer ratings	2.04†	0.75	X	.57**	.41**
Child's report to the dentist	2.16	0.96		X	.65**
Child's report to the parent	2.44	1.13			X

*significantly different from all other ratings p<0.01;

† Significantly different from self-report to the parent p<0.01;

** Significant correlation at p<0.01.

Distress

Gender and age were not associated with any of the distress assessments. An ANOVA for repeated measures and subsequent paired comparison showed a lower amount of distress assessed by both the dentists and the observers during the start of the treatment (Mean 2.38, SD 1.12 & Mean 2.20, SD 1.59) than during local anaesthesia (Mean 2.66, SD 1.06 & Mean 3.00, SD 1.65). The dentist's assessments of distress during the injection (Mean 3.00, SD 1.65) were higher than those of the observers (Mean 2.66; SD 1.06) ($t(49) = -2.43$, $p=0.019$). The means are presented in Table 2.

Table 2. Means of the distress assessments.

Variable	Observers		Dentists	
N=50	Mean	SD	Mean	SD
Start of the treatment	2.38*	1.12	2.20*	1.59
During topical anaesthesia	2.40	0.73	2.20	1.15
During local anaesthesia	2.66†	1.06	3.00†	1.65

*Significantly less distress at the start of the treatment as during local anaesthesia at p<0.01.

†Significant difference between the rates of the observers and the dentists.

Pain versus Distress

The pain assessed by the observers correlates significantly with the different distress assessments over the three treatment phases (i.e. entering, topical anaesthesia, local anaesthesia). The pain as reported by the child to the parent

correlates with all distress assessments except for the distress assessment as given by the dentist for phase 1. On the contrary, the pain assessments by the dentist and the pain as reported by the child to the dentist only correlate significantly with the distress assessment as given by the dentist for phase 3. The correlations are presented in Table 3.

Table 3. Correlation between the pain assessments and the distress ratings.

	Distress phase 1		Distress phase 2		Distress phase 3	
Pain report/rates	Observer	Dentist	Observer	Dentist	Observer	Dentist
Observers' pain	0.40†	0.36†	0.44†	0.50†	0.47†	0.70†
Dentists' pain	0.08	0.13	0.12	0.26	0.29*	0.51†
Child's pain to dentist	0.26	0.23	0.28	0.22	0.24	0.41†
Child's pain to parent	0.38†	0.22	0.41†	0.35*	0.39†	0.44†

*Significant at $p<0.05$; †Significant at $p<0.01$.

Discussion

The group studied here seems to be homogenous, no effects were found for age and gender. The mean total CFSS-DS score was 34.6 (SD 11.7) and 59% of the children suffered from some form of dental anxiety. This is higher than the mean of the Dutch population (M 27.0, SD 9.7; 14%), which one might expect for this group of children (ten Berge et al., 1999). No correlations were found between the total CFSS-DS score and any of the pain or distress ratings. In this age group the amount of pain and distress seems to be influenced by factors other than dental anxiety.

The pain scores are mostly low to moderate because of the use of a topical anaesthetic. The pain ratings reported by children to the dentists and those reported by the observers were comparable, there was a moderate correlation and no difference in mean scores. The two pain reports of the child (to the parent and to the dentist) were closely associated although the exact ratings show that in 40% of the cases, the children gave a slightly different rating to the dentist than to their parents. This discrepancy may be the consequence of family expectations or socially desirable answers to the dentist.

The pain ratings reported by the dentists were poorly correlated with, and had a lower mean than the pain ratings reported by the child to the dentist. Other studies also found low correlations between pain ratings given by healthcare professionals and those given by their pediatric patients (Singer et al., 2002). The pain ratings reported by the dentists look almost standard, as if assuming that each dental

injection causes the same amount of pain to every child. The dentists' pain scores are the lowest and have a small standard deviation.

In a study of pain measurement in the clinical practice, Hester et al. (1998) describes an 'illusion of certainty', in which providers assume they know a patient's pain level without having to measure it, on the basis of the type of illness or procedure, and without regard to the individual patient's experience. Other research has found that practitioners who regularly perform painful procedures are becoming 'blind' to the amount of pain behaviour displayed by the patient. Neither do dentists always question children regarding their comfort; some of them do not find child reports of pain fully credible (Murtomaa et al., 1996). Of course, all dentists have background information about their patients, and will subjectively incorporate that knowledge into their assessments of pain.

The distress during anaesthesia as rated by the dentists correlates with all four different pain assessments. A possible explanation is that the dentist underestimates the amount of pain experienced by the child, so all the overt behaviour displayed by the child is interpreted as distress. In reality, however, part of this overt behaviour is the result of the pain experienced at that moment. When communication is difficult (due to age), all personal impressions by health care professionals regarding the behaviour's meaning should be examined carefully. Because pain expression reflects physical and emotional state, coping style, and family and cultural expectations, it can be misinterpreted (AAP, 2001). For example, children with 'difficult' personality types may express more negative behaviour when in pain; 'easier' personality types, conversely, may express less negative behaviour, and their pain may be overlooked (Franck et al., 2000).

The pain ratings by the observer and the child as reported to the parent correlate with almost all the distress ratings. This indicates that these pain and distress ratings share similar variance. In other words these concepts partly overlap. The pain ratings by the child as reported to the parent and by the observers may be biased by the amount of distress displayed by the child during the treatment. The authors add that the observers were not blind to the amount of distress displayed by the child during the phases preceding the injection phase. Furthermore, perhaps the child was so overwhelmed by the emotions experienced that it confused its concept of pain when reporting to the parent afterwards.

During the injection phase the child expresses a certain amount of overt behaviour. Part of this is the consequence of the distress the child experiences, and the other part is the consequence of the pain he or she experiences. It seems that while the dentist and the observers detect the same amount of overt behaviour, the

dentist attributes more of this behaviour to distress and less to pain, and the observer attributes a smaller part to distress and a larger part to pain. The different pain rates show that the observers' rates are congruent with the rates reported by the child to the dentist.

Conclusion

Observation of a child on a video apparently is the most reliable method to accurately assess pain behaviour and discriminate pain from distress. A combination of self-report of the child and video observation is advised to assess pain in young children.

Chapter 8

Computerized anaesthesia delivery system versus traditional syringe: comparing pain and pain-related behaviour in children

Versloot J, Veerkamp JSJ, Hoogstraten J. Computerized anaesthesia delivery system versus traditional syringe: comparing pain and pain-related behaviour in children. European Journal of Oral Sciences 2005;113:488-493.

Abstract

Objectives: To compare the behaviour reaction of children who receive local anaesthesia with a traditional syringe with the behavioural reaction of children who receive local anaesthesia with a computerized device (Wand®) and to differentiate between the reactions of highly anxious children with those displaying low anxiety.
Methods: A total of 125 children aged 4-11 yr were randomly allocated to receive local anaesthesia with the Wand® or a traditional injection. Parents completed the Dental Subscale of the Children's Fear Survey Schedule (CFSS-DS). Two independent observers scored videotapes of the anaesthesia in 15-s intervals. The occurrence of muscle tension, crying, verbal protest, movement and resistance was registered and a score was given on the Venham distress scale.
Results: The mean injection time with the Wand® was four times as long as with the traditional syringe. During the first 15-s of the injection, low anxious children receiving local anaesthesia with the Wand® displayed less muscle tension, less verbal protest and less movement than children receiving local anaesthesia with the traditional syringe. Within the high anxious group no differences were found.
Conclusion: Low anxious children seem to benefit from the use of the Wand® instead of the traditional syringe in receiving local anaesthesia.

Introduction

Pain is a complex multidimensional phenomenon (AAP, 2001). Many contextual, psychological and physiological factors may moderate the relation between the pain stimulus and the pain response. In children, the level of maturation of physical, cognitive, and emotional systems are also of influence (Franck et al., 2000; Zeltzer et al., 1992). In addition, the characteristics of the painful stimulus, such as intensity, duration and location, seem to directly influence the relation between pain stimulus and response.

Dental visits are often associated with pain, particularly when an injection is expected. An injection can also provoke anxiety, particularly in children. Research shows that about 14% of 4-11-yr-old Dutch children are dentally anxious and the strongest fears are associated with injections (ten Berge et al., 2002; Locker et al., 1999). While patients' fears may be acquired through vicarious experiences and threatening information, direct experience is the most common source of dental fear (Milgrom et al., 1997). This occurs despite many dentists having developed the skill of delivering almost painless injections, although a totally painless injection is impossible to achieve in all circumstances. As a consequence, there is a constant search for ways to avoid the invasive and often painful nature of the injection, and to find more comfortable and pleasant means of producing local anaesthesia before starting the dental procedure. One of the systems developed to address the shortcomings of traditional dental syringes is the Wand® system (Milestone Scientific, 1998). The Wand® device is a computer-automated injection system that provides a precise injection flow-rate, regardless of tissue resistance. The system maintains a constant positive pressure on the flow of the anaesthetic solution. It is claimed that when advanced slowly, the drops of solution anesthetize the tissue ahead of the needle, thereby yielding a virtually painless needle insertion (Milestone Scientific, 1998).

A few studies have been conducted (Table 1) using the Wand® in children. Some of these studies found a reduction in disruptive behaviour as a result of the use of the Wand® system (Ram & Peretz, 2003a; Allen et al., 2002; Gibson et al., 2000; Palm et al., 1999). Other studies did not find a reduction of pain when using the Wand® in comparison with the traditional injection (Ram & Peretz, 2003b; Asarch et al., 1999). However, in at least one study (Asarch et al., 1999) the Wand® system was not used in accordance with the instructions of the manufacturers (Casagrande, 2000).

Table 1. Studies with children and the Wand in dentistry.

Author pub year	N	Age yr	Design		*	Pain behaviour	Pain self-report	Result
ASARCH et al.	57	5-13	1	Topical anaesthetic (30-45 s)	a,b,c	Body movement, crying, restraints, dentist interference.	VAS	No difference
GIBSON et al.	62	5-13	1	Topical anaesthetic (60 s)	b,c and d,e	Body movement, crying, restraints, temporary halt to treatment.	VAS	Fewer disruptive beh. First 15s (palatal). No difference (buccal). No difference pain rating at all.
ALLEN et al.	40	2-5	1	78% male. Topical anaesthetic (30 s)	b,c and d,e	Body movement, crying, restraints, temporary halt to treatment.	None	Fewer disruptive behaviours with Wand and less restraint.
RAM et al.	98	2-4	1	Hydroxyzine and nitrous oxide	c and f	Facial display, arm/leg movements, torso movements and crying.	None	Fewer children reacted negatively to the wand, no signs of discomfort after treatment.
RAM et al.	55 47	3-5 6-10	1, 2	Topical anaesthetic gel	g, h	Facial display, arm/leg movements, torso movements and crying.	None	No difference in pain behaviour.
PALM et al.	33	7-18	3	Topical anaesthetic (60 s)	h	Crying, moving the head or other disruptive behaviours.	VAS	None of the children reacted with any of the disruptive behaviours. Pain ratings were higher after the traditional injection than after The Wand.

1. Randomized Controlled Trial; 2. Random cross over design; 3. Split-mouth design; * = Injection: a. Inferior alveolar block, b. palatal, c. buccal, d. palatal approach to anterior and middle superior alveolar nerves, e. anterior superior alveolar nerve, f. periodontal ligament injection g. maxillary infiltration, h. mandibular block.

Furthermore, it was found that children tended to react positively to both injection systems, possibly because the traditional injection was also administered at a slow speed (Ram & Peretz, 2003b).

The divergent results could be a consequence of the large age span used in some studies as this causes difficulty in choosing instruments that are valid for the total age group. Moreover, the behavioural pain response of the children can be difficult to assess in older children because their behaviour is influenced by self- or social control (Hadjistavropoulos & Craig, 2002). It is reasonable to expect a change in the pain response by changing aspects of the painful stimulus. The use of the Wand® includes changing the duration, intensity and location of the pain stimulus.

The purpose of the present study was to compare the pain response of children who received local anaesthesia with a traditional syringe injection and a computerized device (Wand®), and to study the possible influence of several child characteristics -gender, age, and level of dental anxiety- on the pain response.

Material and methods

Participants

Following a power calculation (power .80, alpha .05, medium effect size on the Venham distress scale) (Cohen, 1988) a sample size of 63 subjects per injection method was found to be necessary. Therefore, this study was conducted among 125 children (57 girls) aged 4-11 yr (mean age 6.2 yr, SD 1.6). Children were selected as a convenience sample of patients treated by two pediatric dentists in a specialist clinic. The reasons why the children were referred to the specialist dentist were heterogeneous. Most of the group was referred because of behaviour management problems. Other reasons included extensive caries, young age, or their usual dentists being uncomfortable treating children. The selection criteria included: need for treatment requiring local anaesthesia and age between 4 and 11 yr; fluent in Dutch; and no suspected or known developmental delay. All children who visited the specialist clinic in a period of 4 months were included in the randomization process. In this study only children recently referred were included (N=130), which also explains the difference in group size (Table 2). Five children had to be excluded afterwards; two because they were too old, one because of technical difficulties with the video recorder, and two because the dentist did not adhere to the randomisation protocol.

Ethical approval was obtained from the University Ethics Committee and the

Interuniversity Dentistry Research School (IOT) at the Academic Centre of Dentistry Amsterdam. Written parental consent was obtained by the researchers before every individual treatment. The authors have no connection with the manufacturers of the Wand®.

Methods

All treatments were videotaped and analyzed by two independent observers: a psychologist and a third year dental student. Both observers were extensively trained using video recordings of patients who were not included in the study.

Each child was randomly assigned to either the Wand® or the traditional injection condition based on a randomisation list generated by SPSS (SPSS, 11.0: Chicago, IL, USA). The randomization was checked for age, gender, dental anxiety and previous experience with local anaesthesia. To avoid possible preference of the dentists, they were required to decide on the tooth to be treated before the anaesthetic condition was told. As all children had been referred only recently the dentist could easily explain the anaesthesia procedure similarly for both techniques, and the dentists announced local anaesthesia as a special child-injection. Wand® injections for maxillary teeth used one of two insertion sites - anterior middle superior alveolar injection (AMSA, n=9) or palatal anterior superior alveolar injection (PASA, n=28) - and in the lower jaw the periodontal ligament (PDL, n=25) was used. Traditional anaesthesia was performed after topical anaesthetic had been placed in the area of the injection site for 60 s. For maxillary teeth, buccal (n=27) and palatal (n=5) injection sites were used, whereas in the mandible only the mandibular block (n=26) anaesthesia was given.

Measurements

Pain-related behaviour: Five different pain-related behaviours were recorded as being present or absent during each 15 s interval of the injection phase: 1. body movement, movement of more than 15 cm of an extremity or turning of the body; 2. muscle tension, clear tension in the hands (white knuckles) or tension of the body; 3. crying or screaming; 4. verbal protest; and 5. bodily resistance, when it was needed to hold the child.

Distress: Because the behavioural response of children in dentistry is often a mixture of anxiety and pain, and because these two concepts are difficult to separate (Versloot et al., 2004a) it was decided to also assess distress behaviour. Distress behaviour can be defined as an occurrence of emotions felt or behaviour displayed during (dental) treatment which is caused by factors like pain, fear,

anxiety, and anticipatory or situational stress. The distress behaviour was measured using Venham's (modified) clinical rating of anxiety and cooperative behaviour. The scale consists of 6 points: 1) relaxed, 2) uneasy, 3) tense, 4) reluctant, 5) resistance, and 6) out of contact or untreatable. The scale has an established reliability and validity (Veerkamp et al., 1993; Venham et al., 1980).

