RIGA STRADIŅŠ UNIVERSITY

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TYPES OF CHILDREN'S DENTAL TRAUMA AND DIRECT COSTS OF TREATMENT

(specialty – pediatric dentistry)

Summary of doctoral thesis

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1. General characterisation of the paper

1.1 Topicality of the theme

Children's dental care and dental traumatology are very closely interrelated disciplines. Results of studies show that 2/3 of all TDI (traumatic dental injuries) affect children and adolescents [Andreasen J.O., Lauridsen E., et.al. 2009].

Facial and jawbone traumas resulting in broken teeth, dislocation of teeth or complete loss of the teeth cause pain and problems of functional aesthetic and psychological character which seriously influence the quality of life of a child or an adolescent later on [Glendor U. 2008].

Traditionally, treating and prevention of caries has been considered the main task of children's dental care. As the prevalence of caries is decreasing, more and more attention is paid to other problems related to oral health, especially traumas of the teeth [Andreansens I.S.2002].

Teeth and facial traumas are the second most widespread area of physical traumas in pre-school aged children and the fourth most frequently traumatised area in children aged 7 – 30 [Brunner F., Krasti G. 2009].

The highest figure of teeth trauma intensity was registered in children aged 7 - 12 with traumatised central permanent incisors. Active teeth – jawbone growth takes place at this age. Development disorders of the growing tooth and surrounding alveolar bone may arise as a result of the trauma [Pissotis A., et.al. 2007]. The tactics for treating the sustained trauma must follow the general growth of the child while constantly assessing the morphofunctional development of the tooth and the surrounding tissue which may even last for several years in the most severe cases. For the patient and their parents this includes frequent and regular visits to the doctor as well as a long term observation period – optimum duration thereof is five years after sustaining the trauma [IADT guidelines 2007].

Usually teeth traumas are sustained unexpectedly and are qualified within the area or emergency healthcare which requires additional time resources from the child and their parents (falling behind schedule at school, disruption of the usual weekday schedule of the parents [Cavalcanti A.L. 2010].

A crucial aspect in the assessment of the topicality of the trauma is the character thereof. The damage may simultaneously affect both soft and hard tissue of the tooth (enamel, dentin, pulp, root cement), as well as accompanying tooth structures (periodontal tissue, alveolar bone). In severe cases both types of damage may be combined. Simultaneous cooperation of different experts is necessary for assessment of the aforementioned multipathogen factor complex and treatment of dental traumas (i.e. children's dentist, endodontist, orthodontist, surgeon, and others).

Dental traumas are emergency care situations that require immediate assistance and adequate treatment in order to get positive therapy results, reduce therapy costs, as well as save the time resources of the child, their parents, and the medical personnel [AI – Jundi S.H. 2004]. The main factor ensuring a beneficial forecast after dentoalveolar trauma is preserving the vitality of the traumatised tooth. This has to be the leading aim in providing the emergency care and planning the therapy.

Extensive studies of dental trauma care models and therapy result assessments provide a for much more conservative approach in treatment of dental trauma by achieving unified communication between primary and secondary healthcare personnel in order to ensure an optimum knowledge based approach in the development of the healthcare model [Stewart G.B., et.al. 2009]

1.2. Approach to the problem.

Prevalence of dental trauma in children varies in different countries of the world from 1.8% in Norway [Skaare A.B. 2003] to 34% in Saudi Arabia [Al – Majed 2001].
Summary of the studies on indicators of dental trauma prevalence allows the conclusion that they are frequent and many of the traumatised teeth were not treated or received inadequate therapy [Hamilton FA 1997].
In contrast to the statement confirmed by research that caries are a national health problem in Latvia topical for all population groups [Care R., et.al. 2007], no research has been performed on indicators of prevalence and intensity of dental trauma. Similarly, no cross-sectional cohort studies have been performed that would allow conclusions to be drawn as to whether dental traumas are treated at all and the quality of the therapy provided and its correspondence to IADT guidelines.
Clinical trials on types of dental trauma, treatment results, and factors affecting the forecast are lacking. Latvia does not have widespread educational curricula and visual informative materials concerning this crucial area of oral health which is most directly affecting children's quality of life.

1.3. Novelties of the research

Data on types and degrees of severity of TDI will be acquired for the first time in the university clinic in Latvia.
The assessment of the correspondence of the emergency care provided to IADT (International Association of Dental Traumatology) guidelines will be performed for the first time in Latvia.
For the first time in Latvia, posttraumatic teeth vitality indicators and factors affecting them will be assessed in all diagnostic groups according to WHO (World Health Organization) classification.
Direct therapy costs and factors increasing or reducing the amount of costs will be calculated.

1.4. Aim of the paper

To acquire data about dental traumas in children treated at the Children's Department of the Institute of Stomatology of Riga Stradiņš University within a period of two years, types and degrees of severity thereof. To assess teeth vitality indicators after trauma, as well as to calculate direct costs of treatment.

