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No 624

ON DENTAL TRAUMA IN CHILDREN AND ADOLESCENTS

INCIDENCE, RISK, TREATMENT, TIME AND COSTS

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*If you want to succeed in guiding a man towards a predetermined goal
you must find him where he is and start just there.*

Sören Kierkegaard

To my family, Anja
Lena and Pär

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ABSTRACT

Background: Dental trauma occur in childhood and adolescence with consequences in time and costs for both patient and family. The scientific knowledge of these matters is scarce. For some individuals, dental trauma will result in long, time-consuming and costly treatments in childhood which will continue into adulthood.

Aim: The thesis aimed to increase the knowledge of incidence, risk, treatment, time and costs spent on dental traumas to primary and permanent teeth in children and adolescents.

Material and method: The material for the studies emanated from the county of Västmanland, Sweden, and the municipality of Copenhagen, Denmark, and from a Swedish nation-wide material (Folksam). The material was collected from accident reports, dental files, dental trauma forms, questionnaires and telephone interviews. Descriptive, prospective and analytical methods were used. A classification of uncomplicated and complicated dental traumas was presented.

Results: The incidence of dental trauma to boys was higher, compared to girls, in the county of Västmanland in almost all age groups. For both sexes, the first years in life and the first years in school were the most accident prone periods with incidence twice as high as the average incidence for all children and adolescents in the county. Every third trauma was complicated with injuries to the pulp or periodontal ligaments. Every second patient with a dental trauma to permanent teeth suffered from multiple dental trauma episodes (MDTE) during a period of 12 years. In almost every second patient with MDTE, at least one of the affected teeth had sustained repeated trauma episodes. The risk of sustaining MDTE increased when the first trauma episode occurred in the age interval of 6-10, compared to 11-18 year olds. During a 12-year period, treatment times for complicated traumas were 2.0 and 2.7 times higher for primary and permanent teeth, respectively, compared to corresponding values for uncomplicated traumas. On average, direct time (treatment time) represented 11% and 16% of the total time, while the direct costs (health care service, transport, loss of personal property and medicine) represented 60% and 72% of the total costs of traumas to primary and permanent teeth, respectively, during a 2-year period for cases of a nation-wide material.

Conclusion: Dental traumas are frequent and some individuals are injured several times. Besides treatment time, efforts from the family are substantial in time and costs. Parameters such as degree of severity, access to treatment and place of injury are of major importance to both patient and family and should be considered when calculating time and costs of dental trauma in children and adolescents.

Key words: adolescence, child, time, incidence, costs, permanent dentition, primary dentition, risk, tooth injuries.

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ABBREVIATIONS

C	Complicated dental trauma
CPI	Consumer price index
ICD-DA	International classification of diseases to dentistry and stomatology
MDTE	Multiple dental trauma episodes
MSEK	Miljon Swedish kronor
PDL	Periodontal ligament
RTT	Repeatedly traumatized tooth
STT	Single traumatized tooth
SEK	Swedish kronor
U	Uncomplicated dental trauma

ORIGINAL PAPERS

This thesis is based on the following papers, which will be referred to by their Roman numerals I-V.

- I** Glendor U, Halling A, Andersson L, Eilert-Petersson E. Incidence of traumatic tooth injuries in children and adolescents in the county of Västmanland, Sweden. *Swed Dent J* 1996;20:15-28.
- II** Glendor U, Kouchecki B, Halling A. Risk evaluation and type of treatment of multiple dental trauma episodes to permanent teeth. *Endod Dent Traumatol* 2000;16:000-000.
- III** Glendor U, Halling A, Andersson L, Andreasen JO, Klitz I. Type of treatment and estimation of time spent on dental trauma. – A longitudinal and retrospective study. *Swed Dent J* 1998;22:47-60.
- IV** Glendor U, Halling A, Bodin L, Andersson L, Nygren Å, Karlsson G, Kouchecki B. Direct and indirect time spent on care of dental trauma: a 2-year prospective study of children and adolescents. *Endod Dent Traumatol* 2000;16:16-23.
- V** Glendor U, Jonsson D, Halling A, Lindqvist K. Direct and indirect costs spent on care of dental trauma: a 2-year prospective study of children and adolescents. *Community Dent Oral Epidemiol*. Submitted.

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PREAMBLE

The work for this thesis was initiated in 1986, when I had been working as a general dentist for several years and, among other things, had been taking care of children and adolescents with dental traumas. Some of these traumas required prolonged care and the prognoses did not seem too good. When I took care of these young children, seeing their fear and the shock in their eyes soon after the trauma, and with parents asking “what is going to happen now?, how will everything work out in the future?, what will happen to her beautiful smile?...”, I began to wonder whether some of these traumas might not have been prevented. I realised that my knowledge was inadequate in this field and that I had to do something about it. I contacted one of my former colleagues, and with some short notes on a slip of paper, one of the most exciting times in my life began. My interest grew more and more, and I soon made up my mind to focus on a subject which finally ended up with this thesis.

Through participating in the Third International Conference on Dental Trauma in Copenhagen 1991, I came in contact with some enthusiastic colleagues who had a great experience in taking care of dental traumas. A small informal group was formed with the aim of “increasing the knowledge of dental trauma regarding incidence, treatment and costs”. During the years I have been working with this thesis, I have had the privilege to continuously meet the members of this group, which has taught me a lot. My wish is now that my contribution with these series of studies will have some impact for future dental trauma care.

1. INTRODUCTION

The most vulnerable periods of dental traumas occur in childhood and adolescence (for review, see Andreasen and Andreasen 1994). Dental trauma may from a professional point of view seem unproblematic in the acute phase, but the long-term consequences can be considerable. For many cases they can result in life-long, time-consuming and costly re-treatments and maintenance (Andreasen and Vestergaard Pedersen 1985, Andersson 1988, Andreasen and Andreasen 1989, Häyrinen-Immonen et al. 1990, Andreasen and Andreasen 1994, Feiglin 1996, Oulis and Berdouses 1996).

During recent decades, increased research has enhanced our knowledge of clinical and biological aspects of tooth- and bone healing (for review, see Andreasen and Andreasen 1994), whereas the knowledge of occurrence and resources in time and costs spent on dental trauma need to be further elucidated. To the best of our knowledge, there is no study presenting both direct and indirect costs spent on dental trauma.

Dental traumas affect children and adolescents unequally, and the difference is related to biological, behavioural and socio-economic factors as well as the health care organisation (Ottawa charter for health promotion 1986). While some individuals are not affected at all, or just once, during school time, others suffer from multiple dental trauma episodes (MDTE) (Hedegård and Stålhane 1973, Ravn 1974, Onetto et al. 1994).

As a consequence of dental trauma to children and adolescents, several actors are involved comprising generally one or more companions, mostly family members, as support and help. This involvement can consume substantial resources in time and costs. Accompanying patients and waiting at dental visits, but also resources spent, e.g. in transportation, lost working or leisure time and actual costs for damaged personal equipment are examples of this.

In times of economic constraints, the need for knowledge in health economics is even more important as a basis for judging health gain in curative and preventive care within dental traumatology as well as assessing epidemiological tools for evaluating the consequences of dental traumas. Questions about what the individual, the caregiver and the society can do to reduce incidence, duration of treatment and complications from dental trauma await for answers.

2. AIMS

General aim

The general purpose of the five studies presented in this thesis was to increase the knowledge of incidence, risk, treatment, time and costs spent on dental traumas to primary and permanent teeth in children and adolescents.

Specific aims

- To determine the incidence of different kinds of traumatic tooth injuries related to age and gender (I).
- To evaluate the risk of multiple dental trauma episodes to permanent teeth (II).
- To compare types of treatments used between patients with one and those with more than one trauma episode and with single and repeatedly traumatized permanent teeth (II).
- To estimate the total time spent in treating uncomplicated and complicated dental traumas (III).
- To account for the total time, direct and indirect, in the treatment and care of dental trauma (IV).
- To account for the total costs, including direct and indirect costs, and to present predictors of importance to the costs in treatment and care of dental trauma (V).