Self-reported pain: The pain experience of the child was measured using a modified version of the visual analogue scale (VAS). The scale resembled a thermometer and consisted of 11 points on a scale of 0 (no pain) to 10 (worst pain possible). Six faces, expressing different levels of pain/distress, were presented parallel to the scale so that young children could point out the face matching their own level of pain/distress (Chapman & Kirby-Turner, 2002).

Dental anxiety: To assess the level of dental anxiety the parent was asked to complete the Dental Subscale of the Children's Fear Survey Schedule (CFSS-DS) on behalf of their child. As younger children are unable to complete the CFSS-DS on their own, and to enable comparisons between different age groups, it was decided to use the parent's version of the CFSS-DS. The CFSS-DS has been extensively validated and consists of 15 items, related to various aspects of dental treatment (e.g., how afraid is your child of: the noise of the dentist drilling or having somebody examines their mouth). Each item is scored on a 5-point scale, from 1 (not afraid at al) to 5 (very afraid). Total scores thus range from 15 to 75. Previous research has indicated scores below 32 as non-clinical. Children scoring in the non-clinical range are generally not or only a little fearful, and are expected not to cause problems during treatment. Of the Dutch child population 14% suffers from some degree of dental fear, as evidenced by CFSS-DS scores of >32 (ten Berge et al., 2002b).

Procedure

Each treatment session was videotaped from the moment the child entered the treatment room until the end of the local anaesthesia. The period from entering the room until the start of the local anaesthesia (when the needle touched the mouth) was designated the anticipation phase. The period from the start until the end of the local anaesthesia (the needle leaving the mouth) was divided into 15-s intervals. For each interval the observers coded the occurrence of the five pain-related behaviours and gave an overall distress score on the Venham scale. After the dental injection, when the child was calm (e.g., after a sip of water), the dentist presented the modified VAS to the child and read aloud the standardized instructions. Then, the child was asked to point out his or her level of pain on the scale. While the

child was being treated the parents filled out the CFSS-DS. As part of the routine in the dental clinic parents were not present during treatment.

Observer's evaluation

A reliability exercise was performed using 20 cases from a training-video. Results showed good agreement between two observers (intraclass correlations: 0.87 for the Venham scale and 0.93 for pain-related behaviours). The videotapes from the study were evaluated by both observers independently and in the event of disagreement a final rating was reached by joint decision.

Statistical Analysis

Distress scores on the Venham rating scale for the anticipation phase, and for the first and the second interval, were analyzed using a multivariate general linear model (GLM) (no covariates). Self-reported pain (VAS) was compared across the two groups using the t-test for independent samples. The different pain-related behaviours were compared across the two groups using the Pearson chi-square test. Only the first 30-s could be compared because after 45-s the number of subjects anaesthetized using the traditional system was too small for analysis.

Results

First, no difference was found between the two experimental groups regarding age, gender, mean level of dental anxiety and children's experience with local anaesthesia injections (Table 2). Furthermore, no differences were found between the two dentists on the variables mentioned above.

Table 2. Basic characteristics of the study population.

	Injection method	
	Traditional n=58	Wand n=67
Age (yr)	6.0 (4-10.5)	6.4 (4-11.0)
Gender (girls)	31 (53%)	26 (39%)
Mean score CFSS-DS (min-max)	30.7 (16-49)	32.7 (15-57)
Local anaesthesia in past 6 months	20 (37%)	23 (38%)

The Wand® injection was found to take an average of 152.5 s (SD 40.6), whereas the traditional injection took an average of 33.9 s (SD 20.0). No differences were found relating to the distress response and the self-reported pain of the children between the different injection techniques for the Wand® (the

AMSA, PASA or PDL) or for the traditional injection techniques (buccal, palatal or mandibular). Therefore, the injection site is not included as a variable in the statistical analysis.

Pain-related behaviour

During the anticipation phase, no significant differences were found within the pain-related behaviours for the Wand® and the traditional injection, although the pain-related behaviours tended to occur less often before an injection using the Wand®. During the first 15-s interval of the injection, children in the Wand® group showed less body movement, muscle tension, and verbal protest than children in the traditional-injection group. During the second 15-s interval of the injection, children injected using the Wand® still showed less muscle tension and less verbal protest. (Table 3).

Table 3. Frequency of pain-related behaviours during the anticipation phase, and the first and second injection interval.

	N	Muscle tension (%)	Cry/scream (%)	Verbal protest (%)	Body movement (%)	Resistance (%)
Anticipation						
Traditional	58	62	19	10	24	9
Wand	67	49	13	8	12	5
First interval						
Traditional	58	91**	50	26*	35**	14
Wand	67	72**	33	12*	13**	8
Second interval						
Traditional	42‡	93*	45	12*	17	14
Wand	67	73*	37	2*	18	8

*significant difference between the two groups, chi2 test, $p<0.05$.

‡16 traditional injections finished during the second 15s interval and are therefore not included in the analysis.

Distress

Less distress was displayed during the first two intervals of the injection phase when injected using the Wand® than when injected in the traditional way although this difference did not reach significance (Multivariate GLM, $F(3,105)=1.29$, $p=0.283$; first 15-s interval: mean 1.09 versus 1.48; second 15-s interval: mean 1.09 versus 1.52) (Table 4).

Table 4. Mean Venham distress scores and 95% confidence intervals for the Wand® and traditional injection.

	Injection method			
	Traditional n=42‡		Wand n=67	
Injection phase				
Anticipation	1.12	(0.78-1.46)	0.81	(0.54-1.08)
First 15s interval	1.48	(1.13-1.83)	1.09	(0.81-1.37)
Second 15s interval	1.52	(1.18-1.87)	1.09	(0.82-1.37)

‡16 traditional injections finished during the second 15s interval and are therefore not included in the analysis.

Self-reported pain

No difference was found for the self-reported pain of the children. The mean pain score was 4.40 (SD 3.22) for the Wand® injection and 3.76 (SD 3.57) for the children injected with the traditional method.

Gender

Girls were less likely to display muscle tension in the first two intervals when injected using the Wand® in comparison with the traditional injection (first: 65% versus 94% p=0.007; second: 69% versus 97% p=0.017). Boys showed verbal protest (10% versus 30%; p=0.035) and body movement (12% versus 37%; p=0.016) less frequently in the first interval and also less verbal protest in the second interval (0% versus 16%; p=0.009) when injected with the Wand®.

Dental anxiety

The mean dental anxiety score for the combined sample was 31.8 (SD 9.6). When the group was divided into low anxious (n=50) (scores below 32) and high anxious (n=49) children, the mean anxiety scores were 24.5 (SD 4.9) and 40.3 (SD 6.1), respectively. Significant differences were found between the low- and high-anxious groups regarding the pain-related behaviours. It was found that highly anxious children were significantly more likely to cry than low-anxious children during anticipation and the first two intervals of the injection (anticipation: 26% versus 5% p=0.002; first 15-s interval: 49% versus 31% p=0.047; second 15-s interval: 59% versus 22%, p=0.001). Furthermore, it was found that highly anxious children more frequently have muscle tension during anticipation (69% versus 41% p=0.003) and protest verbally during the first 15-s of the injection than low anxious

children (29% versus 14% p=0.041). Differences were also found regarding the Venham distress scores, as highly anxious children showed more distress during the anticipation phase and during the first two 15-s intervals of the injection (multivariate GLM, F(3,95)=3.39, p=0.021) (Table 5).

Table 5. Mean Distress score on the Venham scale for low and highly anxious children.

	Dental anxiety				
	Low n=50		High n=49		p
Injection phase					
Anticipation	0.66	(0.36-0.96)	1.10	(0.80-1.40)	0.043
First 15s interval	0.90	(0.60-1.21)	1.59	(1.28-1.90)	0.002
Second 15s interval	0.94	(0.64-1.24)	1.61	(1.31-1.92)	0.002

The results are expressed as mean value (95% Confidence interval).

Table 6. Frequency of pain-related behaviours during the anticipation phase, and the first and second injection interval among low anxious children.

	N	Muscle tension (%)	Cry/scream (%)	Verbal protest (%)	Body movement (%)	Resistance (%)
Anticipation						
Traditional	28	50	11	7	29**	4
Wand	31	32	0	0	3**	0
First Interval						
Traditional	28	93**	39	29**	32*	7
Wand	31	65**	23	0**	10*	7
Second interval						
Traditional	19 ‡	95*	26	21**	11	5
Wand	31	65*	19	0**	13	3

*significant difference between the two groups, chi2 test, p<0.05.

**significant difference between the two groups, chi2 test, p<0.01.

‡ 9 traditional injections finished during the second 15s interval and are therefore not included in the analysis.

Low-anxious children reacted more positively to the Wand® than to the traditional injection. During the anticipation phase low-anxious children displayed body movement less frequently when injected with the Wand® (29% versus 3%

p=0.007). During the first interval of the injection they displayed muscle tension (93% versus 65% p=0.009), body movement (32% versus 10%, p=0.032) and verbal protest (29% versus 0% p=0.001) less often, and in the second interval they displayed muscle tension (95% versus 65% p=0.015) and verbal protest (21% versus 0% p=0.008) less often when injected with the Wand® (Table 6).

The children in the Wand® group also had a lower Venham distress score in the anticipation phase and during the first two intervals (anticipation phase, mean 0.45 versus 1.00; first interval: mean 0.65 versus 1.32; second interval: mean 0.68 versus 1.37) (Table 7). However, multivariate analysis showed that this difference was not statistically significant (multivariate GLM: F(3,46)=2.13, p=0.110).

When the reaction of highly anxious children to the Wand® injection and the traditional injection was compared, no significant differences were found on the pain-related behaviours or the Venham distress scores.

Table 7. Mean Venham distress scores for the Wand® and traditional injection for low anxious children.

	Injection method			
	Traditional n=19‡		Wand n=31	
Injection phase				
Anticipation	1.00	(0.61-1.39)	0.45	(0.15-0.75)
First 15s interval	1.32	(0.87-1.76)	0.65	(0.30-1.00)
Second 15s interval	1.37	(0.91-1.83)	0.68	(0.32-1.04)

The results are expressed as mean value (95% Confidence interval).

‡ 9 traditional injections finished during the second 15s interval and are therefore not included in the analysis.

Discussion

The pain response of children receiving a local anaesthesia injection with the Wand® in comparison with the traditional method was more positive during the first 30 seconds, as they showed less body movement, less muscle tension and less verbal protest. Girls were found to show less muscle tension in response to a Wand® injection and boys showed less verbal protest and less body movement. In particular, low-anxious children seem to benefit from an injection with the Wand® system in comparison to an injection with the traditional syringe as demonstrated by less pain-related behaviour (such as muscle tension, body movement and verbal protest).

Highly anxious children did not seem to benefit from the use of the Wand®.

Their reactions to both injection systems were similar, probably because of a ceiling effect. It is generally found that anxious children have higher distress scores in response to an injection than low-anxious children, and they also display more crying, muscle tension and verbal protest. This group of children is already highly sensitive and distressed when entering the treatment room and it seems that the pain-related behaviour is not influenced by the type of injection method. In a study by Ram & Peretz (2003a) a trend was found for children who reacted negatively to one technique to react in the same way to the other. Further study seems necessary, as the relationship of the anxiety level with the anticipation to aversive stimuli is only partially explained. It seems that the Wand® primarily influences the response of low-anxious children as they experience the negative stimulus (injection) more consciously. The highly anxious children have been over stimulated much earlier in the process by situational factors and therefore they may not be able to experience the process in full consciousness. In order to positively change the anxiety threshold of these highly anxious children during the anticipatory part of the treatment, more treatment sessions are probably needed. It is possible that the use of the Wand® system in sequential visits may have a positive effect for highly anxious children, as the longer injection time of the Wand® system permits habituation.

No difference was found in self-reported pain of the children between the two conditions. One reason for this might be that the recording of self-reported pain in young children is not always reliable. In some 4-5-yr-old children the cognitive level is not yet sufficiently developed to understand the pain scale used in this study. However, analyzing only the self-reported pain of the older children did not change the results. Furthermore, although time was taken to calm the child during the study, it is possible that some children are still aroused from the injection at the moment the question is asked and therefore are too upset to be capable of rating their pain thus influencing the self-reported pain result.

Interesting differences were found in the behavioural reaction of boys and girls. It appears that the Wand® system reduces internalizing behaviour (such as muscle tension) in girls and externalizing behaviour (such as verbal protest and body movement) in boys. Reducing externalizing behaviour during treatment is of great importance because it often leads to behaviour management problems thereby complicating the treatment of these children. Behaviour management problems are the most important reasons why children are referred to the specialized pediatric dentist. A study by Ten Berge and colleagues (1999) indicated that children referred to a special dental care centre not only suffer from high dental fear but also have

problems in several other behavioural and emotional areas. These problems appear to be heterogeneous; they were found in several specific problem areas, both external and internal (ten Berge et al., 1999).

The injection time of the Wand® was much longer than that of the traditional method. Even so, time is saved because no additional time is needed for the setting of the local anaesthesia. However, children who are already reacting negatively to the injection are thus longer in distress with the Wand® system. On the other hand, the longer injection time of the Wand® system may facilitate fear habituation, whereas a shorter duration may actually sensitize an already mildly anxious patient by not allowing sufficient time for habituation. As a result of its longer injection time, the Wand® creates an opportunity for the dentist to teach a child to cope with the injection which may enhance the child's behaviour during a future local anaesthesia injection. Further research is needed to test this hypothesis.

In this study the injection method of the dentists, when using the traditional syringe, was left unchanged. However, injecting more slowly could have led to a different reaction of the children during the injection. It was also decided not to use a topical anaesthesia when injecting with the Wand®. Again, the reaction of the children could have been different when a topical was used. Furthermore, the results concerning the pain-related behaviours should be interpreted with caution. Taken all together the Wand® injection causes less pain-related behaviour. However, not all children seem to benefit equally from the use of the Wand® system. It seems that low anxious children have the most positive reaction which makes the Wand® a useful system in normal practice.

Chapter 9

Computerized anaesthesia delivery system versus traditional syringe: pain and pain-related behaviour in children on sequential dental visits

(Submitted)

Abstract

Objectives: Firstly, to clarify the pain and distress response of children receiving a local anaesthesia injection using a computerized device (Wand®) or a traditional syringe over two consecutive treatment sessions. Secondly, to study if dental anxiety was of influence as a co-variate.

Methods: 147 children aged 4-11 yr were randomly allocated to the Wand® or traditional injection condition. Parents completed the Dental Subscale of the Children's Fear Survey Schedule. Based on video recordings the occurrence of pain-related behaviours was registered and a score was given on the Venham distress scale, for each 15 seconds.

Results: The mean injection time with the Wand® was three times longer than with the traditional syringe. No difference in pain-related behaviour or distress level was found between children receiving a Wand® or a traditional injection. Furthermore, high anxiety children seem to report more pain , display more pain related behaviour and more distress in reaction to an injection than low anxiety children on the first treatment session. For the second treatment session, no difference was found.

Conclusion: No clear difference between an injection with the Wand® or the traditional syringe could be found in the behavioural pain response of children. Dental anxiety was found to be of influence on the response of referred children.

Introduction

Dental caries is a common problem in young children. Often, more than one tooth is affected and several treatment sessions are needed. Although use of anaesthetics can lead to a relatively painless dental procedure, the delivery of local anaesthetic solutions and the needle puncturing the mucosa can be uncomfortable. Besides pain and discomfort, an injection can also provoke anxiety, particularly in children. Research shows that about 14% of Dutch children between 4-11 yr are dentally anxious and the strongest fears are associated with injections (ten Berge et al., 2002; Locker et al., 1999). Fear and anxiety associated with dental injections can be a significant barrier to dental care. While patients' fears may be acquired through vicarious experiences and threatening information, direct experience is the most common source of dental fear (Milgrom et al., 1997).