1.5. Tasks of the paper

- To summarise general data on dental trauma in children at the Children's Department of the Institute of Stomatology of Riga Stradiņš University (RSU SI) within a period of two years - types of TDI, degrees of severity, demographic indicators, causes thereof.
- To analyse types and degrees of severity of trauma using standardised forms of examination, to stratify the factors affecting vitality of the pulp according to the type of TDI diagnosis.
- To assess the correspondence of the emergency care provided to IADT guidelines in patients referred to SI from other medical institutions.
- To treat and observe children's dental traumas according to IADT guidelines.
- To assess the number of vital and devital teeth within a period of two years, to assess influence of one, as well as several factors on the vitality indicators of pulp after dentoalveolar trauma.
- To calculate treatment duration and number of visits for different types of trauma, depending on the severity of the trauma.
- To calculate direct and indirect costs within a period of two years, analysing the factors affecting the costs.

1.6. Ideas proposed for presentation

Types and degrees of severity of the children's dental traumas treated and observed at RSU SI correspond to distribution of TDI registered at dental trauma care centres or other university clinics in worldwide practice.
Posttraumatic teeth vitality primarily depend on the type and degree of severity of the trauma.
Use of coalescing therapy principles that are based on biological considerations (vital pulp therapy methods) enables reduction of direct treatment costs.

2. Material and methods

2.1. Sampling and distribution of materials before commencement of therapy.

The research was performed from 2005 through 2008 at the Children's Department of the Institute of Stomatology (SI)of Riga Stradiņš University (RSU). Treatment and observation of children aged 7–18 with traumatic dental injuries (TDI) was performed within two years, since 2005 through 2006. Control visits were performed in 2007 and 2008. Data registered during treatment and observation of dental trauma patients were used in the research. The permission to use the data was approved by the decision of the Ethics Committee of Riga Stradiņš University. Total of 188 children with 268 traumatised central incisors were included in the research.

2.1.1. Inclusion criteria:

Children diagnosed with dental trauma who have received treatment by the author of the present research and who were observed at the Children's Department of the Institute of Stomatology of RSU from January 2005 until December 2006 were included in the present research. Treatment of severe traumatic injuries was completed in 2007 and control visits were performed in 2007 and 2008.
Only children with primarily acquired traumas were included in the research. Minimum observation period after completion of the therapy was 6 months in 100% of the respondents and 12 months in 90% of the respondents. X-ray images from the moment of trauma are available.
Complete treatment of the traumatised tooth, full set of data for analysis and x-ray images as of the date of emergency assistance or commencement of the therapy and control visits are included. The age of the child at the moment of trauma – 0 through 18 – for calculations of intensity at RSU.

The age of the child at the moment of trauma is 7 - 18 for analysis and assessment of clinical results.

If, in the case of dental trauma, the patients received emergency assistance outside the Institute of Stomatology or if a type of emergency care before treatment was provided under supervision of another expert of the Children's Department, it was compared to the emergency care guidelines determined by IADT (see table 1) and registered in the primary examination form as adequate or inadequate.

Table 1 Type of emergency assistance which is considered to be adequate according to IADT guidelines.

Diagnosis (abbreviation)	Type of emergency care, which is adequate to IADT guidelines
Uncomplicated crown fracture (CF)	Cover of damaged, open dentin (SJ CEMENT, SSJ)
Complicated crown fracture (CCF)	Protection of open pulp and dentin cover
Root fracture (RF)	Application of flexible splint
Subluxation (Subl)	Application of flexible splint (subluxation > 1mm)
Extrusion (Extr)	Reposition, application of flexible splint (luxation > 1mm)
Lateral luxation (Later)	Reposition, application of flexible splint (luxation > 1mm)
Total luxation (Tot lux)	According to the protocol of the guidelines.

2.1.2. Exclusion criteria:

Insufficient amount of data (unfinished treatment, lack of data from control visits).

Carious or sealed incisors, where the cause of fracture was loss of resistance instead of mechanically acquired trauma. Repeated restorations of traumatised teeth (lost or broken seals). Patients who primarily applied with complications after dental trauma which was treated outside the Children's department of SI. Children aged 0 - 6 for analysis of clinical results.

2.1.3. Distribution of material before commencement of therapy

All the traumatised teeth (n268) in children aged 7-17 were subdivided depending on the type of trauma into traumas of hard dental tissue and traumas with damage to periodontal tissue (luxations). These groups were further subdivided depending on the aspects of emergency care and treatment, which are summarised in tables 2 and 3.