3. MATERIAL AND METHODS

The materials in Paper I – V were based on samples collected from the county of Västmanland, Sweden (I), the municipality of Copenhagen, Denmark (II, III) and a national register from an insurance company, Folksam, Sweden (IV, V). The participants in the studies were children and adolescents attending regular dental care at the public dental health services free of charge in Denmark ($n=106$) and in Sweden ($n=883$). Dental traumas to primary and permanent teeth were classified as uncomplicated (U) and complicated (C). The studies were of descriptive and analytic character, and the designs were historical prospective and prospective. An overview of materials, drop-outs and methods used related to studies of incidence (I), risk and treatment (II, III), time (IV) and costs (V) spent is presented in Table 1 and 2.

Table 1. Characteristics of the studies; materials and methods related to incidence, risk and treatment, time and costs

PAPERS	I (Incidence)	II (Risk) III (Treatment)	IV (Time) V (Costs)
Source of population	County of Västmanland	Municipality of Copenhagen	Swedish policy holders at Folksam
No of injured	$n=691$, age ≤ 19 years, 425 boys, 266 girls	$n=83$, age 6-18 years (II), $n=106$, age 2-18 years, 62 boys, 44 girls (III)	$n=192$, age 1-17 years, 121 boys, 71 girls
Drop-outs	15.5%	12.4%	4.0%
Period	1989-1990	1972-1988	1992-1995
Data sources	Physical and dental injury form	Dental file, specific dental trauma file, questionnaire	Accident report, dental injury form, checklist
Type of study	Descriptive/prospective	Descriptive and analytical/historical prospective	Descriptive and analytical/prospective

Table 2. Methods used in Paper I-V

Paper	I (Incidence)	II (Risk)	III (Treatment)	IV (Time)	V (Costs)
Data registration					
Classification of dental trauma	+	+	+	+	+
Historical prospective		+	+		
Prospective	+			+	+
Questionnaire			+	+	+
Telephone interview				+	+
Statistical methods					
Binominal test			+		
Chi-square test	+	+	+	+	+
Cox regression analysis				+	
Interaction test				+	+
Kappa statistics				+	
Multicollinearity test				+	+
Multiple regression analysis				+	+
Reliability			+	+	+
Student's t-test			+		
Survival analysis		+			
Validity	+	+	+	+	+

Classification of dental trauma

Dental traumas were classified (UG) into uncomplicated and complicated taking into account the increased risk of complications such as pulpal necrosis or root resorption, i.e. when the pulp has been exposed by fracture or the periodontal membrane injured by dislocation of the tooth (Andreasen and Vestergaard Pedersen 1985, Andreasen et al.1987, Andersson 1988, Feiglin 1996). The diagnoses used were in accordance with the International Classification of Diseases to Dentistry and Stomatology (ICD-DA, WHO 1992) as revised by Andreasen & Andreasen for teeth with dental trauma (Andreasen and Andreasen 1994, p. 151-155).

Incidence of dental trauma

The material for calculating incidence of dental trauma (I) was collected from a prospective study presenting all physical injuries including dental traumas affecting persons in all ages in the county of Västmanland, Sweden during the period 1 October 1989 to 30 September 1990 (Eilert-Petersson 1993) (Table 1). Registration took place at all public health institutions in the county (district dental clinics including specialist clinics, hospital emergency rooms and health centres). Private dentists participated mainly in the registration of patients seeking acute treatment at the county's emergency dental clinic. Individuals who were injured outside the county were registered when they came for further treatment.

Information about patients in the age interval 0-19 years of age, gender, date and type of injury was recorded from the registration form of all physical injuries (Appendix 1), and data on injured teeth and extent of the dental injuries was obtained from a special dental trauma form from the caring dentists (Appendix 2).

Risk evaluation of multiple dental trauma episodes and treatment time of dental trauma

In Paper II, and Paper III, respectively 83 patients with 160 dental trauma episodes (permanent teeth) and 106 patients with 203 episodes (primary and permanent teeth) were included in the studies (Table 1). The patients, born in 1970, were randomly selected from a database representing the last three decades at the University Hospital in Copenhagen, Denmark of all dental files and specific dental trauma files of children and adolescents treated by the School Dental Service, Municipality of Copenhagen and the Department of Oral Medicine and Oral and Maxillofacial Surgery, University Hospital (Rigshospitalet), Copenhagen. The designs of studies II and III were historical prospective, using descriptive methods. Study II also included a survival analysis.

In Paper III, data were collected from dental files and specific dental trauma files on the number of visits and types of treatment delivered on uncomplicated and complicated trauma to primary and permanent teeth and from a questionnaire time study to 14 care-providing school dentists. The data in the questionnaire time study covered the frequency of different types of dental traumas, estimated treatment time, and a statement of comparison of two periods. The criteria for including the 14 school dentists was that they should have provided treatment to the patients in the study when the traumas occurred,

but also be on duty when the questionnaire time study was performed.

From the questionnaire time study (Appendix 3), three different types of data were collected:

1. Frequencies of different types of dental traumas treated during the previous two years (1995-1996).
2. Estimated treatment time for different emergency measures (time for patient in treatment room) and planned measures (time reserved in appointments diary) according to the routines used for making appointments related to time for information and follow-ups, composite restorations, endodontics, surgery, prosthetics, consultations, contact with relatives/referrals, etc.
3. Statement of estimated treatment times comparing the periods of 1972-1988 and 1995-1996.

Direct and indirect time and costs of dental trauma

The material, presented in Paper IV and V, was based on a consecutive random sample of 511 insured children and adolescents in the age interval 0-19 years, who reported a dental trauma to the insurance company, Folksam, Sweden during a 3-month period in 1993. The study was maximised to 200 patients consisting of all patients with complicated traumas to permanent teeth (n=37) and a consecutive random sample collection of 163 patients consisting of uncomplicated traumas to primary and permanent teeth and complicated traumas to primary teeth. Eight patients discontinued their participation; thus the final number was 192, aged 1-17 years (Table 1). Every trauma was followed during two years from the dental trauma episode.

The designs of studies IV and V were prospective, using descriptive methods including regression analysis. Information about the dental trauma episode was collected from an accident report at the insurance company (Appendix 4) about when, where and how the dental trauma occurred and about the type of care providers involved. Other information collected was from a dental injury form mailed to the attending dentists about injured teeth and trauma diagnoses (Appendix 2), and from patient and parent information about direct and indirect time (IV) and costs (V) spent. Direct and indirect time activities and variables of costs for patient and companion at the emergency visit and at all visits after dental trauma are presented in Table 3. The information was collected by telephone interviews following a predetermined checklist (Appendix 5).

Table 3. Direct and indirect time activities and variables of costs for patient and companion at the emergency visit and at all visits after a dental trauma

	Emergency visit		All visits	
	Patient	Companion	Patient	Companion
Direct time				
Treatment	+	*	+	*
Indirect time				
Pre- and post ¹	+	+	+	+
Transport	+	+	+	+
Waiting	+	+	+	+
Nursing (hospital, home)	+	+	+	+
Direct costs				
Health care service	+	–	+	–
Transport	–	+	–	+
Personal property	–	–	+	–
Medicine	–	–	+	–
Indirect costs				
Loss of production or leisure	–	+	–	+

¹ Pre-time was time from notification of dental trauma until transport began and post-time was time after transport was completed and earlier activity was resumed.

– No costs recorded.

* The companion's treatment time was included in waiting time.

Statistical methods

Differences in the distributions of categorical data were tested by chi-square tests, and $p < 0.05$ was considered statistically significant (I-V).

Survival analysis (Kaplan-Meier) was used to estimate the risk of receiving a repeatedly traumatized tooth (Armitage and Berry 1994) and to show time-to-event, where event was defined as the second, third, and fourth dental trauma episode (II).

The binominal test was used to test differences between proportions, and Student's *t* test was used to test differences between means (III).

Agreement between variables measured on different occasions or recorded from different sources was analysed by the Kappa statistic (Fleiss 1981). The value of the Kappa statistics with the categories given by Landis and Koch (1977) was interpreted (IV).

The outcome variables of time (direct time, transport time, other time, total time) and costs (costs within the health care service, transport costs, total costs) for the patients and companions in connection with treatment of dental trauma were presented descriptively and analysed by multiple regression analysis (IV, V). A secondary analysis of the time variables was performed using Cox proportional hazard regression models with the same set of explanatory variables as in the multiple regression analysis (IV). The models were also examined for the presence of multicollinearity and interactions between the explanatory variables. No differences were found (IV, V).