Therefore there is a constant search to find more comfortable and pleasant means of producing local anaesthesia before starting the dental procedure. One of the systems developed to address the shortcomings of traditional dental syringes is the Wand® system. The Wand® device is a computer-automated injection system that provides a precise injection flow-rate, regardless of tissue resistance. The system claims to maintain a constant positive pressure on the flow of the anaesthetic solution. It is also claimed that when advanced slowly, the drops of solution anesthetize the tissue ahead of the needle, thereby yielding a virtually painless needle insertion (Mileston Scientific, 1998).

In previous studies with children, divergent results are found with the Wand®. A study found lower pain ratings for injections with the Wand® in comparison to injections with the traditional syringe (Klein et al., 2005; Palm et al., 2004) and Nusstein et al. (2000) reported lower pain ratings upon anaesthetic solution depositing using the Wand® system but similar pain ratings for needle insertion. In addition, there are also studies reporting no difference between the two injection methods, the Wand® system and the traditional syringe (Ram & Peretz, 2003b).

As said, often, more than one treatment session is necessary to treat all caries. Consequently, the child needs to undergo several local anaesthesia injections. When a painful stimulus is repeated over time there are different reaction-trends possible. Habituation may occur, which means that the child is getting accustomed to the stimulus and shows a lessened reaction over time. Another possibility is that the child is getting sensitized to the stimulus. In this case there is an increased reaction to pain over time and/or a reduced threshold for the reaction to painful stimuli. In addition, no differences between the initial and subsequent reaction to pain stimuli

and random reactions to repeated pain stimuli are also possible (von Baeyer et al., 2004).

In our earlier study we found that low anxiety children showed less pain-related behaviour when injected with the Wand® compared to the traditional syringe (Versloot et al., 2005a). No research is done so far to study the effect of the Wand® on the pain behaviour of children over sequential treatment sessions. Therefore, it is unknown if the reported positive effect of the Wand® for low anxiety children is also shown during a following local anaesthesia injection. In the same study it was suggested that high anxiety children may benefit from more treatment sessions with the Wand® as the longer injection time of the Wand® system permits habituation to occur. Therefore, in the present study, the pain and distress response of children receiving a local anaesthesia injection using a computerized device (Wand®) was compared with the response of children receiving an injection using a traditional syringe over two sequential treatment sessions. The level of dental anxiety was measured to see whether this was of influence on children's response.

Material and methods

Participants

This study was conducted among 147 children (71 girls) aged 4-11 yr (mean age 6.4 yr, SD 1.7). Children were selected as a convenience sample of patients treated by two pediatric dentists in a specialist clinic. Selection criteria included: need for two subsequent treatments requiring local anaesthesia, age between 4-11 yr and no suspected or known developmental delay. From 23 children, however, only there first treatment session could be included due to rescheduling of the second appointment. Furthermore, three children could not be included in the study because their parents did not give permission to videotape the treatment session and 2 because the parents did not have sufficient knowledge of the Dutch language to fill out the questionnaires.

Ethical approval was obtained from the University Ethics Committee and the Interuniversity Dentistry Research School (IOT) at the Academic Centre of Dentistry Amsterdam. Written parental consent was obtained by the researchers before every individual treatment. The authors have no connection with the manufacturers of the Wand®.

Methods

The methods and measurements used in the present study are similar to the ones used in our earlier study. Therefore the present material and methods section is concise (see Versloot et al., 2005a, for more information).

Each child was randomly assigned to either the Wand® or the traditional injection condition based on a randomisation list generated by SPSS (SPSS Inc, 12.0, Chicago, USA). The success of the randomization was checked for age, gender, dental anxiety and previous experience with local anaesthesia. To avoid possible preference of the dentists, they were required to decide on the tooth to be treated before the anaesthetic condition was revealed. For the Wand® injections one of three insertion sites were used after application of topical anaesthetic for 30 s: anterior middle superior alveolar injection (AMSA) or palatal anterior superior alveolar injection (PASA) and the periodontal ligament (PDL). Traditional anaesthesia was performed after topical anaesthetic had been placed in the area of the injection site for 30 s. For maxillary teeth, buccal or palatal injection sites were used, whereas in the mandible only the mandibular block anaesthesia was given.

All treatments were videotaped and analyzed by two independent observers: an advanced psychology student and an advanced dental student. Both observers were extensively trained using video-tapes not included in the study.

Measurements

Pain-related behaviour: Five different pain-related behaviours were recorded as present or absent during each 15 sec interval of the injection phase: 1. Body movement, movement of more than 15 cm of an extremity or turning of the body; 2. Muscle tension, clear tension in the hands (white knuckles) or tension of the body; 3. Crying or screaming; 4. Verbal protest; and 5. Bodily resistance, when it was needed to hold the child. The occurrence of the five behaviours are summed and divided over the number of intervals to calculate the mean number of behaviours per interval.

Distress: The behavioural response of children in dentistry is often a mixture of anxiety and pain, and because these two concepts are difficult to separate (Versloot et al., 2004a) it was decided to also assess distress behaviour. The distress behaviour was measured using Venham's (modified) clinical rating of anxiety and cooperative behaviour. The scale consists of 6 points: 1) relaxed, 2) uneasy, 3) tense, 4) reluctant, 5) resistance, and 6) out of contact or untreatable. The scale has an established reliability and validity (Veerkamp et al., 1993; Venham et al., 1980).

Self-reported pain: The pain experience of the child was measured using a modified version of the visual analogue scale (VAS). The scale resembled a thermometer and consisted of 11 points running from 0= no pain to 10= worst pain possible. Parallel to the scale were six faces presented, expressing different levels of pain/distress so young children could point out the face matching their own level of pain/distress (Chapman & Kirby-Turner, 2002).

Dental anxiety: To assess the level of dental anxiety the parent was asked to complete the Dental Subscale of the Children's Fear Survey Schedule CFSS-DS on behalf of their child. Since younger children are unable to complete the CFSS-DS on their own and to enable comparisons between different age groups, it was decided to use the parent's version of the CFSS-DS. The CFSS-DS has been extensively validated and consists of 15 items, related to various aspects of dental treatment e.g., "how afraid is your child of: the noise of the dentist drilling or having somebody examines your mouth". Each item can be scored on a 5-point scale 1) "not afraid at all"; to 5) "very afraid". Total scores thus range from 15-75. Previous research has indicated scores below 32 as non-clinical. Children scoring in the 'non-clinical range' are generally not or only little fearful, and are expected not to cause problems during treatment. Of the Dutch child population 14% suffers from some degree of dental fear, as evidenced by CFSS-DS scores above 32 (ten Berge et al., 2002b).

Procedure

Each treatment session was videotaped from the moment the child entered the treatment room till the end of the local anaesthesia. The period from entering the room until the start of the topical anaesthesia was designated as the anticipation phase. The period from the start of the topical anaesthesia until the start of the local anaesthesia (when the needle touched the gums) was designated as the topical phase and the period from the start until the end of the local anaesthesia (the needle leaving the mouth) was designated as the local anaesthesia phase. The anaesthesia phase was divided into 15-s intervals. For each interval the observers coded the occurrence of the 5 pain-related behaviours and gave an overall distress score on the Venham scale. After the dental injection, when the child was calm (e.g., after a sip of water), the dentist presented the modified VAS to the child and read aloud the standardized instructions. Next the child was asked to point out his or her level of pain on the scale. While the child was treated the parents filled out the CFSS-DS. As part of the routine in the dental clinic parents were not present during treatment.

A reliability analyses was done using 20 cases from a training-video. Results showed a good agreement between two observers (Interclass correlations: 0.98 Venham scale and 0.93 pain-related behaviours). The videotapes from the study were evaluated by both observers independently and in case of disagreement a final rating was reached by joint decision.

Statistical analysis

Independent t-tests (injection time, age, CFSS-DS score) and Chi2 tests (gender, experience with injection) were used for the randomization check. Differences between variables on a set of dependent variables were analyzed using a Multivariate Analysis of Covariance (MANCOVA), with dental anxiety as covariate followed by Univariate analysis.

Results

No difference was found regarding age, gender, dental anxiety level and dental experience with earlier anaesthesia injections, between the participants in the experimental (Wand®) and in the control group (traditional). The time needed for an injection with the Wand®, however, was on average three times longer (Mean 153.3 SD 33.7 seconds) than the time needed with the traditional syringe (Mean 47.8 SD 22.3 seconds) ($t(144)=-22.46$, $p<0.001$) (Table 1).

Table 1. Randomization check.

N=147	Injection time (sec)	Age years M (SD)	Boys	Total CFSS M (SD)	First dental injection
Traditional	47.8 (22.3)**	6.3 (1.7)	59% (n=45)	29.7 (11.5)	39% (n=29)
Wand®	135.7 (33.7)**	6.4 (1.6)	44% (n=31)	31.0 (11.0)	36% (n=25)

** Significant difference $P<0.01$.

As for the injection sites with the Wand® the dentist gave the highest pain score for the children receiving the PASA technique in comparison to the AMSA and the PDL ($F(2,66)=3.25$, $p=0.045$). No difference was found between the injection sites with the Wand® for the self-reported pain score and the mean Venham score. Between the injection sites with the traditional syringe the child rated the Mandibular injection as more painful than the buccal injection ($F(2,73)=3.32$, $p=0.042$). Furthermore the dentist rated both the palatal and mandibular injections as more painful for the children than the buccal injection

(F(2,73)=4.56, p=0.014). No difference was found between the injection sites with the traditional syringe for the mean Venham score (Table 2).

Table 2. Pain and mean Venham scores for the different injection sites on the first treatment session.

		Pain child	Pain dentist	Mean Venham score
	n	Mean (SD)	Mean (SD)	Mean (SD)
Wand®				
AMSA	3	2.67 (1.16)	0.75 (0.96)	1.83 (1.49)
PASA	8	4.75 (3.69)	2.89 (1.90)*	1.60 (0.91)
PDL	58	3.05 (3.26)	1.41 (1.71)	1.39 (1.00)
Traditional				
Buccal	31	1.84 (2.16)**	0.90 (1.11)***	1.28 (1.34)
Palatinal	4	2.50 (2.38)	3.00 (2.94)	0.83 (0.33)
Mandibular	41	3.66 (3.50)**	2.10 (2.23)	1.67 (1.29)

* Significantly higher than AMSA or PDL $p<0.05$; **significantly difference between buccal and mandibular injections; ***buccal injection significantly lower score than palatinal and mandibular.

Injection on the first treatment session

The mean CFSS-DS score was 30.33 (SD 11.24) and 38% (n=53) of the children had a CFSS-DS score above 32 which means these children suffer in some degree of dental anxiety. The mean CFSS-DS score for the low anxious children (LAC) 23.24 (SD 5.06) and for the highly anxious children (HAC) 41.77 (SD 9.14).

Looking at the individual pain-related behaviours, before treatment during the anticipation phase high anxiety children more often than low anxiety children cry (10% versus 1%), protest verbally (8% versus 1%) and move there arms and legs more often (65% versus 47%). During the first interval of the injection (0-15 s) high anxiety children more often cry (37% versus 14%) and move there arms and legs (33% versus 17%) and during the second interval the high anxiety children (15-30 s) cry more (38% versus 12%) and move more (24% versus 8%).

Differences between the independent variable (injection technique) on the multiple dependent variables from the first treatment session (mean Venham score, mean number of pain-related behaviours, self-reported pain) were tested using a MANCOVA. Results show no main effect of injection technique but did show a

main effect for level of dental anxiety, F(3,133)=6.11, p=0.001. Subsequent Univariate analysis shows that the high anxiety children had a higher score on all three dependent variables. These results indicate that high anxiety children had a higher mean Venham score, displayed more pain-related behaviour and reported more pain than low anxiety children (Table 3).

Table 3. Mean and standard deviation for the mean Venham scores, mean number of pain-related behaviours and self-reported pain during the first treatment session.

		N	Mean Venham	Mean behaviours	Pain child
Traditional		74	1.48 (1.24)	1.14 (1.27)	2.77 (3.00)
	LAC	50	1.37 (1.19)**	1.01 (1.14)**	2.46 (2.87)**
	HAC	24	1.71 (1.34)**	1.42 (1.47)**	3.42 (3.20)**
Wand®		66	1.38 (0.94)	1.03 (0.83)	3.269 (3.27)
	LAC	41	1.04 (0.60)**	0.78 (0.61)**	2.17 (2.37)**
	HAC	25	1.94 (1.13)**	1.44 (0.98)**	5.04 (3.79)**

LAC: low anxiety children; HAC: High anxiety children; **significant difference between LAC and HAC, p<0.001.

Injection on the second treatment session

Table 4. The mean Venham scores, mean number of pain-related behaviours and self-reported pain during the second treatment session.

	N	Venham Mean (SD)	behaviours Mean (SD)	Pain child Mean (SD)
Traditional	65	1.49 (1.16)	1.20 (1.19)	3.83 (3.32)
LAC	43	1.36 (1.02)	1.17 (1.14)	3.65 (3.34)
HAC	22	1.76 (1.40)	1.26 (1.31)	4.18 (3.40)
Wand®	55	1.31 (1.21)	0.89 (1.21)	3.49 (3.40)
LAC	35	1.15 (1.18)	0.75 (1.13)	3.06 (3.10)
HAC	20	1.61 (1.23)	1.15 (1.33)	4.25 (3.84)

LAC: low anxiety children; HAC: High anxiety children; *significant difference between LAC and HAC, p<0.05.

On the mean Venham score, the mean number of pain-related behaviours and

the self-reported pain during the second treatment session also a MANCOVA was done for the independent variables (injection technique) with anxiety as covariate. Results show no multivariate main effect for the two independent variables on the dependent variables and no significant covariate (Table 4).

Differences between the independent variables (injection technique) on the multiple dependent variables during the anticipation phase from the second treatment session (Venham score and mean number of behaviours) were tested using a MANCOVA. Results show no multivariate main effects. Univariate analysis shows, however, that the high anxiety children had a higher Venham score during the anticipation phase than low anxiety children, $F(1,118)=5.23$, $p=0.024$ (Table 5).

Table 5. Mean and standard deviation for the Venham scores and mean number of behaviours during the anticipation phase of the second treatment session.

	N	Venham score Mean (SD)	Mean behaviour Mean (SD)
Traditional	66	0.92 (0.90)	0.86 (0.65)
LAC	43	0.79 (0.68)*	0.81 (0.63)
HAC	23	1.17 (1.19)*	0.96 (0.71)
Wand®	55	1.05 (1.19)	0.91 (1.02)
LAC	32	0.84(0.99)*	0.75 (0.98)
HAC	23	1.35 (1.40)*	1.13 (1.06)

LAC: low anxiety children; HAC: High anxiety children; *significant difference between LAC and HAC, $p<0.05$.

In addition, looking at the individual pain-related behaviours, during the anticipation phase of the second treatment session high anxiety children cry (17% versus 5%) and protest verbally (12% versus 3%) more often than low anxiety children. and move there arms and legs more often (65% versus 47%).

Sequential dental visits

Repeated measures for mean Venham score, mean number of pain-related behaviours and self-reported pain over the first and second treatment session shows for the independent variables (injection technique) and level of anxiety as covariate shows only a significant effect for the covariate. low anxiety children had a significant increase in their pain report from the first (mean 2.19 SD 2.50) to the second (mean 3.43 SD 3.27) injection ($F(1,120)=5.26$, $p=0.024$. Furthermore, no

significant effects were found. The pain scores from the high anxiety children, however, are higher during both treatment sessions than the scores from low anxiety children (Table 3 and 4).