Table 2 Distribution of the material (n268) before commencement of therapy for traumas of hard dental tissue

Material distribution into groups before commencement of therapy.	Uncomplicated crown fractures E-D (n116)	Complicated crown fractures (n40)	Root fractures (n16)
Emergency care and treatment was provided under supervision of the author of the thesis	n54 (46.6%)	n29 (72.5%)	n8 (30%)
Emergency care was provided under supervision of another Children's Department doctor, treatment and observation were performed under supervision of the author of the thesis	n28 (16.8%)	n3 (7.5%)	n2 (12.5%)
Emergency care provided outside SI, treatment and observation were performed by the author of the thesis.	n34 (29.3%)	n8 (20%)	n6 (37.5%)

Table 3 Distribution of the material (268) before commencement of treatment for dental trauma with damage of periodontal tissue – luxations.

Distribution of material before commencement of therapy.	Bruise (n10)	Subluxation (n40)	Lateral luxation (n14)	Extrusive luxation (n14)	Intrusion (n3)	Total luxation (n10)
Emergency care and treatment was provided under supervision of the author of the thesis	n3 (30%)	n23 (57.5%)	n8	n11	n1	n2
Emergency care was provided under supervision of another Children's Department doctor, treatment and observation were performed under supervision of the author of the thesis	n7 (70%)	n8 (20%)	n1	0	n2	0
Emergency care provided outside SI, treatment and observation were performed by the author of the thesis.	0	n9 (22.5%)	n5	n3	0	n8

2.2. Registration of traumatic dental injury data

When performing the primary check-up and examination, a unified documentation and clinical - roentgenological data record system was used for each child based on IADT and Andeasen et al. [Andreasen J.O.Andreasen F.M., et al. 2003] recommendations on principles of emergency care visit and observation data registration which consisted of the following sections of data for analysis:

Primary dentoalveolar trauma analysis form

History data. Check-up form (results of visual check-up of hard and soft tissue).
Examination results (percussion, palpation and pulp tissue sensitivity test results).

X-ray assessment form (for confirmation of clinical diagnosis, monitoring the healing process or complications).

For acquisition of history data, a questionnaire about the patient's parents was used, to learn about the cause of the trauma, date and time of the trauma, time period until receipt of emergency care, general condition of the child at the moment of trauma, as well as medical history data, the RSU SI standard patient clinical examination card was filled out. Summarisation of check-up, examination and x-ray data is planned prospectively and designed according to a unified system by including as precise research material stratification possibilities according to each clinical diagnosis as possible, pursuant to proof-based clinical research data registration methods as described in the literature [Day P.F., Duggal M.S. 2006, Andreasen J.O., Andreasen F.M. 2003].

- **Treatment procedure protocols**

The protocols for each diagnosis were developed based on IADT guidelines and therapy recommendations for patients with traumatic dental injuries and included sections of material for further analysis such as: duration of therapy (gradation depends on time interval), materials used for each diagnosis according to pulp protection, restoration of the crown of the tooth, splinting and performance of other manipulations, method - short description of the method according to the type of trauma, control x-ray as of the treatment completion visit.

- **Clinical–rentgenological treatment result assessment form**

The form was used as of 6 months after completed treatment, including such sections as: history data (patient's complaints), results of clinical check-up and examination (pulp sensitivity tests), control x-ray for assessment of healing and complications.

2.2.1. TDI classification according to WHO standards

All dental traumas acquired with full data range for analysis were classified according to: World Health Organization (WHO) classification [World Health Organization's Application of International Classification of Diseases to Dentistry and Stomatology] in its modification as proposed by J.O.Andreasen, which is summarised in Table 3.

Table 3 TDI classification according to WHO standards

Type of trauma	Definition
Traumas of the hard dental tissue	
Enamel cracks	Partial fracture of the enamel or crack without loss of substance
Enamel fracture	Uncomplicated crown fracture. Fracture of enamel only with loss of substance
Enamel – dentin fracture	Uncomplicated crown fracture. Fracture of enamel and dentin without injury to the pulp.
Complicated crown fracture.	Fracture of enamel, dentin with pulp trauma
Crown–root fracture	Fracture of enamel, coronal and radicular dentin and root cement.
Root fracture	Fracture of radicular dentin, cement and pulp trauma at the site of fracture. Depending on the height (apical ⅓, medial ⅓ and coronal ⅓) of the root fracture.
Luxations	
Concussion	trauma of periodontal tissue without dislocation and pathological tooth mobility
Subluxation	trauma of periodontal tissue without dislocation, but with pathological tooth mobility.
Extrusion	partial dislocation of the tooth in vertical direction outside dental alveolus
Lateral luxation	dislocation of the tooth axially, may be combined with alveolar compression or fracture
Intrusion	central dislocation of the tooth deeper into the alveolar bone, complicated by alveolar fissure
Total luxation	complete dislocation outside alveolus

2.2.2. TDI classification by severity.

All dental traumas, depending on the scope of the injury, were classified into complicated and uncomplicated traumas according to the classification proposed by Glendor U. in 1996.

- ***Uncomplicated traumas***

  Injuries without trauma to pulp tissue (enamel cracks, uncomplicated crown fracture, uncomplicated crown root fracture) and luxations, without dislocation of the traumatised tooth (bruise, subluxation).