Drop-outs

The share of drop-outs was 15.5% (I), 12.4% (II, III) and 4.0% (IV, V). Drop-outs were mainly found among those where dental trauma was not reported or the information was incomplete, or due to discontinued participation.

Validity and reliability

Almost all patients with dental trauma were taken care of at the Public Dental Services in both Sweden and Denmark. If the acute treatment was taken care of in a private dental clinic, the patient was referred back to a public dental clinic and thus registered (I, II, III). The diagnoses were based on generally accepted criteria (ICD-DA, WHO 1992, Andreasen and Andreasen 1994, p. 151-155), and directives for diagnoses and treatment of dental traumas are generally followed at each clinic (I-V). The registration of dental trauma in the county of Västmanland was based on well-established routines and printed guidelines as a result of continuously ongoing courses in treatment of dental trauma during the 80s (I). Dental traumas in the municipality of Copenhagen, from where the random sample was collected, have been documented and collected systematically at the University Hospital during more than three decades.

Reliability tests were performed on the number of trauma episodes (III), classification into uncomplicated and complicated traumas (III, IV), number of visits (III, IV) and registration of diagnoses (IV). The tests showed a good agreement concerning the

number of dental trauma episodes (III) and verified that the classification into uncomplicated and complicated traumas was easy to use (III, IV). A high agreement was also found between the number of visits recorded by companions and those noted in dental records (IV), whereas there was a discrepancy in the number of visits due to a lack of identification of non-clinical and clinical treatments (III).

To test the agreement, the wages of all male and female companions with loss of production in our study were compared with figures found in official wage statistics in Sweden (V). A good agreement was found for females, but higher wages for males were found in our study, compared with males in Sweden. This overestimation of males' loss of production only represented 3% of the total costs of loss of production (V).

Ethical considerations

The studies have been approved by local ethical committee and by the Swedish Data Inspection Board.

4. RESULTS

Paper I

Incidence

The incidence during one year (1989/1990) in the county of Västmanland, Sweden, in the age interval 0-19 years was 13.0 individuals and 13.2 injury episodes per 1000 individuals at a ratio of 1.6:1 boys to girls. The age interval 0-19 years represented 83% of all dental traumas in all ages in the county. The highest incidence to both sexes occurred in the ages of 2, 8 and 9 years (in average 22.4 individuals per 1000 per year), suggesting that the first years in life and the first years in school are the most accident prone periods. The incidence of dental traumas for boys was higher in almost all ages, compared to girls. Boys showed their highest incidence in the ages of 2-4 and 7-12, representing 62% of all boys with a mean incidence of 23.8 individuals per 1000 per year. Girls showed their highest incidence in the ages of 2-12 years, representing 75% of all girls with a mean incidence of 14.5 individuals per 1000 per year. The highest incidence of complicated injuries to permanent teeth occurred in the age intervals of 7-12 years.

Complicated traumas occurred in 33% of all dental traumas in the age interval 0-19 years in the county and in 14%, to permanent teeth. Luxation injuries dominated for primary teeth, while there was a majority of hard tissue injuries for permanent teeth. Subluxation was the overall dominating diagnosis for primary teeth, and uncomplicated crown fracture, for permanent teeth. Complicated traumas, irrespective of gender, were represented mainly by intrusion and lateral luxation to primary teeth and complicated crown fracture and lateral luxation to permanent teeth.

In Table 4, diagnoses are presented as uncomplicated (U) and complicated (C) traumas to primary and permanent teeth according to fractures with and without pulp exposure and luxations with and without dislocation.

Table 4. Number of diagnoses (n=1,537) of uncomplicated (U) and complicated (C) traumas to primary and permanent teeth

Diagnoses ¹	Primary		Permanent	
	U	C	U	C
Fractures without pulp exposure	76		546	
Infracton	12		119	
Uncomplicated crown fracture	61		412	
Uncomplicated crown root fracture	3		15	
Fractures with pulp exposure		19		79
Complicated crown fracture		8		49
Complicated crown root fracture		2		9
Root fracture		9		21
Luxation without dislocation	255		259	
Concussion	80		134	
Subluxation	175		125	
Luxation with dislocation		219		84
Intrusion		78		3
Extrusion		30		14
Lateral luxation		73		49
Exarticulation		38		18
TOTAL	331	238	805	163
	569		968	

¹ Source: ICD-DA, WHO (1992) and Andreasen and Andreasen (1994).

Paper II

Risk

Of 83 patients with a total of 160 dental trauma episodes to permanent teeth during a period of 12 years, 41 were registered with multiple dental trauma episodes (MDTE), mean 2.9/patient, SD=1.1. No significant gender differences were found between the number of single episodes and MDTE. The mean age of patients with single episodes was 11.4 (SD=3.6) years, compared to 8.6 (SD=2.1) years for patients with MDTE episodes. Of all patients in the study, the number of patients with MDTE was significantly higher among those who suffered their first trauma episode in the age interval 6-10 years, compared to patients who suffered their first trauma episode in the age interval 11-18 years ($p<0.001$). The risk of sustaining MDTE was 8.4 times higher when comparing the first trauma episode at 9 and 12 years of age. The time intervals between each subsequent trauma episode became ever shorter.

For patients with one trauma episode, follow-ups were the most common type of treatments, representing 53%, whereas an increased number of trauma episodes per patient was followed by an increased number of follow-ups, filling therapy, information and prosthetic treatment.

In 45% of all MDTE, at least one of the affected teeth had sustained repeated trauma episodes. When repeated traumas occurred to the same tooth (RTT), there was an increase in follow-ups, filling therapy and information, whereas there were minor differences when there were no repeated injuries to the same tooth (STT).

Paper III

Dental traumas occurred in boys and girls at a ratio of 1.4:1. Primary teeth mainly suffered luxation injuries, while fractures were the most common type of injury in the permanent dentition ($p<0.001$).

Treatment time

The number of visits and treatment time per individual for trauma to primary and permanent teeth, during an average period of 12 years, amounted to 3.0 (range 1-12) visits and 1.0 (range 0.3-4.4) hours, and 10.6 (range 1-27) visits and 4.2 (range 0.3-20.5)

hours, respectively. Complicated traumas to permanent teeth represented an average of 16.4 (range 1-24) visits and 8.5 (range 1.7-20.5) hours per individual. Treatment time for permanent teeth exceeded that of primary teeth and especially complicated traumas to permanent teeth showed large variations per individual, compared to other dental traumas (Fig 1). Fifteen percent of all individuals, representing 18% of all trauma episodes, suffered complicated traumas to permanent teeth and the same individuals consumed 36% of all treatment time during the period.

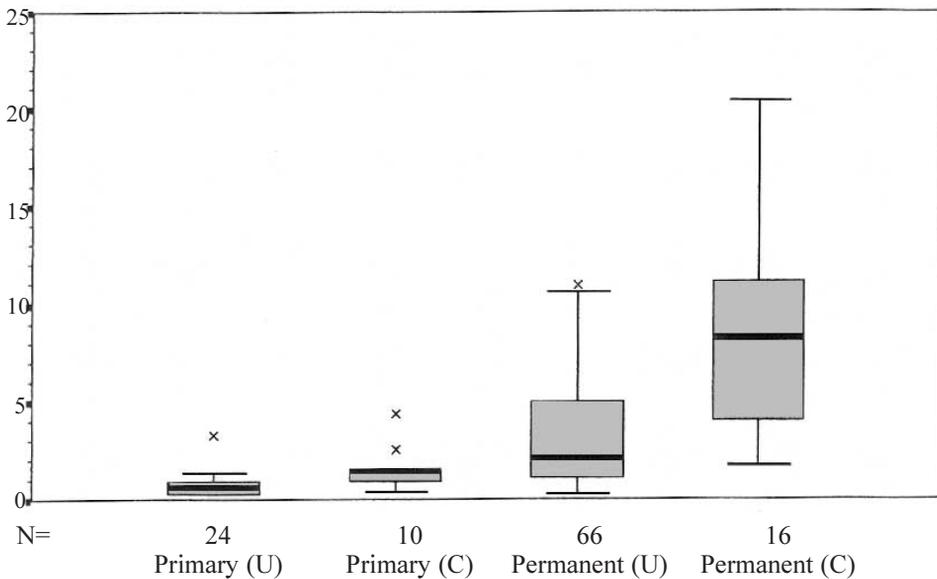


Fig. 1. Total estimated treatment time of individuals in the age interval 2 - 18 years with uncomplicated (U) and complicated (C) trauma episodes to primary and permanent teeth.