Discussion

During the first treatment session no clear difference was found between the pain report and distress reaction of children to an injection with the Wand® or the traditional technique. The results of the current study could not replicate the finding of our previous research that is when treated by experienced pediatric dentists, low anxiety children displayed less pain-related behaviours and distress during an injection with a computerized device (Wand®) than during an injection with the traditional syringe on the first treatment session. Furthermore, on the second treatment session and over the two sequential sessions, no specific effect of the injection technique could be identified.

The level of dental anxiety did have an effect. On the first treatment session high anxiety children reported more pain and displayed more distress behaviour than low anxiety children. On the second treatment session high anxiety children, displayed more distress before and during the injection than low anxiety children. The reaction of low anxiety children suggests that they are able to cope well with a long but mild pain stimulus. In contrast, the reaction of high anxiety children suggests that they lack sufficient coping strategies and perhaps have a lower tolerance for pain resulting in more crying, movement and verbal protest. This might suggest that high anxiety children seem to be sensitized before being exposed to the actual treatment. Perhaps, more treatment sessions are necessary in order to habituate high anxiety children to a mild pain stimulus or more specific techniques are needed like teaching children how to cope with dental injections.

Furthermore, low anxiety children tend to report more pain after the second injection. This could mean that these children get sensitized on the first treatment session and therefore report more pain during a second injection. An other alternative could be that the increase is a result from a bottom effect, whereas the levels of pain and distress found in response to the local anaesthesia injections in this study are relatively low. The dentists participating in this study are specialised pediatric dentists with many years of experience in delivering local anaesthesia injections they seem to be able to do a good job with both techniques. Furthermore topical anaesthesia was used before all injections and the traditional injection was given super slowly supporting the idea that injecting slowly is an imported technique for delivering a comfortable injection.

The injection time of the Wand® was much longer than that of the traditional method so, children who are already reacting negatively to an injection are longer in distress with the Wand® system. Time is claimed to be saved, however, because it seems that no additional time is needed for the setting of the local anaesthesia with the Wand®.

Some limitation of the present study must be taken into account. First of all, this study is done with a referred population with a relatively large proportion of dentally anxious children, therefore, caution must be taken when generalizing the results. Furthermore, additional studies seem necessary to get an insight into the response pattern of children on sequential dental visits.

To conclude, the current study could not clarify the divergent results found in former studies with the Wand®. It does appear that the dentist's experience is of stronger influence on the delivery of a social anaesthesia injection than assumed. Besides, it does seem that the level of dental anxiety is of greater influence on children's reaction than the injection technique. Therefore, it is of great importance to the dentist to know the level of dental anxiety of the patient in order to help them tailor their treatment to the needs of their paediatric patients.

Chapter 10

Children's self-reported pain at the dentist

(Submitted)

Abstract

Objectives: This study describes children's self-reported pain to a local anaesthesia injection over two sequential dental visits. Furthermore, the possible influence of age, level of dental anxiety, previous experience and injection site is examined.

Methods: One hundred and forty seven children (4-11 years old) were included in the study. After receiving a local anaesthesia injection prior to their dental treatment, they were asked how much pain they had felt. The level of dental anxiety was measured by the parental version of the Dental Subscale of the Children's Fear Survey Schedule.

Results: Young children who are high anxiety or those having an injection in the lower jaw reported the most pain on the first treatment session. For the older children, the children having previous experience with a dental injection gave the highest pain ratings on the first treatment session. Furthermore, for both young and older children the amount of pain reported for the second injection was best predicted by the amount of pain reported for the first injection and for the young children the amount of pain was also predicted by the injection site of the first injection.

Conclusions: It appears that the most vulnerable children, that is, the high anxiety or young children are at risk to get sensitised by previous treatment sessions resulting in a higher pain report.

Introduction

Acute pain is a highly complex and subjective experience that is useful to children to warn them of danger. The pain experience of children during aversive medical procedures is related to personal or procedural factors such as: age and anxiety of the child or intensity or duration of the procedure. Conditioning paradigms can be applied to aversive medical procedures. For instance in case of local anaesthesia injection, the needle insertion may serve as an unconditional stimulus (UCS), eliciting the unconditional response (UCR) of procedural distress (e.g., facial expressions, crying or screaming). Over time (repeated procedures), other cues present at the time of the procedure (e.g., the dentist, the treatment room) serve as conditional stimuli (CS) that become associated with the UCS and elicit the conditional response (CR) of anticipatory distress. The CR is also influenced by the cognitions and memory of the child on their experience with the painful UCS. If a child has experienced a painful procedure, the memory of that event may cause anxiety about subsequent procedures. This anticipated anxiety might influence the degree of pain the child feels during those later procedures (Weisman et al., 1998).

A study by Chen and colleagues (2000) on children's memory for painful cancer treatment procedures found a strong association between memory and pain/distress during subsequent treatment. It was found that older children had a more accurate memory for details of their lumbar puncture than younger children. Furthermore the study showed children who displayed greater distress at the first lumbar puncture remembered fewer details of it one week later. It was found that greater exaggeration in children's memories of anxiety and pain over the previous lumbar puncture was associated with higher distress during the subsequent lumbar puncture. This finding is in line with previous findings that high anxiety subjects tended to over predict their experienced pain and anxiety during treatment. As a result they expect more pain and feel more anxious during subsequent treatment (van Wijk, 2006; Arntz et al., 1990).

The order in which one experiences a sequence of events can also have a profound influence on how such events are remembered. A laboratory study using the cold pressure model with adults and children found lower pain reports when experimental pain was experienced in a improving sequence (from high to low pain) rather that in a worsening sequence (from low to high pain) (Kaakko et al., 2003). In clinical practice there is not always a choice in the sequence of painful treatments. Also not everybody experiences the same amount of pain during

comparable procedures. This makes the prediction of the amount of pain during a certain procedure very speculative.

Another demonstration of the role of memory and conditioning for pain is provided in a study by Weisman and colleagues (1998) they found that inadequate analgesia for initial procedures in young children (8 years or younger) may diminish the effect of adequate analgesia in subsequent procedures. It was found that when children experience pain, due to inadequate analgesia, during the first treatment session they had an increased change of reporting pain during subsequent sessions even though they got sufficient analgesia in the subsequent sessions which should exclude pain.

When a painful stimulus is repeated over time there are different reaction-trends possible. Habituation may occur, which means the child is getting accustomed to the stimulus and shows a lessened reaction over time. This is likely to occur with milder pain stimuli and with more mature persons who can cope better with events. Another alternative is getting sensitised to the stimulus. In this case there is an increased reaction to pain over time and/or a reduced threshold for reaction to painful stimuli. When sensitisation occurs the child is likely to show a lower tolerance for pain, greater emotional distress, and greater avoidance of further painful stimulation. It would be reasonable to speculate that a sensitizing reaction is more likely to occur in younger children, in whom the initial pain is more severe and less well understood by the child, an in whom resources to modulate or cope with the pain are less developed. Furthermore no differences in reaction or random reactions are also possible (von Baeyer et al., 2004).

The aim of the present study is to get an insight into the pain report of children to sequential dental visits. Therefore, the pain report of children for the local anaesthesia injection is assessed at both visits. Furthermore, the effect of age, level of dental anxiety and the injection site will be analysed.

Materials and Methods

Participants

This study was conducted among 147 children (47% girls) aged 4-11 yr (mean age 6.4 SD 1.7). Children were selected, for a study on injection techniques, as a convenience sample of patients treated by two pediatric dentists in a special dental care clinic. The reasons children were referred to the specialist dentist are heterogeneous. Most of the group was referred because of behaviour management problems. Other reasons were extensive caries, young age, or their general dentists

being uncomfortable treating children. Selection criteria included: need for two restorative treatment sessions requiring local anaesthesia and age between 4-11 yr. Ethical approval was obtained from the University Ethics Committee and the Interuniversity Dentistry Research School (IOT) at the Academic Centre of Dentistry Amsterdam. Written parental consent was obtained by the researchers before every individual treatment.

Measurements

Self-reported pain: The pain experience of the child was measured using a modified version of the visual analogue scale (VAS). The scale resembled a thermometer and consisted of 11 points running from 0= no pain to 10= worst pain possible. Parallel to the scale were six faces presented, expressing different levels of pain/distress so young children could point out the face matching their own level of pain/distress (Chapman et al., 2002).

Dental anxiety: To assess the level of dental anxiety the parent was asked to complete the Dental Subscale of the Children's Fear Survey Schedule CFSS-DS on behalf of their child. Since younger children are unable to complete the CFSS-DS on their own and to enable comparisons between different age groups, it was decided to use the parent's version of the CFSS-DS. The CFSS-DS has been extensively validated and consists of 15 items, related to various aspects of dental treatment e.g., "how afraid is your child of: the noise of the dentist drilling or having somebody examines your mouth". Each item can be scored on a 5-point scale 1) "not afraid at all"; to 5) "very afraid". Total scores thus range from 15-75. Previous research has indicated scores below 32 as non-clinical. Children scoring in the 'non-clinical range' are generally not or only little fearful, and are expected not to cause problems during treatment. Of the Dutch child population 14% suffers from some degree of dental fear, as evidenced by CFSS-DS scores above 32 (ten Berge et al., 2002b).

Procedure

Al dental injections were given after application of topical anaesthesia for 30 seconds. After the dental injection was given and when the child was calm (e.g., after a sip of water), the dentist presented the modified VAS to the child and read aloud the standardized instructions. Subsequently the child was asked to point out his or her level of pain on the scale. While the child was treated the parents filled out the CFSS-DS. As part of the routine in the dental clinic parents were not present during treatment.

Statistical analysis

Because an age-effect was expected the study population was split in pre-school children under 6 years of age (n=71, mean age 5.0 SD 0.5) and school children 6 years and older (n=77, mean age 7.6 SD 1.3). With independent t-tests the difference in pain report for young and older children was analyzed. Furthermore, binary logistic regression analyses were used to determine which variables predict the presence or absence of pain felt during the dental injection given on the first and second treatment session. Therefore, the reported pain variable was split into two levels: score 0-2 "no pain" and score 3-10 "pain". Finally, a linear regression was done to analyze which of the variables from the first treatment session were predictors for the amount of pain reported the second time.

Results

First injection

Table 1.Young children's mean pain scores and standard deviations, divided by: anxiety level, injection site and experience with local anaesthesia injection.

	Young children under 6 years of age					
	First treatment			Second treatment		
	N	Mean	SD	N	Mean	SD
Pain scores child						
Total	70	3.34	3.58	65	4.32	3.66
Pain score 0-2	44	0.95	1.01	32	1.09	1.00
Pain score 3-10	26	7.38	2.56	33	7.35	2.33
Anxiety level						
Low	42	2.33**	2.86	4	4.29	3.56
High	25	5.04**	4.08	22	4.41	3.74
Injection site						
Upper jaw	29	2.17*	2.88	32	4.56	3.73
Lower jaw	41	4.17*	3.82	33	3.97	3.56
Experience with LA						
Yes	40	3.70	3.80		n/a	
No	29	2.97	3.28		n/a	

*p<0.02, **p<0.01, Significant difference between the two groups for the first treatment.
n/a: Not applicable.

Young children reported a similar mean pain score 3.34 (SD 3.58), as older children 2.78 (SD 2.69), for the local anaesthesia injection during the first treatment session. Differences in reported pain between highly and low anxiety children, children with injection in the upper or lower jaw, and children with or without previous experience with dental injections were compared for young children and older children. The analysis for young children showed high anxiety children gave a higher pain score 5.04 (SD 4.08) than low anxiety children 2.33 (SD 2.86), ($T(65)=-3.19$, $p=0.002$) and young children injected in the lower jaw gave a higher pain score 4.17 (SD 3.82), than young children injected in the upper jaw 2.17 (SD 2.88), ($T(68)=-2.49$, $p=0.015$). No difference was found for children with or without previous experience with a dental injection (Table 1).

The analysis for older children showed children with previous experience with a dental injection gave a higher pain score 3.08 (SD 2.84), than children without previous experience 1.96 (SD 1.93), ($T(72)=2.01$, $p=0.049$). Besides, no difference was found in the reported pain between highly or low anxiety children or injections in the upper or lower jaw (Table 2).

Table 2. Older children's mean pain scores and standard deviations, divided by: anxiety level, injection site and experience with local anaesthesia injection.

	Children 6 years or older					
	First treatment			Second treatment		
	N	Mean	SD	N	Mean	SD
Pain scores child						
Total	77	2.78	2.69	62	3.06	2.89
Pain score 0-2	49	1.10	0.96	35	0.97	0.92
Pain score 3-10	28	5.71	2.18	26	5.92	2.13
Anxiety level						
Low	50	2.36	2.46	40	2.55*	2.57
High	24	3.42	2.81	20	4.10*	3.30
Injection site						
Upper jaw	39	2.59	2.64	32	3.13	3.19
Lower jaw	38	2.97	2.77	29	3.03	2.63
Experience with LA						
Yes	49	3.08**	2.84		n/a	
No	25	1.96**	1.92		n/a	

*$p=0.048$, **$p<0.05$, Significant difference between the two groups for the first treatment.
n/a: Not applicable.

To analyze which variables were significant predictors for the pain reported on the first injection a binary logistic regression was done with reported pain (no pain, score 0-2; pain, score 3-10) as dependent variable and level of dental anxiety, injection site and experience with a dental injection as predictor variables. Results for the young children showed level of dental anxiety and injection site to be significant predictors and together the three predictor variables explained 30% of the variance in the pain variable. The odds ratio's showed that high anxiety children had an almost eight times higher change than low anxiety children to report pain during a dental injection and children injected in the lower jaw had a four times higher change to report pain than children injected in the upper jaw (Table 3).

Results for the older children showed that experience with dental injections was the only significant predictor. Together, all three predictor variables explained 16% of the variance in the pain variable. The odds ratio's showed that children who had previous experience with dental injection had an almost four times higher change than children without experience to report pain during a dental injection (Table 3).

Table 3. Predictors of pain reported during the first dental injection.

	Young children				Older children			
	OR	CI: 95%	Wald	p	OR	CI: 95%	Wald	p
High anxiety level	7.84	(2.32-26.43)	11.01	.001	2.37	(0.83-6.82)	2.57	ns
Injection in lower jaw	3.72	(1.07-12.97)	4.27	.039	1.86	(0.66-5.21)	2.57	ns
Experience with previous injection	0.94	(0.29-3.05)	0.01	ns	3.86	(1.17-12-70)	4.94	.026
All three predictors	R^2= 0.30				R^2=0.16			

OR: odds ratio; *significant at p<0.05. CI: 95% confidence interval; ns: not significant.

Second injection

Young children reported a higher mean pain score 4.32 (SD 3.66), than older children 3.06 (SD 2.89), for the local anaesthesia injection during the second treatment session (T(125)=2.15, p=0.034). Within the young children no difference in mean pain score was found between highly and low anxiety children or children injected in the upper or lower jaw. Since all children now had experience with dental injections this variable is left out. Within the older children high anxiety

children had a higher mean pain score 4.10 (SD 3.30), than low anxiety children 2.54 (SD 2.54), (T(60)=-2.06, p=0.044). The Levene's test for equality of Variances, however, showed a difference in variance between the two groups. When corrected for this, the difference between highly and low anxiety children turned out not to be statistically significant (p=0.067). Further, no difference was found between children injected in the upper or lower jaw.