- ***Complicated traumas***

  Traumas with damage to pulp tissue (complicated crown fracture, complicated crown - root fracture, root fracture) or dislocation of the traumatised tooth (intrusion, extrusion, lateral luxation and total luxation).

3.4. Stratification of clinically diagnostic parameters – for performance of statistical analysis

For traumas of the hard dental tissue

For uncomplicated crown fractures

Classification of the crown fracture depending on the type of fracture and depth in dentin according to the classification proposed by Ellis in which enamel cracks, enamel fractures, and medium depth enamel dentin fractures were classified into one group, while enamel-dentin fractures close to pulp tissue into the other. The first group was named superficial crown fracture CF, while the other group was named deep CF close to pulp tissue.

For complicated crown fractures

Complicated crown fractures were clinically classified into two groups. Traumatised teeth with pulp aperture below 12 mm were classified into the first group. In the second group the pulp aperture was ≥ 2 mm up to complete loss (fracture) of dental crown.

For luxations

Subluxation mobility degrees	Dislocation degrees of extrusive, lateral and intrusive luxation
I degree – horizontal mobility ≤ 1 mm	I degree – dislocation ≤ 1 mm
II degree - horizontal mobility 1 - 2 mm	II degree – dislocation 1mm – 2 mm
III degree horizontal mobility > 2mm	III degree – dislocation > 2mm
IV degree – vertical mobility.	IV degree – dislocation >3mm.

Where the first (I) degree is defined as mild, the second (II) and the third (III) – as a medium severe and the fourth (IV) – as a severe degree.

Degree of root formation

The degree of root formation of the traumatised tooth was read from the x-ray image of the tooth at the moment of trauma and classified according to the classification used in publication and proposed by M. Cvek in which 5 stages of root development are observed after tooth eruption intraorally and where roots in stages 1-4 are considered to be incompletely formed and a stage 5 root is considered to be completely formed [Cvek M., Mejare I. 2002].Two parameters determined the degree of root formation – length of the root and width of the apical aperture.

3.5. Diagnostic and assessment criteria of posttraumatic examinations.

3.5.1. Assessment of the pulp status.

The minimum observation period, irrespective of the diagnosis, was 6 months and could extend up to two years. The pulp status was determined using clinical-roentgenological examination criteria which were developed based on the clinical research results.

3.5.2. Pulp sensitivity test

The sensitivity of the pulp tissue was tested using a cold test with ethyl-chloride (-41^{o}C) application by applying it from the sprayer vial onto a cotton wool swab, as a result of which ice crystals formed, and then applying it to the vestibular surface of the traumatised tooth between the apical and medial third. The response to the pulp sensitivity test was compared to two nearby teeth that were previously diagnosed as intact. On the whole, pulp sensitivity tests were performed from d13 to d23 in the maxilla and from d33 to d 43 in the mandible.

3.6. Statistical data analysis methods

The data were recorded in the standard forms (trauma analysis form) from which the values for research were coded and transferred into electronic format. Descriptive and analytic methods were used for data processing. The differences of the percentage value proportions were tested using Pierson's chi-square test in which the statistical confidence interval 5% and value $p \leq 0.05$ will be assumed to be statistically credible. Influence of the variable values on dental vitality after trauma was researched using the ***Cox*** regression method which assumes the influence of the variable values on the result, in this case preserving vitality is a constant value. Single, as well as multiple factor regression analyses were used, to determine the influence of each factor on the pulp vitality indicators, as well as the significance of influence by mutual interrelation of the factors (by creating multiple factor regression models). ANOVA analysis and T test were used for analysis of factors affecting vitality (as the data corresponded to normal distribution). In cases of nonconformity to the norm (when determining factors affecting treatment costs) they were logarithmised, resulting in an equation: $^{0}\log(Y) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 \ldots\ldots\ldots$

where – Y – direct treatment costs, $X_{1;2;3}$; = variables (influencing factors)

$\beta_{1;2;3}$ = respective regression quotients.

The statistical data analysis was performed using standard statistical data processing software (SPSS for Windows 10.0)