Type of treatment

During emergency treatment for uncomplicated traumas, irrespective of dentition, the visits were mainly used for information, whereas for complicated traumas, besides information, primary and permanent teeth were mostly treated with extractions. Furthermore, for permanent teeth, surgical and endodontic treatment was also given. Filling therapy was performed to a smaller extent on permanent teeth, independently of degree of severity.

At planned treatments, follow-ups were the dominant type of treatment, irrespective of dentition and degree of severity. For complicated traumas to permanent teeth, follow-ups were complemented with, in descending order, endodontic treatments, filling therapies, prosthetic, consultations, and contacts with relatives/referrals etc., and surgical treatments. There were more consultations etc., than prosthetics at complicated trauma to permanent teeth.

Within the first year uncomplicated traumas to permanent teeth required endodontic treatment in 3% of the cases, compared to 67% in complicated traumas. After the first year endodontic treatment was needed for only two cases with uncomplicated dental traumas.

The school dentists in Copenhagen reported uncomplicated hard tissue or luxation injuries once or more a month and complicated injuries once or more a month or once or more a year. A comparison of treatment times during the periods of 1972-1988 and 1995-1996 showed a tendency towards increased treatment time for information and follow-ups and less time for endodontics, surgery and prosthetics in the latter period.

Paper IV

Dental traumas occurred in boys and girls at a ratio of 1.7:1 and, in general, more often in other places and in traffic settings than in day-care centres or schools in all age groups, except in the age group of 7-9, where no difference could be seen. Complicated traumas occurred significantly more often in other places and in traffic settings than in day-care centres or schools ($p<0.005$). Falls were significantly more frequent causes of traumas to primary teeth, compared to being hit, pushed or struck ($p<0.001$), whereas there was no difference for permanent teeth.

Total time

Total time during a period of two years for traumas to primary and permanent teeth, including both patient and companion, represented an average of 7.2 (SD=8.4) hours and 16.1 (SD=20.0) hours, respectively. Of total time the direct time (treatment time) only constituted 11% and 16% for trauma to primary and permanent teeth. Transport time, irrespective of type of dentition, was the most extensive indirect time variable of all, representing about one third of the total time.

Multiple regression analysis

The presence of complicated trauma in both the dentitions had a strong impact on all time variables in the multiple regression analysis. For complicated traumas to permanent teeth, there was a significant increase (102 - 134%) in total time for both patient and companion, compared to uncomplicated trauma. Lack of access to a dental clinic near the place of residence, as expected, also showed a high, independent contribution to transport time for both patient and companion, irrespective of dentition. Emergency dental traumas professionally attended outside working hours increased the values of total time, transport time and total other time for patients with injuries to permanent teeth. Traffic settings increased all time variables for both patient and companion, except for transport time. The regression analysis showed no significant difference at any of the time variables for the gender variable.

A graphic representation of a hazard function of total time, according to the severity of trauma to permanent teeth showed the proportions of patients in treatment for the 2-year period. The hazard ratio indicated that patients with complicated dental trauma have a strong tendency to stay in treatment, whereas patients with uncomplicated trauma finished treatment more quickly (Fig 2).

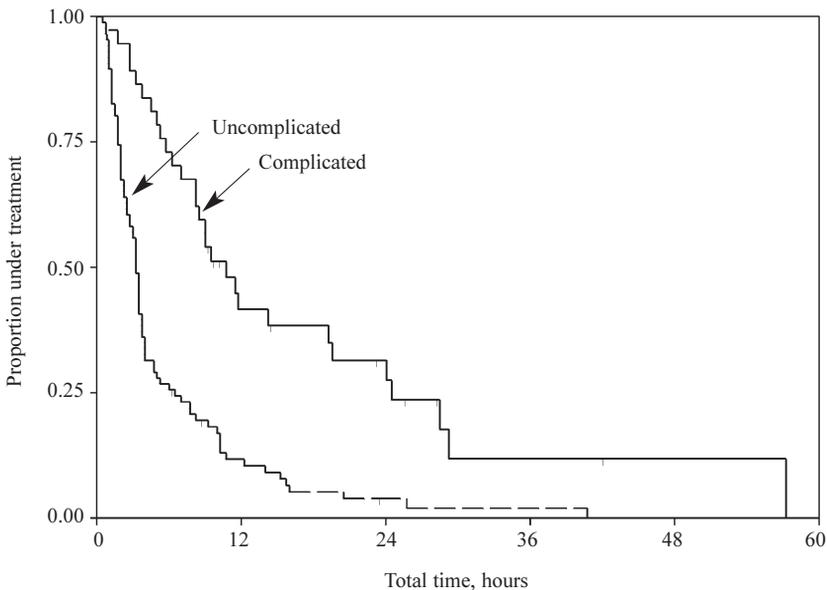


Fig. 2. Total time stratified according to severity of trauma for patients, permanent teeth. Proportion of patients remaining in treatment for the 2-year period following initial treatment is shown for uncomplicated trauma ($n = 86$) — — — — , and for complicated trauma ($n = 37$) ————. Censored observations = |.

Paper V

Total costs

Total costs per patient, including the average number of companions, for traumas to primary and permanent teeth were SEK 1,746 (range 5-10,272) and SEK 4,569 (range 106-24,791), respectively. Health care service costs for traumas to primary and permanent teeth were SEK 837 (range 84-5,534) and SEK 2,955 (range 167-24,491), which was 48% and 65% of total costs, respectively. Direct costs (health care service costs, transport costs, costs from loss of personal property, and medicine costs) represented 60% of the total costs for primary teeth and 72%, for permanent teeth. Indirect costs (loss of production or leisure) amounted to 28% of the total costs for permanent teeth and 40% for primary teeth, whereas transport costs represented only 5% and 12%, respectively. On average, the number of companions engaged per patient with traumas to permanent teeth was 1.4 and 1.2 for primary teeth.

Multiple regression analysis

The regression analysis showed, as in Paper IV, that the degree of severity and access to treatment were of major significance to direct and indirect costs at dental trauma. Complicated trauma, compared to uncomplicated trauma to permanent teeth, increased the patient's health care service costs, the companions' transport costs and total costs by 108 - 151%, which was comparable with the results from Paper IV. The gender variable showed no significant difference for any of the cost variables included in the regression analysis.

5. DISCUSSION

The material in the thesis was based on samples from large and well-defined populations: a county, a municipality and a national insurance company, and the drop-out frequencies were low (4.0-15.5%). The low drop-out rate may be interpreted as an expression of the importance of teeth as reflected by the concern of the parents, day-care staff, school nurses, teachers, sport leaders, friends, neighbours etc., but probably also due to the personal contacts (UG) when interviewing the families by telephone (IV, V). As a conclusion, the Swedish material should be regarded as representative of a county (I) and of a nation-wide insurance company (IV, V), while the Danish material should primarily be regarded as representative of large municipalities like Copenhagen (II, III).

Data for the studies were based on a number of documents with information already collected. These documents were physical and dental injury forms (I), dental files and specific dental trauma files (II, III) and accident reports (IV, V). Special forms were designed to obtain more specific information about resources spent on dental traumas concerning estimated treatment times, type of treatments delivered (III) and time and costs spent (IV, V). Lack of information was related more to information already collected, than in the specially designed forms. By spending a great deal of work on finding missing information, only a few patients were excluded due to loss of information (I, III). In Paper I, information was focused on the degree of severity, whereas setting and injury mechanism were not included. These variables were instead included in Paper IV and V.

The appointment diaries were not available for the studies in Paper III. Therefore, a questionnaire time study had to be designed to get the estimated treatment time for different emergency and planned measures performed earlier. In order to get as accurate a treatment time as possible, 14 school dentists, who had treated the patients and were still on duty, were identified. These school dentists classified the estimated treatment time in a maximum, minimum and normal value due to e.g. type of patient, the dentist's skill etc. The normal value from each dentist was then used to present the average value of estimated treatment time for different specific treatments.