To analyze which variables were significant predictors for the pain reported on the second injection a binary logistic regression analysis was done with pain/no pain as dependent variable and level of dental anxiety and injection site as predictor variables. For both young and older children none of the predictors were found to be significant predictors.

First and Second injection

To analyze which variables from the first treatment session were significant predictors for the pain reported on the second injection a linear regression analysis was done with reported pain for the second injection as dependent variable and level of dental anxiety (total CFSS-DS score), injection site of the first injection and reported pain for the first injection as predictor variables. The stepwise analysis showed for young children the injection site of the first injection and the reported pain for the first injection contributed significantly to the prediction of pain report for the second injection and together these predictors explained 29% of the variance (Table 4).

The stepwise analysis for the older children showed only reported pain for the first injection to contribute significantly to the prediction of pain reported for the second injection, alone this predictor explained 36% of the variance (Table 4).

Table 4. Significant predictors for pain during second local anaesthesia injection.

	R^{2}*	Beta	T	P
Predictors for young children				
Pain reported for the first injection	0.23	.479	4.26	<.001
Injection site	0.29	.246	2.20	.031
Predictor for older children				
Pain reported for the first injection	0.36	.601	5.77	<.001

* R^2: after inclusion of this variable.

Finally, a repeated measure analysis on the self-reported pain for the first and second dental injection with level of dental anxiety as between subject factor was done for both young and older children. The analysis for the young children showed an interaction effect between reported pain and level of dental anxiety. Low anxiety children were found to report more pain the second time than the first time whereas high anxiety children did not differ in there pain report between the first and second injection ($F(1,61)=76.90$, $p=0.011$) (Table 1). For older children no main or interaction effect was found.

Discussion

Young children who are high anxiety or those having an injection in the lower jaw reported the most pain on the first treatment session. For the older children, the children having previous experience with a dental injection gave the highest pain ratings on the first treatment session. Furthermore, for both young and older children the amount of pain reported for the second injection was best predicted by the amount of pain reported for the first injection and for the young children the amount of pain was also predicted by the injection site of the first injection.

The results seem to be related to a number of theories mainly form the learning and conditioning pathways. The level of dental anxiety seems to influence the level of reported pain over a local anaesthesia injection. High anxiety children seem to be sensitized before their exposure to the actual treatment. Possibly these children heard aversive stories on dental treatment or had a negative dental experience themselves which resulted in an increased anticipation anxiety (Rachman, 1977). Low anxiety young children seem to be sensitized during the first treatment session whereas these children show an increased pain report for the second local anaesthesia injection. Taken together it appears both young and anxious children do not yet have developed sufficient coping strategies to deal with an aversive stimulus like a dental injection. Another explanation could be that these children over-predict the experienced pain and as a result expect more pain and feel more anxiety during subsequent treatment session. Perhaps high anxiety and young children need more treatment session or need to learn different coping strategies before getting used to a local anaesthesia injection and habituation occurs.

This study also found that previous experience with a dental injection can be of negative influence on the subsequent treatment sessions. It could well be this were negative previous experiences and these children might expect their next experience to be similarly negative. The conditioning theory could be applied to the results found, in which case the previous neutral experience of a child serves as an

unconditioned stimulus that was combined with other cues present, such as the dentist or the needle creating the conditioned stimulus. When a child has to go to the dentist again, although a different one, these conditioned stimuli elicit the same response as before thereby perhaps creating anticipation anxiety and subsequently increasing the pain felt by the child.

The conditioning theory can also apply to the finding that the reported pain on the second treatment session is best predicted by the reported pain on the first treatment session. Especially when the circumstances that serve as the conditioned stimulus are similar both times. This mechanism is reinforced by the results found in this study: not the injection site from the second injection but the injection site from the first injection predicts the amount of pain reported for the second injection.

It is important to recognize the limitation of the study, i.e., the current study population consists of referred children and a relative large proportion suffer in some degree from dental anxiety which must be taken into account when generalising the results to an other population.

More studies seem needed to study the effect of sequential visits in dentistry. Especially since each dental treatment is very unique and there are great differences between them. Perhaps limiting the variability within the treatment like taking one injection site and only taking conservative treatment could give more insight into the reaction trend of children in dentistry. Additionally, it could be of interest to study the effect of interventions like giving preparatory information or distraction to the children at risk for sensitization.

In conclusion, the memory of previous experience with dentistry and earlier treatment seems of great influence on the behaviour and the experience during subsequent treatment sessions. It appears the most vulnerable children, that is, the high anxiety or young children are at risk to get sensitised by previous treatment sessions resulting in a higher pain report. It is of great importance for the interventions used by the dentist during treatment to know the characteristics of a child. And, furthermore, although the self-reported pain is not always a reliable measurement of the amount of pain felt by the children it does give a good indication of the child's experienced. For this reason it is always valuable to ask the child about his or her experience.

Chapter 11

Children's coping with pain during dental care

Versloot J, Veerkamp JSJ, Hoogstraten J., Martens L.C. Children's coping with pain during dental care. Community Dentistry and Oral Epidemiology 2004;32:456-61.

Abstract

Objectives: The purpose of this study was 1) to assess the coping strategies of 11-year-old children when dealing with pain at the dentist, 2) to determine the extent to which the level of the children's dental fear and their experience with pain at the dentist, are related to their ability to cope and their choice of strategies, and 3) to analyze the possible differences between subsamples concerning dental caries.
Methods: The coping strategies were investigated using the Dental Cope Questionnaire (N=597); the level of dental fear was assessed using the Children's Fear Survey Schedule (CFSS–DS); a question is asked whether a child had experienced pain at the dentist in the past and dental caries was assessed using the DMFS index.
Results: The results show that 11-year-olds use a variety of coping strategies. Internal strategies are used most frequently, external coping strategies are used less frequently, and destructive strategies are hardly used. The subjects rate internal and external strategies as effective. Children with pain experience and fearful children use more coping strategies, with fearful children using more internal strategies. Reported pain and anxiety were related to the dental status.
Conclusions: The use and choice of coping strategies seems to be at least partly determined by the level of dental fear and the child's experience with pain.

Introduction

Many children find dental visits to be stressful, partly because several aspects of dental treatment remind them of earlier dental or medical treatments that had been uncomfortable or painful. This can result in a variety of anxiety reactions (Venham et al., 1977). Rachman (1977) proposed a model in which he described three pathways of fear acquisition: directly through classical conditioning, and indirectly via modelling or transmission of negative information. So far, no support for a simple, straightforward cause-and-effect conditioning relation has been found. One reason may be that the conditioning pathway is mediated by aversion towards the stimuli and by the children's ability to cope, which in turn may be influenced by other factors. A child's ability to cope does indeed seem to, at least partly, determine the emotional nature of a dental visit (ten Berge et al., 2001).

Two main coping strategies can be identified for dealing with stressors: behavioural and cognitive. Behavioural coping efforts are overt physical or verbal activities that may be quite apparent to the dentist, such as keeping one's mouth shut or trying to get out of the dental chair. Cognitive coping efforts involve the manipulations of one's thoughts or emotions, such as when a child thinks of reassuring thoughts. These efforts tend to be silent or covert and may not be readily apparent to the dentist (Curry et al., 1988).

A child's ability to use various coping strategies is influenced by many factors (e.g., age, training, cognitive development, and parental support). The strategies young children (4-7 years) use at the dentist are generally behaviour orientated. Children in the middle age group (8-10 years) start to supplement, but not replace, behavioural strategies with an increasing repertoire of cognitive strategies. Older children (11-18 years) tend to use more cognitively orientated strategies and demonstrate more self-control when dealing with a stressor (Branson & Craig, 1988). Because older children may have a more extensive coping repertoire than younger children, they may have a greater ability to deal with stressful events (Hodgins & Lander, 1997). Cognitive coping efforts, although silent and often unnoticed, may play a major role in the child's ability to deal successfully with dental treatment, and to generate a lasting positive impression of the dental experience. An awareness and understanding of these processes could enable dentists to stimulate children's use of coping responses, thereby creating a more positive treatment situation.

Research on children's coping with pain is limited. Consequently, little is known about the strategies children are able to use spontaneously in attempting to adjust

either the pain-producing situation or their own experience of pain. Not much is known about the relation between a child's level of dental fear and its coping style. One study assessing differences between exhibited active or passive coping behaviours and reported medical fear levels found no significant difference (Broome et al., 1990).

The aim of the present study was threefold. First, to investigate the coping strategies which the 11-year-old children use when they are in pain at the dentist and how they judge their effectiveness. Second: To study the extent to which the level of children's dental fear and their experience with pain at the dentist, relates to their ability to cope and their choice of coping strategies. Third: to analyze the possible differences between subsamples of children with different levels of dental caries, expressed by DMFS index.

Materials and methods

Participants

For this study, 597 Flemish primary schoolchildren (55% boys) were involved. Their mean age at the time of examination was 11.25 years (SD 0.58). This sample served as a control group for the Signal-Tandmobiel®' project. For this project a cohort (N=4468) of Flemish schoolchildren born in 1989 was selected from school data. Ethical approval was obtained for this project by the local ethics committee and the Education Department in Flanders (Vanobbergen et al., 2000).

Dental Cope Questionnaire

The Dental Cope Questionnaire (DCQ), a self-report checklist, requires the child to think about a painful situation at the dentist and to assess which coping strategies it would use. It is a revised version of the Kidcope (Spirito et al., 1988), developed for this study to obtain a specific pain cope questionnaire for children. The scale consists of 15 coping strategies (for all items see Table 1) related to the dental setting, such as "telling myself it will be soon over", "thinking about something else", "get angry with the dentist". The child is asked to rate both use of each strategy (part A), scoring: "yes" or "no", and perceived effectiveness, (part B) of each strategy, scoring: "not at all", "a little", "a lot".

The Dental Subscale of the Children's Fear Survey Schedule

To assess the level of dental fear the children were asked to complete the Dental Subscale of the Children's Fear Survey Schedule (CFSS-DS). The CFSS-DS

consists of 15 items to be answered on a five-point scale 1) "not afraid at all" to 5) "very afraid" resulting in a possible score ranging from 15-75. Previous research has indicated scores below 32 as ´non-clinical´, scores between 32 and 38 as 'borderline range', and scores of 39 and higher represent 'clinical range' or dental fear. Of the Dutch child population 14% suffers from some degree of dental fear (ten Berge et al., 2002b). Therefore, in the present study a cut-off score of 32 on the CFSS-DS was used to divide children into low-fearful and fearful categories. In addition, all children were asked to also answer the question 'did you ever experience pain at the dentist', on a three-point scale ('no', 'sometimes', and 'often').

Dental status

The DMF index is used to measure dental caries. It is a record of the number of decayed (D), missing because of caries (M), or filled (F) teeth. The DMF index can be applied to teeth (designated as DMFT) or to surfaces (DMFS). For the present study the status of the teeth is coded at surface level, using the guidelines proposed by the British Association for the Study of Community Dentistry BASCD (Pitts et al., 1997).

Procedure

The questionnaires DCQ and CFSS-DS were completed at school and the dental status was obtained during dental examination as part of the Signal-Tandmobiel®' project. For different reasons 29% of the children who completed the questionnaires were not seen at the dental examination.

Statistical analysis

To test the internal consistency of the DCQ, reliability analysis (alpha) was performed (Cronbach's alpha). Pearson's correlation coefficient was used to calculate the relation between use and perceived effectiveness of the strategies. The appropriate t-tests and chi-square tests were performed to assess differences in the strategies used.

Results

On average, subjects said they used 6.1 (SD 2.1) strategies in response to dental pain. The three most frequent coping strategies were 'I do what the dentist tells me to' (97%), 'I think it is good for my teeth' (79%), and 'I think it is my own fault I have cavities' (71%). These data are detailed in Table 1. The three most effective

strategies when looking at the sum of response categories: 'a bit' and 'very much' are: 'I like it when the nurse holds my hand' (94.6%), 'I think of other things' (92.5%), and 'I think it is good for my teeth' (91.4%). The reported effectiveness of a strategy was taken into account only when a child reported having used it. Overall, there is a strong correlation between the percentage of children that does use a strategy and the rated efficacy of that strategy (r =0.72). In other words, the strategies used more often are also the strategies that are rated helpful when one is coping with pain.

Table 1. Percentage of eleven-year-old children reporting different coping strategies and subjective reports of their efficacy, based on the Dental Cope Questionnaire (DCQ).

N=597	(%)Yes	**When yes, does it help?**	
When I am in pain at the dentist……		Not at all	A bit or very much
Destructive			
I get angry at mum and dad	6.1	50.0	50.0
I think of a reason to sneak out	7.4	45.0	55.0
I close my mouth	7.9	30.8	69.2
I get angry at the dentist	8.5	43.2	56.8
External			
I look at the mirror	25.6	36.2	63.8
I like it when the nurse holds my hand	38.6	5.4	94.6
It is good to have friends with me	43.4	11.2	88.8
I tell the dentist	52.0	16.7	83.3
I ask what the dentist is doing	56.5	12.9	87.1
Internal			
I think it is part of dentistry	59.4	27.3	72.7
I tell myself it will be over soon	59.5	9.8	90.2
I think of other things	70.1	7.5	92.5
I think it is my own fault I have cavities	71.3	33.2	66.8
I tell myself I have to do this because it is good for my teeth	79.0	8.6	91.4
I do what the dentist tells me	97.1	11.9	88.1

The internal consistency of the DCQ proved to be moderate; Cronbach's alpha was 0.61 for the total questionnaire, 0.49 for part A, and 0.79 for part B. Because of the moderate values, the choice was made to perform an exploratory factor analysis. Based on this analysis and frequency with which each item was used the strategies were divided into three groups: 1) strategies that were used by less than 10% of the subjects; 2) strategies that were used between 10% and 57%; and 3) strategies that were used over 57% (Table 1).

For each group an underlying component could be identified. The first group consists of destructive strategies. These are strategies which are unhelpful for the treatment such as getting angry or closing one's mouth. The efficacy rate of these strategies is 57.7%; this is the percentage of children that indicated that the strategies helped a bit or very much. The second group consists of strategies where the use of mechanical tools (e.g., mirror) or the presence of a person (external help) is applied to cope. The efficacy rate of these strategies is 84.8%. The third group consists of strategies that use internal help to cope. These are the more cognitive-orientated strategies which help to counteract negative feelings. The efficacy rate is 83.6%.

The mean fear level of the children in this study was 22.9 (SD 6.6). The mean score of the low-fearful children (below 32) was 21.2 (n=505). The mean fear score of the children with a score in the borderline range (between 32 and 38) was 35.0 (n=35) and the mean fear score of the children with a score in the clinical range (39 and above) was 42.8 (n=21). Girls were found to be more fearful than boys (24.0 versus 21.9, $p<0.01$). Questionnaires not totally completed were excluded from analysis (n=38). Children who reported to have experienced pain at the dentist in the past were more fearful than children who did not. The mean fear level of children who never experienced pain at the dentist is 21.3, the mean for children who sometimes experienced pain is 23.2, and the mean for children who often experienced pain is 29.6 ($F(2,519)=15.2$, $p<0.01$).

Furthermore a significant difference was found in the number of coping strategies used by fearful and low-fearful children, the first group using more coping strategies. Fearful children use more external coping strategies and find these strategies more effective than low fearful children (Table 2). Fearful children use the strategy: "I think of a reason to sneak out" more often and "I like it when the nurse holds my hand" less often than low fearful children.

Table 2. Dental anxiety, pain, and the number of coping strategies used.