4. Results.

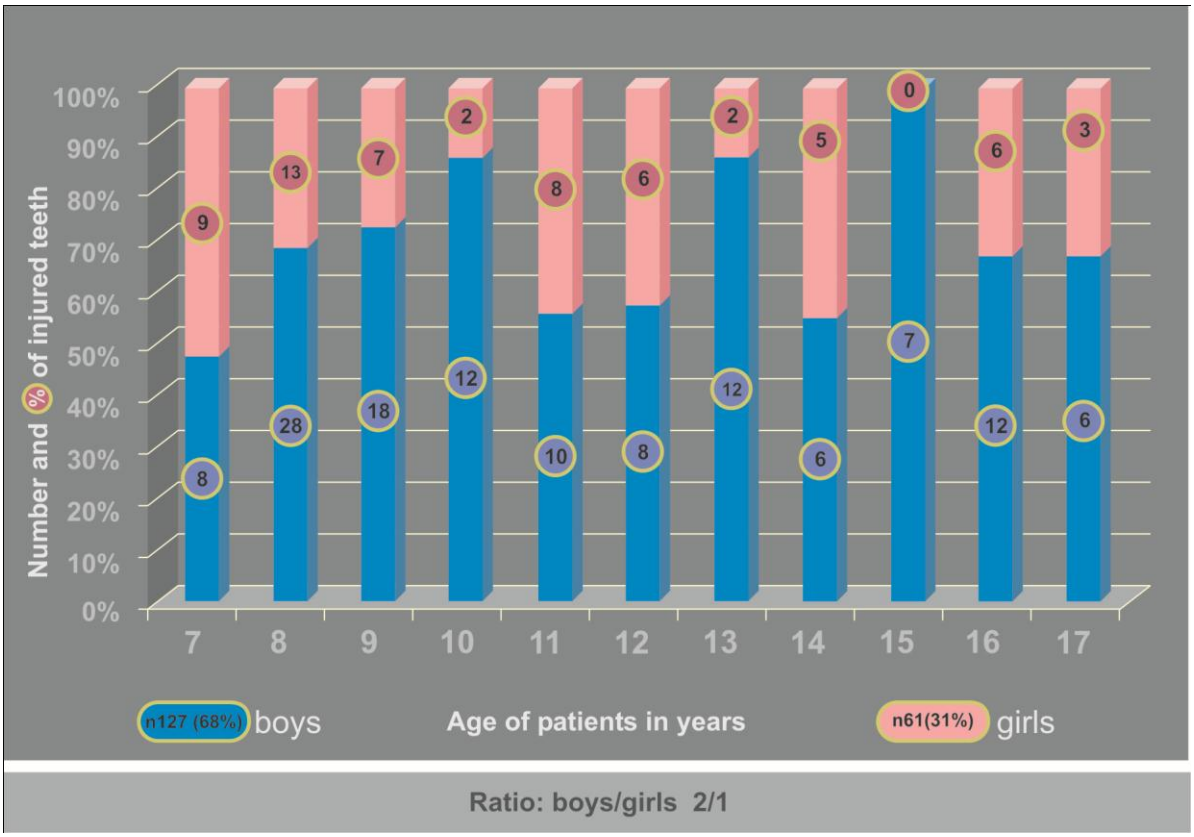
4.1. General demographic characteristics of the research sample.

Within a period of two years, treatment of 188 children and adolescents aged 7-17 (127 boys and 61 girls) was commenced and completed with 268 traumatised mandibular and maxillary incisors.

Over the whole research period, boys sustained trauma 2 times more frequently than girls.

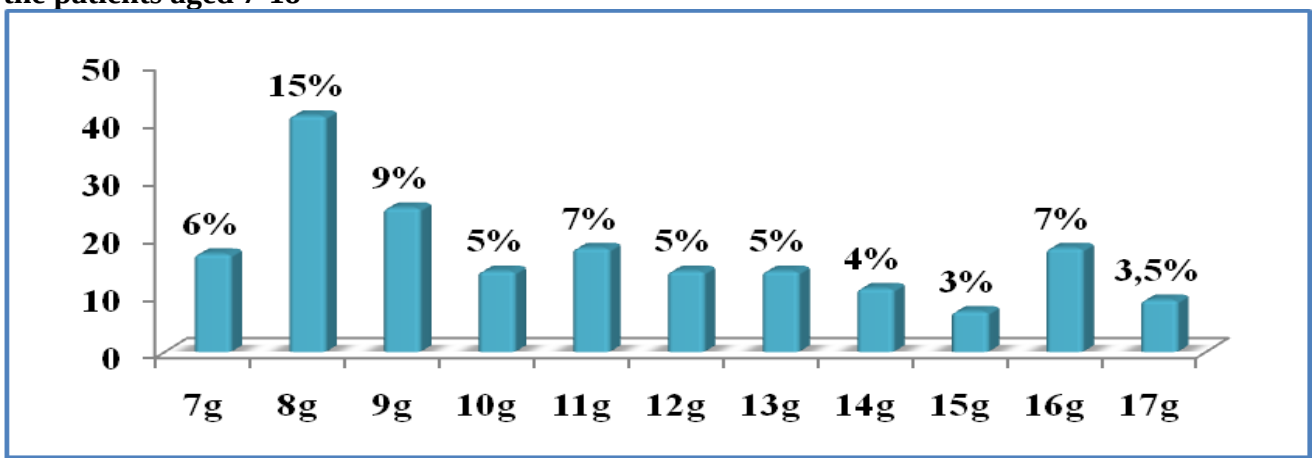
In total, in all age groups boys sustained trauma more frequently than girls except for the age of 7 years when the number of trauma sustained by boys and girls was equal. Slightly higher incidence of trauma among boys is observed at the ages of 11, 12 and 14, while at the ages of 8, 9, 16 and 17 the incidence among boys is twice as high in comparison with girls. Meanwhile, at the ages of 13 and 15, the incidence of trauma among boys exceeded that among girls by 6-7 times (see Image 1).