The method used in presenting costs as direct costs (costs within health care service, transport, loss of personal property and medicine) and indirect costs (costs due to loss of

production or leisure) was based on accepted methods of presenting illness costs (Lindgren 1981, Drummond et al. 1993, Weinstein et al. 1997). A real life study was performed based on a predetermined checklist (Appendix 5) via telephone interviews with people directly involved (IV, V). This has been shown to be preferable, to sending a questionnaire by post (Karlsson et al. 1997). A review showed studies with comparable methods of presenting direct and indirect costs (Lindgren 1981, Jönsson and Karlsson 1990, Drummond et al. 1993, Miller and Galbraith 1995, Lindqvist and Brodin 1996, Jacobsson and Lindgren 1996). Some studies suggested that sickness-allowance should be included in calculations of costs of illness (de Loes 1990, Mönestam and Björnstig 1991, Lindqvist and Brodin 1996), whereas others considered that it should not to be included due to double-counting of production loss and a serious overestimation of the costs of inputs (Lindgren 1981). We decided sickness-allowance not to be included in the calculations.

We measured both loss of production and lost leisure time in monetary terms, as suggested by Lindgren (1981), Drummond et al. (1993), and Lindqvist and Brodin (1996). The value was set to averaged annual earnings of men and women on the labour market in Sweden (Höggqvist et al. 1998). For the patients, we have not presented their lost leisure or school time in monetary terms, which has resulted in an underestimation of indirect costs.

The value of health care service costs, based on information from the County Councils in Sweden, is a fairly rough estimation as there is not yet a constraint to present these types of economic values.

Dental traumas were classified as complicated or uncomplicated. The reason for this level of classification was twofold; First, it should be easy to use by adopting the classification used in clinical praxis. The second reason was that it should be related to risk of complications. We assumed that complications required more treatment time. The results showed that this was a correct assumption. Fractures *without* pulp exposure have been shown to result in less pulp necrosis in 0-6% of cases, and luxations without dislocation, in 3-6% of cases, whereas fractures *with* pulp exposure have shown pulp necrosis in 20-44% of cases, and luxations with dislocation, in 26-96% (Andreasen and Andreasen 1994). Andreasen et al. (1987) showed that concussion and subluxation have a good prognosis, whereas luxations with dislocation (extrusion, lateral luxation and intrusion) increase the risk of pulp necrosis (Fig 3-4).

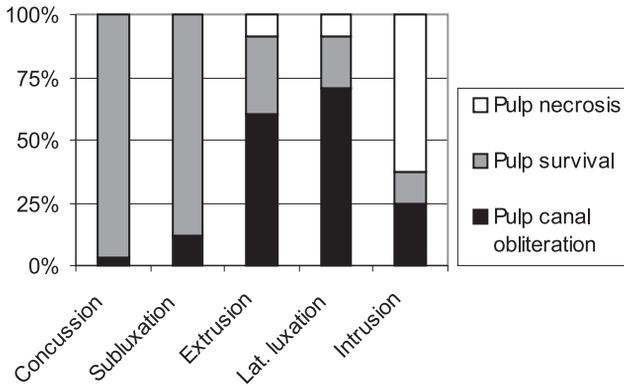


Fig. 3. Pulpal healing following luxation injuries in the permanent dentition: Open apex.
Source: Andreasen et al. 1987.

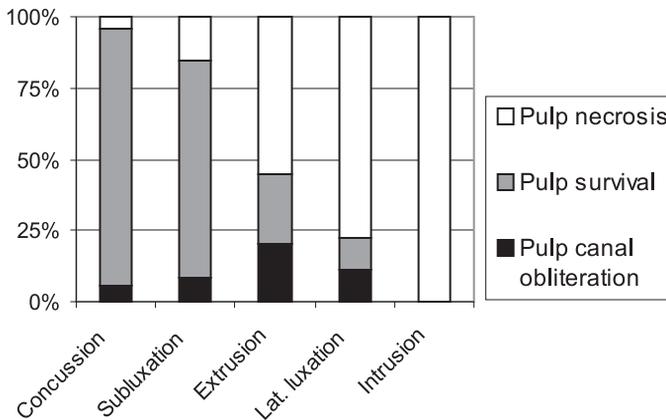


Fig. 4. Pulpal healing following luxation injuries in the permanent dentition: Closed apex.
Source: Andreasen et al. 1987.

The degree of luxation has been shown by Andreasen and Vestergaard Pedersen (1985) to be of importance to the survival of the periodontal ligament (PDL), where e.g. subluxation presented a better prognosis for PDL healing (Fig 5), compared to lateral luxation (Fig 6).

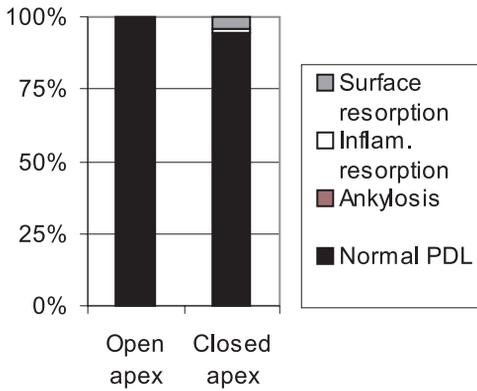


Fig. 5. Periodontal healing in the permanent dentition after subluxation.
Source: Andreasen and Vestergaard Pedersen 1985.

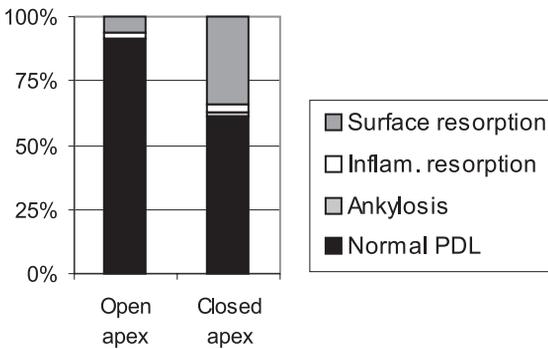


Fig. 6. Periodontal healing in the permanent dentition after lateral luxation.
Source: Andreasen and Vestergaard Pedersen 1985.

Concussion and subluxation, therefore, should be regarded as a low risk for periodontal complications.

Classification of dental traumas regarding degree of severity has earlier been used by Järvinen (1978) and recently in a study of dental traumas performed in Norway by Engelhardtson et al. (1998). In all three classifications, there is a concordance regarding pulp exposure and dislocation of the tooth in all diagnoses, except for uncomplicated crown root fractures (Järvinen 1978, Engelhardtson et al. 1998), root fractures in the apical third, and in subluxation (Engelhardtson et al. 1998). Subluxation, or loosening, is an injury to the tooth-supporting structures with abnormal loosening but without

clinically or radiographically demonstrable displacement of the tooth (Andreasen and Andreasen 1994). With no risk of pulpal necrosis and a minimal risk of root resorption (Andreasen and Vestergaard Pedersen 1985, Feiglin 1996), subluxation, we suggest, should be regarded as uncomplicated. The frequency of uncomplicated crown root fractures and root fractures in the apical third to permanent teeth was lower than 2% of all injuries in Paper I, and would probably be of minor epidemiological importance.

The most severe diagnosis was chosen when there was a combination of several diagnoses on the same tooth, a method which has also been suggested by Järvinen (1978) and Solli et al. (1996). The most severe diagnosis was also chosen in our classification when more than one tooth was injured in the same episode, or in multiple episodes to the same patient (II, III). This was due to that the most severe injury in a dental trauma will determine time and costs spent and thus the group of classification.

Incidence

The majority of the dental traumas were in the age interval 0-19 years, representing 83% of all traumas (I). Davis and Knott (1984), Ianetti et al. (1984) and Redfors and Olsson (1996) found similar figures (71-92%), confirming childhood and adolescence as the most accident prone period in life. Moreover, the first years in life and the first years in school showed the highest incidence peaks and boys were shown to be more often injured than girls. The medial and lateral incisors were more often injured than other teeth, primary teeth mostly sustain luxation injuries and permanent teeth hard tissue injuries. All these results are similar to other studies and represent a well-known pattern of dental trauma (Andreasen and Ravn 1972, Hedegård and Stålhane 1973, Ravn 1974, Forsberg and Tedestam 1990, Borssén and Holm 1997, Engelhardtson et al. 1998).