	Score range	LF (n=505)		F (n=56)		No pain (n=151)		Pain (n=400)	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD
Total CFSS-ds score	15-75	21.2	4.3	37.9**	4.9	21.3	5.6	23.5**	6.8
Coping strategies	0-15	6.1	2.0	7.1**	1.6	5.8	2.0	6.3**	1.9
Destructive coping strategies	0-4	0.3	.63	0.5	.79	.28	.69	.28	.61
External coping strategies	0-5	2.1	1.3	2.8**	1.2	1.9	1.4	2.1	1.3
Internal coping strategies	0-6	4.2	1.4	4.6	1.2	3.8	1.6	4.4**	1.3
Efficacy of destructive coping strategies	0-4	0.1	.42	0.2	.50	.11	.37	.15	.45
Efficacy of external coping strategies	0-5	1.6	1.3	2.3**	1.2	1.4	1.3	1.8**	1.2
Efficacy of internal coping strategies	0-6	3.3	1.8	3.8	1.6	2.9	1.8	3.5**	1.7

LF: low fearful, F: fearful; **significant at p≤0.01; CFSS-ds: Dental Subscale of the Children's Fear Survey Schedule

Table 3. Fear and pain in 11-year-old children versus their caries experience (DMFS index).

	N=(424)		LF (n=352)		F (n=41)		No pain (n=117)		Pain (n=275)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Decade surfaces	.37	1.59	.24	.88	1.29*	3.78	.20	.72	.40	1.73
Filled surfaces	.89	2.06	.87	2.04	.71	1.57	.50	1.81	1.11**	2.18
Decade and filled surfaces	1.26	2.61	1.11	2.26	2.00	4.06	.69	2.14	1.51**	2.74
Decade, missing and filled surfaces	1.41	2.98	1.24	2.64	2.15	4.16	.79	2.55	1.64**	3.01

LF: low fearful, F: fearful; *Significant difference between low fearful and fearful at p≤0.01.

**Significant difference between no pain and pain at p≤0.01.

In addition there was a difference in the number and type of coping strategies used between children who reported to have never experienced pain at the dentist (no pain, n=151) and children who reported to have experienced pain at the dentist (pain; sum of answer categories 'sometimes' n= 377 and 'often' n=23). The latter group used more internal coping strategies and find external as well as internal strategies more effective than children without pain experience (Table 2).

The results on subjects' dental status for fearful and low-fearful and pain and no-pain subsamples are presented in Table 3. Fearful children were found to have more diseased surfaces on their permanent teeth than low fearful children ($F(1,391)= 48.28$, $p\leq0.01$). Children who had experienced pain at the dentist (pain) were found to have more filled surfaces on their permanent teeth than children who reported never to have had pain at the dentist (no pain) ($F(1,390)=18.73$, $p\leq0.01$).

Discussion

The results of this study show that 11-year-olds use a variety of coping strategies. Three groups of strategies could be formed and for each group a clear underlying component could be identified. Internal strategies are used most frequently and these strategies are rated by the children as effective. The external coping strategies are used less frequently but when used they too are often rated as being effective. The destructive strategies are hardly used but on average 45% of the users think they work effectively.

Earlier studies, among adults, stated that the nature of the situation plays an important role in determining the types of coping responses used. When individuals feel something constructive can be done to change the stressor, they tend to use problem-focused coping responses (e.g., work situations favour problem-focused coping). Stressful circumstances that are viewed as unavoidable and must be tolerated ask for emotion-focused coping (Folkman & Lazarus, 1980). A dental treatment resembles this situation and thus demands emotion-focused coping. This seems congruent with our results, which shows that internal orientated strategies are used most frequently.

The use and choice of coping strategies seems to be partly determined by the level of dental fear. Fearful children use more coping strategies and use more frequently externally focused coping strategies than low fearful children. This finding does suggest that fearful children lack personal resources for managing pain and are dependent on the skill of their parents and professional staff to teach them and enhance their coping skills. Information from the dental records of the patients

made clear that our group of fearful children did have more decayed teeth than low fearful children. This might suggest that fearful children postpone their visit to the dentist in an attempt to avoid treatment.

The use and choice of coping strategies seems to be also determined, at least partly, by the level of pain experience. Children with pain experience use more coping strategies and use a broader range of strategies. One possible reason is that because of their pain experience they are forced to actively deal with the situation and as a result start to use new strategies. The pain experience of the children seems to be a consequence of restoring permanent teeth. Children who reported to have experienced pain at the dentist have more restored surfaces than those who did not.

The present study gives support for a relation between pain experiences and level of dental fear in children. Children who did experience pain in the past are more fearful. The relation between pain and dental fear, however, is not straightforward. As mentioned before dental fear is a complex phenomenon and there is no straightforward cause and effect relation known for fear acquisition (ten Berge et al., 2001).

Finally, our results indicate that the validity of the Dental Cope Questionnaire (DCQ) is moderate. Earlier studies have shown (Broome et al., 1990) that children who displayed active or action-oriented coping behaviours (i.e. asked questions, attempted to control, and resisted) reported less pain during lumbar puncture than children who used passive coping behaviours (i.e., ignored staff, remained silent and motionless, and cooperated without complaint). Indeed, the relation between pain perception during an actual dental treatment and the use of certain coping strategies also deserves additional research attention.

From the present study, it can be concluded that the use and choice of coping strategies of 11-year-old children seems to be at least partly determined by their level of dental fear and their pain experience. Dentists' treatment strategies should therefore not only consist of training the child's coping abilities, but also adapt his/her treatment to the level of anxiety or the expected amount of pain during treatment.

Chapter 12

Child coping strategies, dental anxiety and dental treatment: the influence of age, gender and childhood caries prevalence

Meurs van P, Howard KE, Versloot J, Veerkamp JSJ, Freeman R. Child coping strategies, dental anxiety and dental treatment: the influence of age, gender and childhood caries prevalence. European Journal of Paediatric Dentistry 2005;6: 173-178.

Abstract

Objectives: The aim of the study was to investigate what coping strategies are used by children, the efficacy of these strategies and the influences of age, gender, dental anxiety, pain experience and childhood caries prevalence (place of residence) upon the efficacy of the coping strategies used by children in The Netherlands and Northern Ireland (NI).

Method: Convenience samples of Dutch and NI children were taken and asked to fill out a coping questionnaire (Dental Cope Questionnaire) and an anxiety schedule (CFSS-DS). Data were entered onto a SPSS database and subjected to frequency distributions, chi-squared analysis, t-tests and analysis of variance.

Results: The children used a wide variety of coping strategies in dealing with pain in dentistry. The most frequently used and those reported to have the greatest efficacy by the children in this investigation were cognitively based strategies. Different strategies were used in relation to place of residence, age and level of dental anxiety. The variance in the number of strategies used was significantly explained by the experienced pain during dental treatment. The efficacy of the coping strategies used was significantly explained by level of dental anxiety.

Conclusions: Dental coping strategies used by children seem to vary with age, dental anxiety and pain experience. This information can help the dental practitioner to adjust his (her) treatment to the child's emotional needs.

Introduction

Previous investigations have provided evidence that children can be taught specific cognitive and behavioural strategies to reduce their experience of pain during medical procedures. Children undergoing lumbar punctures, for instance, were more likely to show coping behaviour when the medical staff or their parents made coping promoting statements (Blount et al., 1991). This was confirmed in a second study when children showed less distress during immunisation procedures when the staff or their parents were trained in coping promoting behaviours (Blount et al., 1992). Most of these coping behaviours had been based on adult coping strategies which included rationalisation, relaxation etc. Little research has been conducted on children's coping styles when faced with potentially painful experiences. The child's cognitive capacities, emotional responses, age-specific behavioural competence, communication skills and physical maturity influence his/her capacity to understand and react appropriately to invasive medical procedures (McGrath & Craig, 1989). This implies that children respond to adverse stimuli in accordance with their degree of psychological and personality development.

Most research concerning children's coping strategies has been done in the medical setting. Bennett-Branson and Craig (1993) found that adolescents used more cognitively based coping strategies in response to pain compared with younger children. Little, however, is known about children's ability to cope (coping strategies) in the dental setting. One study provided children with the means of cognitive coping in the form of 'tell-show-do' interventions and was shown to assist them manage dental general anaesthetic extractions (Carson & Freeman, 1998). It seemed that an increase in their understanding what would happen, by providing information, reduced their dental anxiety. Comparable interventions have been performed with the use of videotapes prior to treatment (Weinstein et al., 2003). Other research on children's coping strategies has been concerned with a visit to the dentist. It found that younger and more anxious children expressed a greater need for behavioural coping strategies (Weinstein et al., 1996) and it was postulated that a relationship existed between the level of dental anxiety (Karjalainen et al., 2003), previous pain experience and the choice of coping strategy (Versloot et al., 2004b). There is, however, little research on the child's ability to cope with painful dental treatment nor has there been research on how the prevalence of childhood dental caries influences coping strategies. The basis for the present research was that with a higher prevalence of dental caries there will be

a greater chance of experiencing previous and potentially painful dental treatments and these experiences may affect the child's ability to develop cognitive coping strategies (Townsend et al., 2000; Klingberg et al., 1995). Two distinct populations of children were needed, therefore, to represent areas of low and high childhood caries prevalence. Hence a population of children from Amsterdam, the Netherlands was chosen to represent an area of low caries prevalence (70% of 5-year-olds are caries free) and Belfast, Northern Ireland (NI) to represent an area of high caries prevalence (35% of 5-year-olds are caries free) (National Statistics, 2004). The aim of the study was, therefore, to investigate what coping strategies are used by children, the efficacy of these strategies and to determine the influences of age, gender, dental anxiety, pain experience and childhood caries prevalence (place of residence) upon the efficacy of the coping strategies used by two groups of children living in The Netherlands and Northern Ireland.

Materials and methods

Participants

A convenience sample of Dutch children and Northern Irish children in their last year of primary and first year of secondary education who attended schools in comparable socio-economic status areas of Amsterdam and Belfast, were invited to participate. They were asked to complete a questionnaire during school hours. The children were given a brief introduction to the questionnaire and informed how to complete it by using a mock-up question as an example. The questionnaire was completed under 'examination conditions' with children completing it individually. Back translations from English to Dutch and from Dutch back to English ensured that questionnaires were identical for both two groups of children.

Design of the questionnaire

The questionnaire was in four parts. The first part inquired of the child's age, gender and place of residence. The second part was the Dental Cope Questionnaire which assessed the child's coping style using a modified version of the Kidcope (Spirito et al., 1988). The Dental Cope Questionnaire is a 15-item questionnaire that screens the occurrence of coping strategies: 'Do you do that?', scoring "yes" or "no" (Scale A), and their efficacy: 'Does it work?', scoring "not at all", "a little", "a lot" (Scale B). The perceived efficacy of each strategy was formed by a summation of the last two categories ("a little" and "a lot"). A factor analysis and the frequency with which each item was used, revealed three groups of strategies: cognitive

coping strategies (item: 2,5,8,11,14,15), behavioural (external-help) coping strategies (item: 1,3,4,7,12) and behavioural (destructive) coping strategies (item: 6,9,10,13) (Versloot et al. 2004b) (Figure 1).

Figure 1. Dental Cope Questionnaire.

When I am at the dentist and it does hurt:		[Scale A] Do you do this		[Scale B] Does it work?		
		Yes	No	Not at all	A little	A lot
1.	I ask what the dentist is doing	0	0	0	0	0
2.	I think of other things	0	0	0	0	0
3.	I look at the mirror	0	0	0	0	0
4.	I tell the dentist	0	0	0	0	0
5.	I tell myself it will be over soon	0	0	0	0	0
6.	I get angry at the dentist	0	0	0	0	0
7.	It is good to have friends with me	0	0	0	0	0
8.	I do what the dentist tells me	0	0	0	0	0
9.	I think of a reason to sneak out	0	0	0	0	0
10.	I close my mouth	0	0	0	0	0
11.	I tell myself I have to do this because it is good for my teeth	0	0	0	0	0
12.	I like it when the nurse holds my hands	0	0	0	0	0
13	I get angry at mom or dad	0	0	0	0	0
14.	I think it is my own fault I have cavities	0	0	0	0	0
15.	I think it is part of dentistry	0	0	0	0	0

The third part of the questionnaire assessed dental anxiety using a self-report version of the dental subscale of the Children's Fear Survey Schedule (CFSS-DS). The CFSS-DS is a dental anxiety questionnaire; which is most frequently used in western European countries and has been validated in the USA, Sweden, Finland and the Netherlands (ten Berge et al., 2002). The CFSS-DS consists of 15 items to be answered on a 5-point scale from 1) "not afraid at all" to 5) "very afraid" resulting in a possible score ranging from 15-75. Previous research has indicated scores below 32 as non-clinical. Children scoring in the 'non-clinical range' are

generally not or only a little fearful.

The final part assessed child dental treatment pain experience using a three-point Likert Scale ranging from 1) "never experienced pain during dental treatment", 2) "sometimes have experienced pain during dental treatment" to 3) "often have experienced pain during dental treatment".

Statistical analysis

The data was scored and coded and entered onto a SPSS database. The data was subjected to frequency distributions, chi-squared analysis, t-tests and Univariate analysis of variance.

Results

Two hundred and forty-seven Dutch children aged between 8-13 years (123 boys) and 140 Northern Irish (NI) children (72 boys) aged between 11-12 years took part in the study. Children were divided into older, 11-13 years (n=152) and younger, 8-10 years (n=235) aged groups using a median split. Equivalent proportions of boys and girls from The Netherlands and NI took part in the study ($X^2(1)=0.14$, $p=0.71$).

Coping strategies and efficacy

The most commonly used coping strategy (Scale A, Table 1) was 'I do what the dentist tells me' (91%) whereas the least used strategy was 'I think of a reason to sneak out' (9%). Together the children used on average 6.5 (SD 2.10) strategies. The children that used a certain strategy stated that the strategy which worked best (Scale B, Table 2) was 'I tell myself I have to do this because it is good for my teeth' (92%) and the strategy which worked least was 'I close my mouth' (58%). The efficacy over all strategies was 78%.

Table 1. Comparisons between Dutch and NI children's most commonly used coping strategies (Scale A).

Coping strategy (Scale A)	Dutch children n (%)	NI children n (%)
I do what the dentist tells me	229 (92.7)	127 (90.4)
I think it is my own fault I have cavities	172 (69.4)	94 (66.4)
I tell myself I have to do this because it is good for my teeth	162 (65.4)	111 (70.9)

Table 2. Comparisons between NI and Dutch 11-12 years-old coping strategies used.

Coping strategies	Use (Scale A)		Efficacy (Scale B)	
	NI yes	Dutch Yes	NI yes	Dutch Yes
I do what the dentist tells me	90,4%	90,9%	88,5%	88,2%
I tell myself I have to do this because it is good for my teeth *	70,9%	56,8%	90,1%	91,7%
I think it is my own fault I have cavities	66,4%	72,4%	70,8%	63,3%
I tell myself it will be over soon **	65,9%	43,2%	80,8%	88,9%
I think it is part of dentistry	64,6%	60,2%	78,8%	85,1%
I tell the dentist	63,0%	64,0%	80,5%	77,4%
I think of other things	59,7%	56,8%	86,1%	89,1%
I ask what the dentist is doing *	45,9%	61,4%	81,4%	92,3%
It is good to have friends with me **	42,6%	25,0%	82,0%	95,2%
I get angry at the dentist **	32,8%	6,8%	53,8%	80,0%
I get angry at mum or dad **	20,9%	2,3%	66,7%	0%
I like it when the nurse holds my hands	20,1%	14,8%	78,9%	100%
I look at the mirror **	19,2%	54,5%	75,0%	69,6%
I think of a reason to sneak out *	16,2%	4,6%	54,5%	100%
I close my mouth	14,3%	8,0%	47,1%	80,0%

*) significant difference between the NI and Dutch children: * $p < 0,05$; ** $p < 0,001$.