Image 1 Distribution of patients (n188) according to the age and gender of the child at the moment of trauma



Different intensity of TDI was observed among different age groups during the whole period of the research with children aged 8 and 9 sustaining trauma most frequently, (see Image 2). Radical difference between the groups during adolescence was not observed. 68% of all patients involved in the research sustained their traumas before the age of 12. It can be concluded that maximum intensity figures were observed in children in the early changed occlusion period at the age of eight and nine, which is graphically represented in Image 2.

Image 2 Intensity of TDI depending on the age of the child at the moment of trauma (n188) in the patients aged 7-18



The average age of the children in different diagnostic groups fell within the age limits of 8.0 - 12.3 (SD=3.2). The youngest children fell into the intrusive luxation group - 8 years of age (SD = 0.3 years). The average age of children in the uncomplicated and complicated crown fracture group was

practically the same - 10.8 (SD = 3.1) and 10.7 years of age. (SD = 2.8). The highest average age was observed among children with extrusive luxations - 12.3 years of age (SD = 2.9 years). Over all diagnostic groups (except extrusion), the average age of the children was below 12.

4.1.2. TDI intensity indicators within a two-year period at RSU SI.

During assessment of TDI intensity indicators at the Institute of Stomatology, all children with primarily sustained traumas aged 1-18 and treated at the Children's Department were included in the trial.

Incidence figures were calculated by the proportion of the patients who sustained primary dental trauma in relation to 1,000 first-time patients.

In 2005 the number of patients with primarily sustained dental trauma treated and observed at the Children's Department of RSU SI was 96. The lowest patient number and, thus, incidence figure amounting to 9.8 for 1,000 first-time patients was observed at the beginning of the research in January. Afterwards, a gradual growth of TDI number was observed reaching the peak of the period – 15 new patients in May with the intensity of 43.35 for this month.

The dental trauma figure remained rather high for the whole of the summer until November, with a slight upward trend in December – 31.35. The total intensity figure in 2005 reflecting the number of primarily sustained traumas reached 24.37 patients for 1,000 first-time patients.

In 2006 slightly more new TDI cases, amounting to 111, were treated and observed at RSU SI.

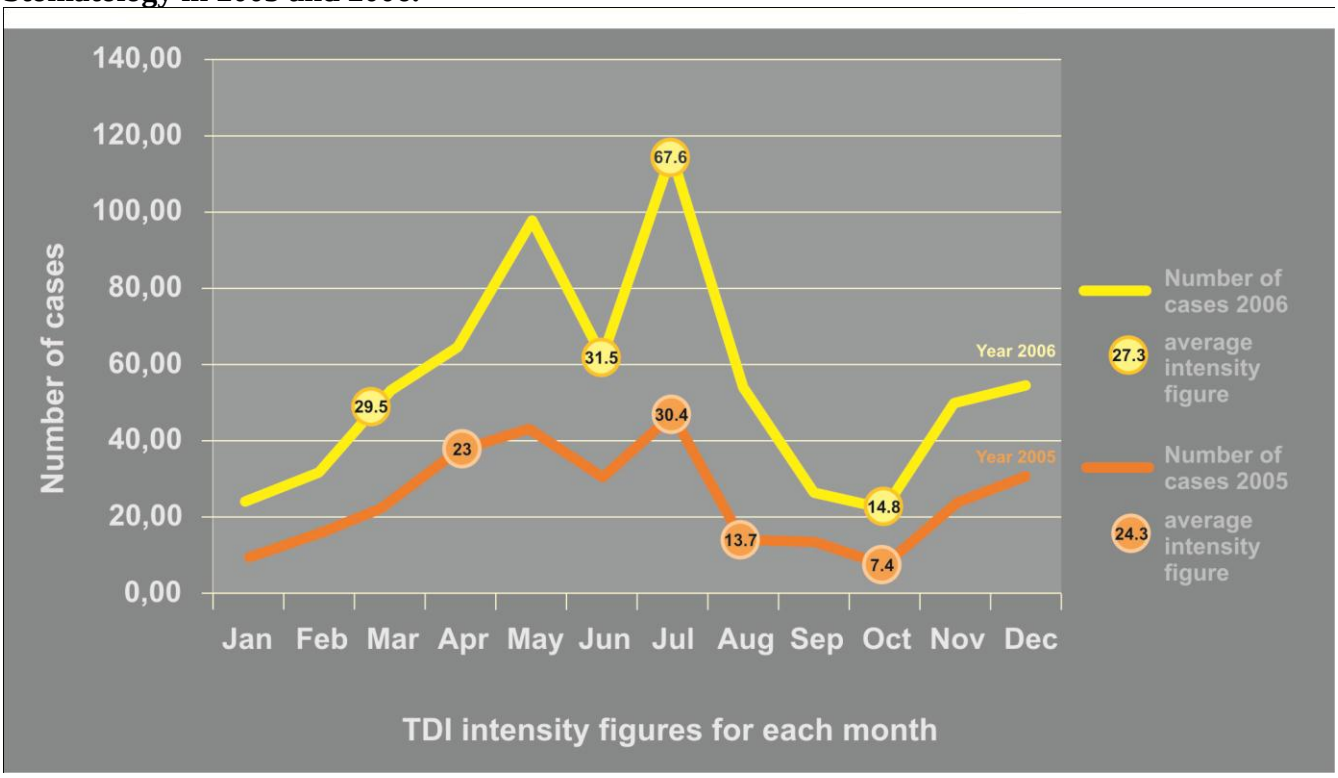
The highest number of dental trauma cases was observed from April through August with the highest incidence figure of the period reaching 67.64 per 1,000 first-time patients (in July). These figures are generally high – from 31.52 to 67.64 per 1,000 patients in summer months. The lowest incidence of TDI is observed in September.