The annual incidence of dental trauma in the county of Västmanland in the age interval 0-19 years was 13.0 individuals per 1000 per year (I). Previous studies in Sweden in large and well-defined areas have reported almost the same incidences of 11-15 per 1000 per year (Hedegård and Stålhane 1973, Sundell and Sundqvist 1991). The results show that the incidence of dental trauma in Sweden is probably stable over time.

Complicated traumas, irrespective of dentition, represented 33% of all traumas to children and adolescents in a county of Sweden, while 15% were complicated traumas to permanent teeth (I). The frequency of individuals with complicated traumas to permanent teeth in the Danish study (III) was also 15%. One can argue that the frequency of compli-

cated traumas to permanent teeth would change during the 12-year period in the Danish study, especially since a number of patients were injured more than once (III). The results showed, however, that patients who were injured several times did not receive complicated traumas to permanent teeth more often than those injured only once (II).

By performing continuously ongoing registrations of dental trauma, it is possible to show the changes in incidence, and especially in the number of complicated traumas to permanent teeth. This knowledge may reflect the future need of resources for complicated dental traumas.

Risk

Multiple dental trauma episodes (MDTE) were registered for every second patient with a dental trauma among 6-18-year-olds (II). This is more than has been reported in other studies (16-30%) (Hedegård and Stålhane 1973, Ravn 1989, Onetto et al. 1994). Forty-five percent of the MDTE was also shown to have at least one of the same teeth affected (II). This is also more than has been shown by Hedegård and Stålhane (1973) (8%) and Stockwell (1988) (13%). These results might be explained by the long follow-up period in our study (in average 12 years), showing the importance of following the patients during a long period.

The results indicated that, of all patients, the number of patients with MDTE was significantly higher for those who suffered their first trauma episode in the age interval 6-10 years, compared to patients in the age interval 11-18 years (II). There obviously seems to be a critical period around nine years of age for dental trauma (I, III, IV). There may be several reasons for this “peak”. One reason could be an increasing protrusion of the medial incisors and therefore also an increased risk of additional traumas (Järvinen 1978, Nguyen et al. 1999). The results also showed that the number of treatments, and especially follow-ups, filling therapy and information, increased when MDTE affected already traumatized teeth. The danger with teeth with repeated injuries might be a reduced potential in future pulpal and periodontal healing, a fact which also has been suggested by (Bakland and Andreasen 1996). A prevention of MDTE would therefore decrease not only trauma episodes, but also the need for future treatment.

Treatment time

The most extensive total treatment time per individual was found for those children and adolescents who suffered complicated traumas to permanent teeth (8.5 hrs), compared to

uncomplicated traumas to permanent teeth (3.2 hrs) and traumas to primary teeth (0.8-1.6 hrs). The treatment time for permanent teeth per individual showed large variations, compared to traumas to primary teeth, and was strongly connected to complicated traumas (Fig 2) (III). Solli et al. (1996) showed a treatment time per individual for permanent teeth of 0.7 hrs for trivial, 1.2 hrs for small, 1.7 hrs for moderate, and 2.1 hrs for serious traumas to permanent teeth, where the moderate and serious traumas could be regarded as complicated. Josefsson and Lilja Karlander (1994) showed an average treatment time of 1.2 hrs per trauma episode and more than 3 hrs for a small number of patients with traumas to permanent teeth. The difference between the studies may be due to the length of time, 12 years in Paper III, compared to one year in the other studies (Josefsson and Lilja Karlander 1994, Solli et al. 1996), but all three studies concluded that degree of severity was of great importance to treatment time, a fact which has also been suggested by other authors (Sane et al. 1988, Häyrynen-Immonen et al. 1990).

The importance of follow-ups appeared to a great extent to be connected with the severity of dental trauma. However, it must be questioned whether uncomplicated traumas to permanent teeth need an average of 6.3 follow-ups, when only 3% of the teeth received endodontic treatment during a period of 12 years. Complicated traumas to permanent teeth needed an average of 9.1 follow-ups, where 67% received endodontic treatment. An injury to the pulp due to an uncomplicated trauma is less severe to the PDL, compared to a complicated injury. In the first case, we only have to deal with an injured pulp, whereas in the second case there is also a risk of root resorption. These findings may be considered when follow-up schedules are planned for uncomplicated dental traumas, a fact which has also been stressed by Solli et al. (1996). All endodontic treatment began, irrespective of degree of severity, during the first year following a dental trauma, except for two patients with uncomplicated trauma (III). A suggestion is therefore to reduce follow-ups for uncomplicated traumas to permanent teeth and when the risk of complication is low incorporate them as much as possible into the regular check-ups.

Time and costs

In Paper IV (study of time) and Paper V (study of costs), the regression analysis showed very strong influence of degree of severity and access to dental treatment regarding time and costs. This is because a complicated injury, especially to permanent teeth, is a serious problem to the pulp and the PDL (Andreasen and Vestergaard Pedersen 1985, Andreasen

1989, Feiglin 1996), demanding extensive time in the form of clinical treatment and follow-ups during childhood (III).

Though incidence in almost all age-groups for both uncomplicated and complicated dental traumas to primary and permanent teeth was higher for boys than girls (I), both sexes suffered from the same degree of complicated traumas to permanent teeth (I, III), a finding also noted by Oikarinen and Kassila (1987) and Schatz and Joho (1994). Forsberg and Tedestam (1990) and Solli et al. (1996) however, registered more severe traumas to permanent teeth among boys. In the study by Forsberg and Tedestam (1990) dental trauma to boys was indicated to be generally more severe and require treatment more often than in girls, but our results showed that if a child or an adolescent suffered a dental trauma, gender was of no significance to time or costs (IV,V).

Time used by professional caregivers on dental trauma to permanent teeth represented only 16% of total time, while health care service costs represented as much as 65% of total costs. This is due to the fact that costs for health care service, despite shorter treatment times, are much more expensive than costs incurred by companions for loss of production or leisure. The difference in time and costs was also seen in transport, where 30% of transport time represented only 5% of total costs in trauma to permanent teeth. This difference shows the necessity of also including the time used in calculating total costs. Loss of time for the injured child or the parents working at home must also be taken into consideration. Prevention must be seen from two point of views; saving money on one hand, but also time on the other hand.

For a complicated trauma to permanent teeth, studies have shown that time is essential for the prognosis due to the complexity of this type of trauma with respect to wound healing (Andreasen et al. 1995). Access to treatment is therefore of great importance. But keeping access to treatment at a high level is expensive, especially for traumas occurring outside working hours. Though earlier studies have shown that approximately half of all dental traumas in the age interval of 0-19 years occurred during leisure time, when most dental clinics were closed (Eilert-Petersson et al. 1997), our results showed that only 6-19% of the patients actually sought emergency attention outside working hours and irrespective of the degree of severity (IV). Most patients have a special and close relation to their dentists and probably wait until there is access to their "own" dental clinic. For others, it is less important who takes care of the trauma and for a minor number of the patients, it is essential to be treated as quickly as possible because of the severity of the trauma.

The models developed in Papers IV and V identified independent variables and showed how much each of them influenced the different variables of time and costs. The models can be used to calculate total time and costs for both patients and companions on trauma to primary and permanent teeth during a 2-year period, but also to calculate separate values such as health care service and transport. By performing calculations with different scenarios, the benefit of e.g. prevention may be shown. The models are, however, based on Swedish circumstances and have to be modified for use in other countries.

The average total costs of a dental trauma, irrespective of type of dentition, seemed to be rather moderate. This may be due to the fact that total costs (V) were only calculated for two years and in a period of life when treatment, especially complicated traumas to permanent teeth, is seldom finished (Andreassen and Vestergaard Pedersen 1985). Although costs may be moderate a great number of dental traumas occur every year. A high frequency of dental traumas may therefore contribute to high costs to society. A comparison with other physical injuries in the age interval of 0-19 year showed that 10% of all patients seeking emergency care in a county sought for dental trauma (Eilert-Petersson et al. 1997). The number of visits for treatment of dental traumas was also shown to be twice as high, in general, compared to the number of visits for non-oral injuries treated on an outpatient basis during one year (III). The costs may also be due to the type of treatment performed, and in neither of the studies e.g. was implant surgery performed (IV,V), perhaps because implants were not performed on children and adolescents during the early 90s. If this had been done, as today, the total costs would probably have been higher. Another indicator of the difference in the total costs between individuals was the high values of standard deviation and range (V). The reason for this is the great number of factors which may influence costs. In these series of studies, only a few factors have been taken in consideration.