Coping strategies, place of residence

When the 11-12 year-old children from Northern Ireland were compared with 11-12 year-olds from The Netherlands, the NI children were found to use significantly more strategies than the Dutch children 6.8 (SD 2.10) versus 6.2 (SD 2.29) strategies ($t(221)=-2.01$, $p=0.046$).

Significantly larger proportions of NI children compared with Dutch children used the coping strategies: 'I tell myself I have to do this because it is good for my teeth', 'I tell myself it will be over soon', 'It is good to have friends with me', 'I get angry at the dentist', 'I get angry at mom or dad', and 'I think of a reason to sneak out'. Larger proportions of Dutch children tended to use the coping styles "I ask what the dentist is doing" and "I look at the mirror" compared with NI children (Table 2).

No statistical difference between NI and Dutch children was found for the reported efficacy of the individual coping strategies and the overall efficacy score (Table 2).

Coping strategies, age

No differences were found in the number of strategies used between younger and older Dutch children. Looking at the strategies individually it was found that significantly larger proportions of younger (8-10 years) compared with older (11-13 years) Dutch children used the coping strategies: "It is good to have friends with me" (38% versus 24%), "I like it when the nurse holds my hands" (29% versus 17%) and "I tell myself I have to do this because it is good for my teeth" (71% versus 57%) ($p<0.05$). Whereas, significantly larger proportion of older compared with younger Dutch children stated that they used "I tell the dentist" (66% versus 44%) ($p=0.001$) to cope with dental treatment. For the 11 remaining items no significant differences were found. Also no statistical difference between younger and older Dutch children was found for the reported efficacy of the individual coping strategies and the overall efficacy score.

Coping strategies, dental anxiety status

The overall score for CFSS-DS for all Dutch and NI children was 26.14 (95% CI: 25.11-27.18). Dutch children (mean 22.11 (SD 6.16)) were found to be significant less anxious than NI children (mean 33.28 (SD 12.28), $t(384)=-11.88$, $p<0.001$) , and boys were found to be significant less anxious than girls (mean 23.8 (SD 9.22) versus 28.6 (SD 10.93), $t(348)=-4.61$, $p<0.001$).

Using the CFSS-DS cut-off score of 32 all of the children were divided into low dental anxiety and high dental anxiety groups. Twenty-three percent (n=88) of the total sample were classified as dentally anxious. From the Dutch population only 7.3% (n=18) was classified as dentally anxious versus 50% (n=70) in the NI population ($X^2(1)=92.35$: $p<0.001$). Significantly more strategies were used by NI children classified as having high dental anxiety compared with low dental anxiety (mean 7.20 (SD 2.07) versus 6.36 (SD 2.07), $t(133)=-2.36$, $p=0.02$). The following coping strategies were used by significantly larger proportions of NI children classified as having high dental anxiety: 'I get angry with the dentist' (41% versus 23%, $X^2(1)=4.98$, $p=0.026$) 'I get angry with mom or dad' (25% versus 3%, $X^2(1)=10.97$, $p=0.001$) and 'I close my mouth' (32% versus 9%, $X^2(1)=13.31$, $p<0.001$).

Within the Dutch children only one coping strategy was used by a significantly

larger proportions of Dutch children classified as having high compared with low dental anxiety: 'I like it when the nurse holds my hands' more often (44% versus 23%, $X^2(1)=4.30$, $p=0.038$).

There was no difference found between the rated efficacies between high and low dental anxious children within the NI or Dutch group.

Coping strategies, experience of painful dental treatment

Sixty percent (n=185) of the children stated that they had experienced painful dental treatment at sometime and 2 percent (n=9) stated that they experienced pain often when at the dentist. Forty-three percent (n=132) of Dutch children stated that they had no experience of painful dental treatment compared to 24% (n=25) of the NI children ($X^2(1)=11.34$, $p=0.001$). The children that experienced painful dental treatment sometimes or often used significantly more coping strategies (mean 6.92 (SD 2.01) versus mean 5.75 (SD 2.23), $t(306)=-4.71$, $p<0.001$) and were more dentally anxious (mean 28.34 (SD 11.23) versus mean 22.77 (SD 7.83), $t(305)=-4.66$, $p<0,001$) than children who did not experience painful dental treatment. Girls were found to have experienced painful dental treatment more often than boys (70% versus 55%, $X^2(1)=7.18$, $p=0.007$). No difference was found regarding age, or efficacy of the strategies between children with or without painful dental treatment.

Coping strategies, place of residence, age, pain, anxiety and gender

For the total group there was no difference found for the number of coping strategies used between Dutch and Irish children and young and older children. However, children who had experienced pain at the dentist or were high dentally anxious or were female seemed to use more strategies. A Univariate analysis of variance with the last three factors included showed a significant main effect of the child dental pain experience, on the number of coping strategies used ($F(1,299)=6.99$, $p=0.009$). There were no significant effects found for dental anxiety level and for gender.

A Univariate analysis of variance with the same three factors included showed a significant main effect of level of dental anxiety on the efficacy of coping strategies used ($F(1,289)=4.03$, $p=0.046$). Here no effect was found for child dental pain experience and gender.

Discussion

The children included in this survey used a wide variety of coping strategies in

dealing with pain in dentistry. The most frequently used strategies and those reported to have the greatest efficacy by the children in this investigation were cognitively based strategies such as "I do what the dentist tells me". In general the other cognitive strategies ("I think it is part of dentistry", "I tell myself I have to do this because it is good for my teeth", "I tell myself it will be over soon", and "I think it is my own fault I have cavities") were used more frequently then the behavioural strategies.

When the NI children were compared to the Dutch children, a number of differences were found in the choice of coping strategy. For 8 out of 15 items from Scale A showed a significant relation with place of residence. The NI children, for instance compared with the Dutch children used more behavioural (destructive) coping strategies. However there was no difference between Dutch and NI children with regard to the overall score for efficacy of the coping strategy used.

With regard to the use of coping strategies age was found to discriminate on 4 out of 15. Suggesting that younger children use different strategies in comparison to older children. Younger children used more behavioural coping strategies that offered emotional support ("it is good to have friends with me" or "I like it when the nurse holds my hands") which is similar to the findings from previous studies (Bennett-Branson and Craig, 1993).

More of the NI children were classified as dentally anxious and had higher scores for dental anxiety. Furthermore the NI children reported an increased frequency of painful dental treatment experiences. This suggested the NI children may have had early and possibly more painful dental treatments, due to the higher prevalence of childhood dental caries in that population. As a consequence NI children were dentally anxious and seemed to have a propensity for behavioural (destructive) coping strategies. This proposition is supported by the findings that the children who had the greatest frequency of pain experience were high dentally anxious, female and from NI. The results from this investigation support the view of Weinstein et al. (1996) that there is a connection between the development of behavioural coping strategies, painful dental experiences and dental anxiety.

Although other studies have shown that factors other than oral health status are more important in the acquisition of dental fear (Klingberg et al., 1995; Townsend et al., 2000) this hypothesis is questioned by the results reported here. Our findings indicate that a relationship exists between previous pain experience during dental treatment and the child's choice of coping strategy. It is suggested that it is not the prevalence of childhood dental caries per se but the likelihood of a child, residing in such an environment, to have earlier and younger experiences of painful dental

treatment which appears to be pertinent in their choice of strategy. However, it does seem interesting that the efficacy of the strategy used differed with the level of dental anxiety, high anxiety children rating the strategies with a lower efficacy.

This study has some limitations as the dental health status of the children was not assessed on an individual basis, but based on the national prevalence surveys in representative areas. Therefore, it remains unclear if dental health status or cultural background (place of residence) played a more important role and therefore further research is warranted. Furthermore, research is necessary to clarify the role of pain experience and dental anxiety as determinants of the efficacy of the coping strategies chosen by children. Nevertheless indicative conclusions can be drawn – that is, that differences in the choice of coping strategies, dental anxiety and pain experience were found to exist. Finally, the results concerning the individual strategies should be interpreted with caution because multiple tests were performed.

Despite the above limitations these results have implications for the pediatric dentists. Dentists who have an awareness that children who are dentally anxious have a propensity for behavioural coping strategies will allow them to tailor their anxiolytic interventions to the emotional needs of the child. Dental coping strategies used by children seem to vary with age, dental anxiety and pain experience. This information can help dental practitioners to adjust his or her treatment to the child's emotional needs.

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Chapter 13

Summary and general discussion

Summary of main findings

This thesis discusses a number of studies that aim to provide a contribution to the problem of recognizing, treating and preventing pain in child dental patients. First, the possibility to recognize toothache in young children by their behaviour was reviewed. Second, the pain report and pain behaviour of children receiving a local anaesthesia injection was looked at and in addition these responses were used to compare two different injection devices. Third, the coping strategies used by eleven-year-olds, when in pain, were examined. In this final chapter the main findings will be summarized and discussed.

Chapter 2 describes the development of the Dental Discomfort Questionnaire (DDQ), a questionnaire to identify toothache based on different behaviours. The results show that 8 out of the 12 behaviours chosen were more often present in children with caries and toothache than in children without caries and toothache. The three items concerning earache were found not to be specifically related to toothache or caries and, in addition, the item "problems sleeping" occurred frequently in all groups. At this point it was decided to continue with an 8-item questionnaire. The behaviours: "puts away something sweet to eat", "chewing on one side", and "reaching for the cheek while eating" were found to be the strongest indicators for the presence of toothache.

In chapter 3 it was shown that the receiver operating characteristic curve (ROC curve) of the DDQ indicated that children with a score 3 or higher had an 81% chance of toothache and children with a score below 3 on the DDQ had a 79% chance of no visible caries. In conclusion, the DDQ has a good ability to discriminate between children with caries and toothache and children free of visible caries and toothache.

Chapter 4 related that the mean number of behaviours displayed by the children decreased significantly after treatment. When looking at the behaviours individually, however, no differences were found. Perhaps, due to the delay in follow-up time of 8 months, these children had developed new caries lesions by the time their parents

filled out the follow-up questionnaire.

In chapter 5 it was shown that the occurrence of the behaviours was very persistent, they did not decrease over an eight week period before treatment. Furthermore, it was found that a shorter time span between treatment and questionnaire resulted in a reduction of all but one behaviour from the DDQ. When children had their front teeth extracted they were forced to use their molars until permanent teeth filled the gap. Finally, because children experienced fewer problems sleeping after dental treatment, it was decided to make the DDQ a 9-item questionnaire.

In chapter 6 it was shown that the DDQ with two additional items i.e. "putting her/his hands in their mouth" and "produces more saliva", is a useful instrument for indicating toothache in a population of children with mental disabilities who function on the same verbal level as two-to-four-year-olds.

In chapter 7 the variation in pain and distress assessment by different raters -the child, the dentist and independent observers- during a dental injection is described. The dentist awarded the lowest pain score, followed by the observers and the child's report to the dentist. The highest scores were given by the child when asked by the parent. Together, the self-reported pain when asked by the dentist and the pain scores of the observers based on the video recordings seem to give a good indication of the amount of pain felt by the child. The distress scores were significantly correlated with pain intensity indicating that these two concepts overlap which makes the individual assessments of these concepts difficult.

In chapter 8 the behaviour reaction of children receiving local anaesthesia with a traditional syringe or a computerized device (Wand®) is compared and the possible influence of dental anxiety is studied. The Wand® injection was found to take three times longer than the traditional injection. The results show that in the first 30 seconds low anxiety children have a more positive reaction to the Wand® than to the traditional syringe. Moreover, high anxiety children tend to react similarly to both injection techniques and in most cases, high anxiety children show more distress than low anxiety children.

In chapter 9 the effect of the Wand® was studied during sequential dental visits. The results show that low anxiety children tended to display less and high anxiety children display more pain-related behaviours and distress in reaction to an injection with the Wand® in comparison to an injection with the traditional syringe on the first treatment session. For the second treatment session, low anxiety children tend to report more pain in comparison to the first injection. For high anxiety children no sequential effect was found.

In chapter 10 it was shown that young children who are high anxiety or children receiving an injection in the lower jaw reported the most pain on the first treatment session. For the older children, the children having previous experience with a dental injection gave the highest pain ratings on the first treatment session. Furthermore, for both young and older children the amount of pain reported over the second injection was best predicted by the amount of pain reported over the first injection. For the young children the amount of pain was also predicted by the injection site of the first injection.

In chapter 11 it was shown that eleven-year-olds report using a variety of coping strategies when in pain at the dentist. Internal strategies are used most frequently, external coping strategies are used less frequently, and destructive strategies are hardly used. The children rated internal and external strategies as effective. Children who had experienced pain at the dentist and children with a high level of dental anxiety used more coping strategies, with fearful children using more external strategies.

In chapter 12 it was shown that the most frequently used strategies and those reported to have the greatest efficacy by the children were cognitively based strategies. The children from Northern Ireland (NI), compared with the Dutch children used more behavioural (destructive) coping strategies. However, there was no difference between Dutch and NI children with regard to the overall score for efficacy of the coping strategy used. Younger children used more behavioural coping strategies that offered emotional support. Furthermore, the NI children, who were more often classified as dentally anxious, reported an increased frequency of painful dental treatment experiences and tended to have a propensity for behavioural (destructive) coping strategies.

General discussion

In the next section the three main topics of this thesis will be discussed. This section will be followed by implications for future research and clinical practice and ends with some final remarks.

DDQ and toothache

In the studies described on the Dental Discomfort Questionnaire (DDQ), nine behaviours were found valuable to identify toothache and a score of 3 (out of 8) and above was found to be the optimal cut-off point. The most indicative behaviours for toothache are related to eating: "putting away something sweet to eat", "chewing at one side of the mouth", "problems with chewing", "reaching for

the cheek while eating" and "crying during meals". Furthermore, it was found that the location of the caries and toothache did influence the number of behaviours displayed by the children, suggesting that different caries locations cause a different pain sensation and intensity. In addition, the study with the DDQ and mentally impaired children showed a positive correlation between the total score of the DDQ and the dmfs/DMFS scores indicating a relation between the severity of the caries and the score on the DDQ.

Both young and mentally impaired children are vulnerable suffering from unnoticed pain because these children often have limited communication skills and are unable to express their pain or discomfort. Equally, the child or the parent may realise that a problem does exist but are unable to assess the origin or the degree of discomfort accurately. This is also shown by the fact that parents of special care patients often consult different health professionals such as ear, nose and throat specialists or their general medical practitioner before visiting a dental clinic (Hennequin et al., 2000).

Treatment of the caries has been shown to take away the pain and the pain-related behaviours. In addition, research has also found improvement in social quality of life, such as, "more smiling", "improved school performance", and "increased social interaction". Therefore, parents should be educated in preventive techniques and encouraged to comply with regular dental review programmes.

Some remarks regarding the validity of the DDQ need to be made. This study was done with a study sample of referred children which limits the possibility to generalize the results. Furthermore, it is possible that the behavioural items of the DDQ are biased because parents were first asked whether their child was suffering from toothache and then asked about behaviours. It could be that the parents who indicate that their child had toothache believe he or she "should" therefore have exhibited the listed behaviours and therefore claimed the behaviours regardless. However, children with only caries (without toothache) had a higher score on the DDQ than children with healthy teeth, so parental belief concerning toothache behaviours could not serve as a sufficient alternative explanation. Furthermore, the items concerning earache were rarely answered positively supporting the idea that parents do seriously consider whether their child displays the specific behaviours before answering the question. If parents were biased in the way suggested earlier then one would instead expect them to give negative answers after treatment when the attributed cause of toothache has been removed. However, while parents stopped reporting some behaviours indicative of toothache after treatment, they still reported other behaviours (e.g., that their children were biting things off with

molars instead of front teeth).