The average TDI incidence of 2006 at SI was 27.32 per 1,000 first-time patients.

Comparison of 2005 and 2006 shows a slight increase of TDI intensity.

TDI intensity figures point to pronounced seasonal character of the condition see (Image 3) where both in 2005 and 2006 a pronounced rise of the figure is observed in April and May as warm and sunny weather sets in, with intensity figures of 43.4 (in 2005) and 53.9 (in 2006).

Image 3 Traumatic Dental Injury intensity and seasonal character figures at the Institute of Stomatology in 2005 and 2006.



These figures remain high during the summer and fall sharply in September – 13.4 (in 2005; 2006) and October. The next growth is observed as the new winter season begins – in December – 31.3 (in 2005).

4.1.3. Classification of TDI types and severity degrees at RSU SI within a two-year period.

188 children with 268 traumatised permanent central incisors aged 7-18 and treated and observed at the Children's Department of RSU SI during a period of two years were included in the research
Considering the strict inclusion criteria, traumas of milk-teeth were not included in the further material analysis. Several systems were used for classification of all traumatic dental injuries.
Choice of the system was determined by extensive research results, with the data acquired allowing to draw conclusions about the types and degrees of severity of the registered TDI with the aim of assessing the therapy results, as well as comparing the data of the Children's Department of SI with other research results and assessing the prevalence of complications depending on type and severity of the trauma.

Classification of TDI into diagnostic groups according to WHO classification standards

Analysis of the 268 traumatised central incisors included in the research showed that uncomplicated crown fractures were the most frequent (116; 44%), which is also the most typical group of central incisive TDI. Complicated crown injuries were observed less frequently (44; 16.4%). The least frequently registered hard dental tissue traumas fell into group of root fractures (16; 6%). The total number of hard dental tissue traumas were observed in 176 (66%) traumatised teeth.
Two times less teeth (92; 34%) sustained traumas of periodontal tissue with subluxation as the most frequent one in 15% of the cases (see Table 6).
The least frequent TDI group consisted of intrusive luxations - 3 teeth, amounting to 1% of the total number of traumatised teeth. The summary of these data can be found in Table 6.
Each type of diagnosis can be subdivided in more detail using the WHO classification system, thus exposing all types of TDI up to the finest subdivision groups, where all diagnostic groups and subgroups reflected in Table 4 are included in the conducted research.

Table 4 Total division of the traumatised teeth (268) into the diagnostic groups and subgroups according to the **WHO classification system for individuals (188) aged 7-18.**

Diagnosis according to WHO classification	**Number of traumatised teeth (n268)**	**Percentage of proportion of all types of TDI (n286)**
Traumas of the hard dental tissue		
Enamel cracks	2	0.75%
Enamel fractures	8	2.99%
Enamel – dentine fracture	106	39.55%
Complicated crown fracture.	44	16.42%
Uncomplicated crown-root fracture.	1	0.37%
Complicated crown-root fracture.	3	1.12%
Root fracture (apical 1/3)	3	1.12%
Root fracture (medial 1/3)	7	2.61%
Root fracture (cervical 1/3)	2	0.75%
Total	**176**	**66%**
Luxations		
Concussion	10	3.73%
Subluxation (horizontal mobility)	31	11.57%

Subluxation (horizontal and vertical mobility)	9	3.36%
Extrusive luxation	14	5.22%
Lateral luxation	14	5.22%
Intrusion	3	1.12%
Total luxation	11	4.10%
Total	**92**	**34%**
Grand total	**268**	**100.00%**

TDI classification into uncomplicated and complicated dental trauma according to classification principles of Glendor et al. (1996).