The results of this thesis enable the total costs of dental traumas in Sweden to be calculated on a yearly basis by using the results in the studies on incidence (I) and costs (V). By a rough estimation, the annual number of individuals in Sweden with new dental traumas should be 25,000-30,000 in the age interval 0-19. The total costs for the country (in 1999 prices) of annual new dental traumas, during a 2-year period, including costs of health care service, transport, loss of personal property, medicine and loss of production or leisure, have been calculated to MSEK 90-110. Furthermore, some of the permanent teeth will have to be replaced due to a complicated trauma. Today, implants are the

method of choice after growth is completed. The number of new single implants due to dental trauma in the age interval 0-19 would be roughly estimated at 1000-1500 in Sweden during one year (personal communication, Håkansson 2000). With health care service costs for each single front tooth implant of SEK 20,000 (personal communication, Pettersson 2000), the total annual costs in Sweden could be estimated at MSEK 20-30. The total annual costs of new dental traumas in Sweden, including implants for treatment after 19 years of age, would therefore amount to approximately MSEK 65-85. Considering the first year is more expensive than the second year and the costs of implants were only represented by the health care service costs, the total annual costs of new dental traumas including implants in Sweden is probably higher.

Dental traumas is a concern for the whole community and resources should be spent on promotion, prevention and curative care. An “individual risk profile”, especially for younger individuals who have received their first trauma episode, may be useful in the co-operation between the patient, parents and the caregiver. This risk profile could be a combination of systematic information from the “experts” on the dental trauma episode, the patient and parents, and standard trauma information in dental records. A database, consisting of systematically and continuously compiled information from such risk profiles, would provide better knowledge about how to avoid multiple dental trauma episodes. Another way would also be to reduce the frequencies of complicated traumas, which was found to occur more often during leisure time and in traffic, compared to day care centre/school. A major part of dental trauma to children and adolescents has been shown to be a result of a sport injury (Eilert-Petersson et al. 1997). This may be because the leading cause of dental trauma in sports has been shown to be related to whether sticks are used or bodily contact allowed (Svensson et al. 1994). Sport leaders, especially in teams, therefore have an important mission to see to that participants comply with the rules and use the prevention devices recommended. In curative treatment, all general dentists would continuously be trained to be able to treat all emergencies during opening hours when good access to treatment is possible. When the clinics are closed, emergency treatment could be organised so that it could be carried out by specially trained general dentists and specialists on call during off-duty hours.

6. SUMMARY OF RESULTS

1. Incidence of dental traumas related to age and gender (I)

The incidence of dental traumas was 13.0 individuals and 13.2 trauma episodes per 1000 individuals per year. The incidence to boys (16.2) was higher in almost all ages, compared to girls (10.0) per 1000 individuals per year. The highest incidence, including all children and adolescents, occurred in the ages of 2, 8 and 9 years (22.4 individuals per 1000), suggesting that the first years of life and the first years in school are the most accident prone periods. The highest incidence of uncomplicated traumas, mostly as hard tissue injuries, occurred to permanent teeth, and of complicated traumas, mostly as luxations, to primary teeth, with no gender difference.

2. Evaluation of the risk of multiple dental trauma episodes to permanent teeth (II)

Every second patient with a dental trauma to permanent teeth suffered from multiple dental trauma episodes (MDTE). The mean number of trauma episodes was 2.9 per patient (range 2-7 episodes). The number of patients with MDTE was significantly higher among those who suffered their first trauma episode in the age interval 6-10, compared to the 11-18-year-olds. The risk of sustaining MDTE was highest when the first trauma episode occurred at 9 years of age. At MDTE, almost every second patient injured at least one tooth earlier injured.

3. Comparison of types of treatments used between patients with one and those with more than one episode and with single and repeatedly traumatized teeth (II)

Follow-ups were the most common type of treatment for patients with one trauma episode, while an increased number of trauma episodes per patient was followed by an increased number of follow-ups, filling therapy, information and prosthetic treatment. Repeated traumas to the same teeth increased the frequency of follow-ups, filling therapy and information.

4. Estimation of total time spent in treating uncomplicated and complicated dental traumas (III)

During a period equivalent to 12 years, uncomplicated traumas to primary teeth required a total of 2.5 visits (range 1-9 visits) and 0.8 hrs treatment time (range 0.3-3.3 hours),

whereas 4.3 visits (range 1-12 visits) and 1.6 hrs (range 0.4-4.4 hours) per individual were required for complicated traumas. For permanent teeth with uncomplicated traumas, 9.2 visits (range 1-27 visits) and 3.2 hrs (range 0.3-11.0 hours) were required, whereas for complicated traumas 16.4 visits (range 1-24 visits) and 8.5 hrs (range 1.7-20.5 hours) per individual. Complicated traumas to permanent teeth showed a large variation in treatment time per individual, compared to other dental traumas.

5. An account of total time, direct and indirect, used in the treatment and care of dental trauma (IV)

Total time for dental traumas to primary teeth averaged 7.2 hours (SD=8.4 hours) and to permanent teeth, 16.1 hours (SD=20.0 hours) during a period of 2 years. On average, direct time (treatment time) represented 11% of total time for all visits for dental trauma to primary teeth and 16%, for trauma to permanent teeth. The most extensive type of indirect time was transport time, which encompassed 30% of the total time for injuries to permanent teeth and 36% for injuries to primary teeth. Complicated trauma, traffic injury and access to treatment were of importance to total time spent by both patients and companions.

6. An account of total costs, including direct and indirect costs, and a presentation of predictors of importance to the costs of dental trauma (V)

Health care service costs represented on average of SEK 837 (SD=898, range SEK 84-5,534) and total costs SEK 1,746 (SD=1,183, range SEK 5-10,272) for dental trauma to primary teeth, and SEK 2,955 (SD=3,818, range SEK 167-24,491) and SEK 4,569 (SD=3,053, range SEK 106-24,791) for trauma to permanent teeth. The most extensive type of indirect cost was loss of production or leisure, which, on average, was SEK 699 (SD=SEK 1,239) for injuries to primary teeth and SEK 1,286 (SD=SEK 1,830) for injuries to permanent teeth. Dental traumas will lead to both direct and indirect costs. The direct costs (health care service, transport, costs due to loss of personal property and for medicine) primarily depend on the degree of severity, whereas indirect costs (loss of production or leisure) are mostly due to compromised access to health care service.

7. CONCLUSIONS

1. Boys are more prone to dental traumas than girls, but our studies showed no significant difference in gender concerning degree of severity, time, and costs.
2. The classification into uncomplicated and complicated dental traumas is a useful method of presenting resources spent in dental trauma treatment.
3. Parameters such as degree of severity, access to treatment and place of injury are of major importance and should be included in any analysis of time and costs.
4. Besides treatment time and health care service costs, time and costs for patient and family should also be taken in consideration.
5. The follow-ups of uncomplicated traumas could be kept to a minimum. After initial check-ups these injuries are suggested to be included in regular dental check-ups because the risk of complication is low.
6. After the first dental trauma episode, the patient should be informed about the risk of further trauma episodes, and preventive measures should be taken into consideration.
7. Due to the different risks of additional traumas at different ages, it is important to make individual risk profiles.

8. SVENSK SAMMANFATTNING (SWEDISH SUMMARY)

Tandtrauma drabbar främst i barn och ungdomsåren och engagerar därför även oss vuxna vid det akuta omhändertagandet och i samband med efterföljande besök. Detta kan innebära omfattande tidsåtgång och kostnader för både patient och familj. Skadan kan synas vara mindre allvarlig vid skadetillfället, men dess konsekvenser kan visa sig flera år senare. Vissa komplicerade skador kan vara så omfattande att de medför ett nästan livslångt återkommande omhändertagande.