Furthermore, all the studies with the DDQ deal with young children but the actual participants were the parents. All the questionnaires were filled out by the parents due to the young age of their children. Accordingly, they also answered the question concerning the presence of toothache. Indeed, this raises the question of how capable a parent is of recognizing toothache in their child, and was this not the core problem in the first place, i.e., toothache in young children risks going unrecognised. Of course there are three-year olds who can report their own toothache but at the same time there are four-year-olds or even five-year-olds who can not. In general, however, children as young as three years old can not reliably report toothache, leaving the parent as often the only alternative.

Local anaesthesia injection and pain response

Assessing pain in children is a challenging task, in particular in the dental setting where children are always nervous due to their upcoming treatment session. A comparison of the assessment of pain reported by observers, the dentist and the child showed that the assessment of the child combined with that of the observers gave the most reliable ratings. The behavioural response of children during a local anaesthesia injection however, is not only provoked by pain, but also by distress which is strongly related to anxiety. When the needle is inserted in the gum and there is actual physical damage, the response given at that moment is most likely a reaction to pain. After that moment however, there are few clues that can be used similarly. In an attempt to measure the total behavioural response shown by children, it was decided to include a distress measurement (the Venham scale), in addition to the self-reported pain and the measurement for pain-related behaviours: muscle tension, verbal protest, moving, crying and extreme movement necessitating physical intervention from an adult (restraint). Finally, there was a substantial correlation between the pain and distress measurements suggesting that these concepts partly overlap and can hardly be measured independently.

The self-reported pain, the pain-related behaviours and the Venham scale were used to compare the Wand® technique with the traditional syringe. At first, the Wand® injection, which differs in location, intensity and duration from the traditional injection, was found to have different effects on the pain-related behaviours and distress displayed by low and high anxiety children. In the first study it was shown that low anxiety children seem to benefit from the use of the Wand® technique. This could not be confirmed however, by the results from the subsequent study. In addition, high anxiety children tend to react negatively to both

injection techniques. In conclusion, no clear difference in response of the children between the two techniques could be found. The Wand® technique however, takes three times longer than the traditional technique, so it seems that children with an elevated level of dental anxiety are at risk of being distressed for longer than necessary when injected with the Wand® system.

It was found that factors unrelated to the injection technique such as level of dental anxiety, age and previous experience, played an important role in the self-reported pain of children. It was found that young, dentally anxious children and children with previous dental experience report the most pain after a local anaesthesia injection. Furthermore, when studying sequential dental visits, the most important predictor for the pain reported on the second treatment session was found to be the amount of pain reported on the first treatment session. For young children also the injection site of the first treatment session was found to be a predictor for the pain report the second time. The previous experience of children seems to play an important role in their latter pain experience. Additional attention is therefore needed during the first treatment session because it seems that the child uses that first session as a reference point.

Some remarks regarding the methods and participants used need to be made. First of all, many behavioural measurements have already been developed to measure pain and distress (von Baeyer & Pagrud, 2006). In our studies we decided to use those behaviours which are clearly visible during dental treatment. We did not include facial responses in our measurements because these were difficult to observe during dental treatment. Including these measurements could possibly have led to a more reliable pain measurement since these behaviours are, in general, free of bias. Perhaps when the video recordings are focused only on the face of the child some facial indicators of pain could be used in future studies.

Second, the studies were done in a specialised dental care clinic where all children were referred to, by their general dental practitioner. This population is found to be more anxious than the general population and therefore caution must be taken when generalising the results. Finally, all treatments were done by specialised pediatric dentists and mostly a topical anaesthetic was used. Together, this resulted in low pain reports and minimum behavioural response so, given this "bottom effect", an intervention could only have a limited effect.

Coping

The strategies used most often and rated to work best when dealing with pain at the dentist are cognitively based strategies. This finding supports the idea that

with relatively low-controllability stressors (e.g., dental treatment), the most adaptive form of coping may be that which focuses not so much on altering objective events and conditions (primary coping) but focuses on adjusting oneself to them (secondary coping) (Rothbaum et al., 1982). Secondary coping most often includes cognitive strategies aimed at controlling the psychological impact of stressful events, for example 'I tell myself I have to do this because it is good for my teeth'.

Children who have a higher level of dental anxiety tend to use more behavioural strategies in particular in dealing with pain at the dentist. According to the theory these are less effective for stressors which are unchangeable. Research has shown that when children use coping strategies not in line with the controllability of the stressor they tend to report more problems (Weisz et al., 1994). Perhaps, high anxiety children lack effective strategies, i.e. cognitive strategies, and therefore can not cope with the dental treatment and get anxious as a result. Behaviour oriented coping strategies are learned at a younger age and perhaps therefore used more often by anxious children.

Implications for future research

Although the DDQ can discriminate between children with caries and toothache and children without visible caries and toothache, we did not succeed in identifying children with caries and toothache in the general population. The DDQ seems not specific enough as there are too many false positives. Limiting the number of items to the most specific ones i.e., those displayed by a large proportion of children with toothache and by very few children without toothache, might make the DDQ more specific. Furthermore, the addition of more psychological indicators for pain, such as, "when a child exhibits negative behaviour", "has problems concentrating" or "is more withdrawn than usual", could also be helpful to make the DDQ more specific. Taken together more data need to be collected in order to choose the best combination of items to get a sensitive and specific tool to identify children with toothache in the general population. Perhaps, based on the behaviour indicators found in the studies described in this thesis, a brochure could be developed which can be distributed to parents of young children and teachers to help them recognize toothache in their children.

The behavioural approach as it is used with the DDQ could be useful in future studies to recognize other covert pains or diseases in young or impaired children such as, headaches or bad eyesight. Many studies are already being carried out to

find indicators of pain in different sub-populations e.g., infants, hospitalized children, mentally impaired children, but there is still a lot to accomplish.

As stated before, it seems that factors -other than the injection technique- such as, level of dental anxiety and age, play an important role in the self-reported pain, the behavioural pain response and the distress response of children. Of course, the dentist also plays an important role when using a new injection technique. When the dentist prefers a certain technique one could argue that this could have a positive effect on the response of the child. Besides the preference of the dentist the way a new technique is introduced to the child or the confidence of the dentist in using a new technique could also influence the response of the child. Perhaps more characteristics need to be studied before more detailed advice can be given on who will benefit from the use of the Wand® technique with referred children. Since many factors are of influence it remains crucial to assess each child's situation individually. The role of the dentist in deciding on the treatment technique to be used thus remains central.

Coping strategies are important for children when dealing with pain during dental treatment. Teaching them new and more efficient strategies could, therefore, help children to cope. Further research, by means of interviewing the children just after their dental treatment, could inform us of which coping strategies children use and find efficient. Furthermore, in choosing the best strategies, this thesis has shown that factors such as age, previous dental experience, level of dental anxiety and the characteristics of the stressor should be taken into account. Therefore, it seems appropriate to teach relatively young and more anxious children behavioural oriented coping strategies and older and less anxious children cognitive oriented coping strategies to enhance secondary coping.

Final remarks

Early recognition of toothache is of great importance since this can prevent the child from having more teeth affected and thereby avoiding invasive treatment. Furthermore, when caries remains untreated it can cause toothache. This relative risk increases dramatically when caries development starts at a young age and when the caries lesions are affecting more than one surface. In general, but especially in these cases, treatment is necessary to take away the pain.

Children suffering from toothache tend to show specific behaviours and these behaviours can be used to identify toothache in both young and mentally impaired children. Therefore, parents and perhaps teachers need to be educated regarding these specific behavioural signals for toothache. Parents should also be encouraged

to bring their children to the dentist for regular check-ups in order to prevent suffering caused by advanced disease.

Furthermore, it seems important for the dentist to be aware of the previous dental experience of children and their level of dental anxiety since this will allow them to tailor their treatment and interventions to the needs of their pediatric patients.

Finally, to assess pain during dental treatment, a behavioural approach in combination with self-reports results in a reliable measurement when dealing with young children. Although the self-reported pain is not always the most reliable measurement for this population, it does give a good indication of the child's experience. It will therefore always remain valuable to ask the child about his or her pain or feelings.

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Samenvatting

Pijn in de kindertandheelkunde

Het lijkt niet meer van deze tijd dat kinderen geen gaaf gebit hebben. Toch heeft meer dan de helft van de drie 5-jarige kinderen cariës. Cariës in het melkgebit kan leiden tot kiespijn waarna er meerdere behandelingen nodig zijn om het gehele gebit te herstellen.

In dit proefschrift staan drie vraagstellingen centraal:

1. Kan kiespijn herkend worden aan de hand van gedrag bij jonge kinderen? (Hoofdstuk 2-6)
2. Hoe kan pijn betrouwbaar gemeten worden bij kinderen tijdens een lokale anesthesie-injectie? (Hoofdstuk 7-10)
3. Welke copingstrategieën worden door kinderen gebruikt als ze pijn hebben tijdens een tandheelkundige behandeling? (Hoofdstuk 11-12).

Jonge kinderen (3 à 4 jaar) kunnen zelf nog niet betrouwbaar aangeven of ze kiespijn hebben. Bovendien denken ouders vaak aan een andere oorzaak, zoals oorpijn, wanneer hun kind eigenlijk last heeft van kiespijn. Hierdoor wordt kiespijn vaak niet als zodanig herkend met als consequentie dat kinderen onnodig lang pijn lijden.

Op basis van interviews met ouders van kinderen met cariës en kiespijn hebben wij een vragenlijst samengesteld met kiespijn gerelateerde gedragingen, de "Dental Discomfort Questionnaire (DDQ)". Ons onderzoek laat zien dat kinderen met kiespijn meer van deze kiespijngerelateerde gedragingen vertonen dan kinderen zonder kiespijn. Voorbeelden hiervan zijn: iets lekkers plotseling weg leggen, aan één kant eten of plotseling naar hun wang grijpen tijdens het eten. Ook bij kinderen met een verstandelijke beperking kan aan de hand van deze gedragingen kiespijn worden herkend. Na behandeling van alle cariës blijkt dat de meeste gedragingen verdwijnen. Na acht maanden lijken de gedragingen echter terug te komen. Mogelijkerwijs heeft dit te maken met de aanwezigheid van nieuwe cariës. Behandelen alleen lijkt dus niet voldoende. Er zal daarnaast ook aandacht gegeven moeten worden aan preventie zodat er na de behandeling geen nieuwe cariës ontstaat.

Vervolgens hebben wij de zelfrapportage en het pijngedrag van kinderen onderzocht tijdens de lokale anesthesie-injectie. Zoals al eerder is vermeld is de zelfrapportage van pijn door kinderen niet altijd betrouwbaar. Maar ook de inschatting van de tandarts blijkt niet altijd realistisch. Uit een van onze onderzoeken blijkt namelijk dat tandartsen een veel lagere inschatting maken over de hoeveelheid pijn van een kind dan zowel de observatoren van het kind als het kind zelf. Een combinatie van zelfrapportage en observatie door middel van video-opnames lijkt uiteindelijk de meest betrouwbare methode te zijn om pijn van kinderen tijdens een lokale anesthesie-injectie te kunnen meten. Daarbij blijft het overigens wel moeilijk om pijngedrag te onderscheiden van gedrag als gevolg van bijvoorbeeld angst en stress.

Met behulp van zelfrapportage en video-opnames is vervolgens gekeken of bij kinderen een nieuwe injectietechniek (Wand®) minder pijn veroorzaakte dan de gebruikelijke injectietechniek. Uit de resultaten van ons onderzoek blijkt dat laagangstige kinderen tijdens de eerste 30 seconden van de injectie op de eerste behandelzitting baat hebben bij deze nieuwe techniek. In het vervolgonderzoek, waarbij is gekeken over twee behandelzittingen, is er echter geen verschil gevonden tussen de nieuwe en de gebruikelijke injectietechniek.

Factoren zoals leeftijd, eerdere ervaring en angstniveau lijken van grotere invloed te zijn op de pijnbeleving van kinderen dan de injectietechniek op zich. Bij jonge kinderen (tot 6 jaar) bleek het angstniveau en de locatie van de injectie van invloed te zijn op de pijnrapportage. Hoogangstige kinderen en kinderen die een injectie kregen in de onderkaak geven hogere pijnscores. Bij oudere kinderen (6-11 jaar) blijkt juist het hebben van een eerdere tandheelkundige ervaring van invloed. Kinderen met een eerdere tandheelkundige ervaring geven hogere pijnscores. Verder bleek voor de hele groep kinderen te gelden dat de pijnscores van de injectie tijdens de eerste behandelzitting voorspellend waren voor de pijnscores van de injectie tijdens de tweede behandelzitting.

Ten slotte is gekeken welke copingstrategieën kinderen gebruiken als ze pijn hebben bij de tandarts. Het blijkt dat elfjarige kinderen voornamelijk cognitieve strategieën gebruiken zoals: “als ik pijn heb bij de tandarts dan denk ik dat het snel over zal zijn”. Hoogangstige kinderen blijken meer extern georiënteerde copingstrategieën te gebruiken zoals: “als ik pijn heb bij de tandarts vind ik het fijn als de assistente mijn hand vasthoudt”. Kinderen met eerdere, mogelijk pijnlijke, tandheelkundige ervaringen in combinatie met een hoog angstniveau (uit Noord-Ierland) blijken meer “destructieve” copingstrategieën te gebruiken zoals: “als ik pijn heb bij de tandarts dan word ik boos op de tandarts”. Factoren zoals leeftijd,

eerdere ervaring en angstniveau blijken een belangrijke rol te spelen in het gebruik van copingstrategieën door kinderen.

Conclusie

De Dental Discomfort Questionnaire (DDQ) met negen verschillende gedragingen blijkt een redelijk goed instrument te zijn om aan de hand van het gedrag van kinderen kiespijn te herkennen. Gedragingen van de DDQ kunnen in de toekomst ouders, leerkrachten, hulpverleners en onderzoekers helpen om kiespijn (eerder) te herkennen bij jonge kinderen zodat deze kinderen niet onnodig pijn hoeven te lijden.

Om pijn van kinderen te meten tijdens de tandheelkundige behandeling is een combinatie van zelfrapportage én observatie van video-opnames een betrouwbare methode. Hoewel jonge kinderen niet altijd in staat zijn om een betrouwbare zelfrapportage te geven is dit altijd informatief om een idee te krijgen hoe een kind zich voelt.

Tot slot blijkt dat het angstniveau, de leeftijd en de eerdere ervaring van grote invloed is op de pijnbeleving en de gebruikte copingstrategieën van kinderen tijdens de tandheelkundige behandeling. Het is voor de tandarts van groot belang om hiervan kennis te nemen zodat hij zijn behandeling hierop kan afstemmen.

Publications

From this thesis

Versloot J, Veerkamp JSJ, Hoogstraten J. Dental Discomfort Questionnaire: assessment of dental discomfort and/or pain in very young children. Community Dentistry and Oral Epidemiology 2006; 34:47-52.

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Other publications

Puts MT, Versloot J, Muller MJ, van Dam FS. [The opinion on care of patients with cancer undergoing palliative treatment in day care]. Nederlands tijdschrift voor Geneeskunde 2004;148:277-280. (Dutch)

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