Under de senaste decennierna har forskningen påtagligt ökat vår kunskap om kliniska och biologiska aspekter vid tand- och benläkning, medan mindre vad beträffar vår kunskap om vem, varför och hur tandtrauma inträffar samt resursåtgång vid behandling av tandtrauma.

Det övergripande syftet med avhandlingen var därför att öka vår kunskap om incidens, risk, behandling, total tid och kostnad vid tandtrauma på primära och permanenta tänder på barn och ungdomar.

Materialet i studierna härrörde sig från ett helt län (Västmanland), en hel kommun (Köpenhamn) och från hela Sverige (Folksam). Information inhämtades från skadejournaler, patientjournaler, speciella tandtraumajournaler, frågeformulär och telefonintervjuer. Tandtrauma klassificerades i okomplicerade och komplicerade trauma.

Resultaten från länsstudien visade att pojkar drabbades oftare än flickor i nästan samtliga åldrar. För både pojkar och flickor var de första levnadsåren och de första åren i skolan de mest olycksdrabbade avseende tandtrauma. Incidensen i dessa åldrar var nästan dubbelt så hög, jämfört med övriga åldrar. Vart tredje tandtrauma i barn och ungdomsåren var komplicerat med skador på tandnerven eller på tandens fäste i käkbenet.

Studien från Köpenhamns kommun, där samtliga patienter följdes under en period av 12 år, visade att varannan patient med tandtrauma på permanenta tänder drabbades av upprepade tandtrauma. Risken att drabbas av upprepade tandtrauma ökade om det första traumat inträffade före 11 års ålder, jämfört med om det första tandtraumat inträffade först efter 10 års ålder. Vid upprepade tandtrauma drabbades ungefär varannan patient av ytterligare skada på minst en redan tidigare skadad tand. Behandlingstiden vid

komplicerade tandtrauma i genomsnitt mer än fördubblades, jämfört med okomplicerade tandtrauma.

Vi registrering av den totala tidsåtgången och kostnaden för barn och ungdomar och deras föräldrar i samband med tandtrauma (förberedelser, resor, behandling, vård på sjukhus och i hemmet) visade det sig att behandlingstiden endast motsvarade c:a 11-16% av totaltiden, medan vårdgivarens kostnad för omhändertagandet var c:a 60-72% av totalkostnaden. Det visade sig också att omfattningen av tid och kostnader för patient och föräldrar var starkt knutet till vissa specifika variabler. Dessa variabler var skadans svårighetsgrad, tillgänglighet till vård och i vilken miljö tandtraumat inträffade.

Tandtrauma i barn och ungdomsåren är en angelägenhet för hela samhället och befintliga resurser skall användas till hälsofrämjande, förebyggande och behandlande åtgärder. En "individuell riskprofil", genomförd på unga individer som drabbats av sitt första tandtrauma, kan vara av stort förebyggande värde då den kan innehålla odontologisk information, men även information från tandtraumats "experter", patient och föräldrar. Information från dessa individuella riskprofiler bör samlas i en databas, som sedan kan ligga som underlag för förebyggande arbete riktat mot enskilda eller grupper av individer. Detta borde förbättra kunskapen om hur upprepade tandtrauma kan undvikas. Ett annat sätt är att reducera frekvensen av komplicerade tandtrauma, en skadetyyp som det visade sig oftast förekom under fritiden. En stor andel av tandtrauma förekommer här inom sport och idrott, i synnerhet då klubbor används och kroppstacklingar är tillåtna. Idrottsledare av olika slag har därför en viktig uppgift i att se till att regler följs och att rekommenderade skydd används. Vad gäller behandling av tandtrauma föreslås en fortlöpande vidareutbildning av allmäntandläkare så att ett tillfredsställande akut omhändertagande kan ske, inte bara under ordinarie öppethållande, utan också under jourtid.

9. GLOSSARY AND DEFINITIONS

In this thesis the following definitions are used:

Accident	A sudden, unexpected series of undesired occurrences in interplay between individual and environment which lead to personal injury.
Companion	A person who participated in the transport of the patient.
Complicated dental trauma	Exposure of the pulpal tissue (complicated crown fracture, complicated crown root fracture and root fracture) or dislocation of the tooth (intrusion, extrusion, lateral luxation and exarticulation). Individuals who had suffered both complicated and uncomplicated dental trauma episodes were included in the group complicated trauma.
Degree of severity	See complicated and uncomplicated dental trauma.
Dental clinic near place of residence	A public dental health clinic is situated in the same town or village as the patient's place of residence.
Diagnosis	The diagnoses used were according to the WHO International Classification of Diseases to Dentistry and Stomatology as revised by Andreasen & Andreasen for teeth with dental trauma.
Direct costs	Average treatment time cost, including costs of health care professionals, other labour, capital costs and supplies, according to actual prices in Sweden.
Direct time	Time used by professional caregivers.
Drop-outs	Discontinued participation or incomplete information.
Folksam	The insurance company FOLKSAM, Stockholm, Sweden.
Incidence	The number of new patients with a dental trauma during a given period in a specified population. The incidence rate is presented by dividing the number of individuals with dental trauma at the end of the period with the number of individuals at risk in the beginning of the period. As a comparison prevalence refers to all cases of dental trauma, new or old, in the population at a given time.

Indirect costs	Loss of production or leisure time.
Indirect time	Time spent by others than professional caregivers.
Injury episode	A single dental trauma event.
Inpatient	Persons admitted to health facilities which provide board and room, for the purpose of observation, care, diagnosis or treatment.
Interaction	A measure of the extent to which the variation in the dependent variable cannot be considered to be the results of a simple combination of the main effects of the factors in the analysis.
Leisure time	All other time, except working- or school time.
Multicollinearity	A situation when an independent variable is a linear function of one or more of the other independent variables. An undesirable situation is when the correlations among the independent variables are strong.
Multiple dental trauma episodes	More than one trauma episode during the study period.
Multiple regression analysis	Procedures for finding the mathematical function which best describes the relationship between a dependent variable (e.g. time or costs) and one or more independent variables (e.g. degree of severity, access to treatment). In multiple regression the dependent variable is considered to depend on more than a single independent variable.
Nursing time at home	Time at home during daytime, with a maximum of 8 hours per day for both patient and companion, respectively.
Nursing time at hospital	Time in hospital e.g. over night (see inpatient).
Other time	A pooling of pre- and post-time, waiting time and nursing time in hospital and at home.
Outpatient visit	A visit to a public dental health clinic, primary health clinic or a hospital during daytime for treatment, but with no stay overnight.
Outside working hours	Any other time, but working hours 08.00-17.00.
Post-time	Time after transport of the patient was completed and earlier activity resumed.

Predictor	Explanatory variable (e.g gender).
Pre-time	Time from notification of the accident until transport of the patient began.
Random sample	A sample chosen without systematic.
Reliability	To what degree there is a reproducibility of results.
Repeated traumatized tooth (RTT)	A tooth which sustain repeated trauma episodes.
Risk	The probability that an event will occur.
Single traumatized tooth (STT)	A tooth which sustain only one trauma episode.
Skewed outcome variables	Patients with extraordinarily short or prolonged values.
Survival analysis	In this thesis, a function of time, starting with a population 100% injured with a dental trauma at a given time and providing the percentage of the population still in treatment at later times.
Transport time	Time from transport of the patient or companion begun until the clinic was reached. Transport time in both directions was measured.
Traumatic tooth injury	Dental trauma.
Treatment	Clinical (e.g. follow-up, filling therapy etc.) and non-clinical treatment (contact with relatives/referrals etc.).
Treatment time at emergency visit	Estimated normal time for patient in treatment room (direct time).
Treatment time at planned visit	Estimated normal time reserved in appointments diary according to the routines used for making appointments (direct time).
Uncomplicated dental trauma	No pulpal tissue exposure (infracture, uncomplicated crown fracture and uncomplicated crown root fracture) and no dislocation of the tooth (concussion and subluxation).
Validity	To what extent the data material describes what it intends to describe, especially the relevans of the data material.

Visit	An emergency or planned single stay at a dental/surgeon/emergency clinic for patient or companion in order to receive professional treatment, leaving or receiving documents, etc.
Waiting time	Time in waiting room before treatment start. The companion's waiting time included the patient's treatment time.
Working hours	Workday on working hours 08.00-17.00.

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