Teeth with uncomplicated trauma were more frequent during the research than teeth with complicated trauma. Crown fractures in enamel and dentin is the most frequent diagnosis in the group of uncomplicated trauma, while complicated crown fractures and root fractures were the most frequently treated dental traumas in the group of complicated traumas. The prevalence of uncomplicated traumas is affected by the high proportion of crown fractures in the group, 43% of the total traumatised teeth number. For the summary of data, see Table 5.

Table 5 Classification of traumatised teeth diagnoses into complicated and uncomplicated dental traumas according to Glendor et al. 1996 classification.

Severity degree of the diagnosis	Diagnosis	Number	%	Total
Uncomplicated traumas	Uncomplicated crown fracture	116	43.28%	
	Concussion	10	3.73%	
	Subluxation	40	14.93%	**166 (61.94%)**
Complicated traumas	Complicated crown fracture.	44	16.42%	
	Root fractures	16	5.97%	
	Extrusive luxation	14	5.22%	
	Lateral luxation	14	5.22%	
	Total luxation	11	4.10%	
	Intrusion	3	1.12%	**102 (38.06%)**
Total				**268 (100%)**

Classification of the traumatised teeth according to teeth group.

Only traumatised central and lateral incisors of mandible and maxilla were included in the research. These were divided into groups depending on the number of the tooth, as described in Image 4.

Image 4 Total number of traumatised teeth (268) depending on the group of the traumatised teeth in children aged 7-18

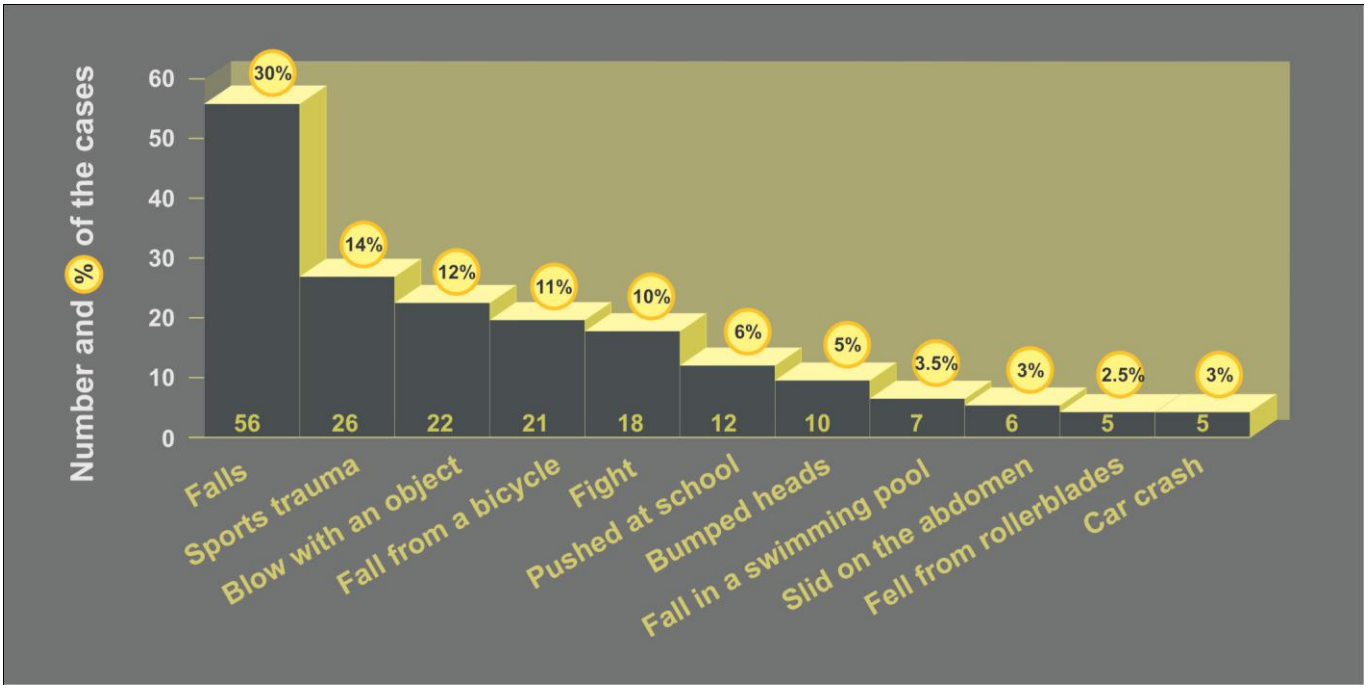
The most frequently traumatised group of teeth is central incisors of maxilla d11(34%) and slightly more frequent d21 (40%). Lateral incisors d22 of the maxilla follow, with a considerably less frequent traumatisation figure, which only slightly differs from the percentages for central incisors of the mandibula. Comparison of the left and right side within the research showed that teeth of the left side are traumatised slightly more often than teeth of the right side, 145 (54%)> 123 (46%).

4.1.4. Pretraumatic characteristics and characteristics linked to the moment of trauma.

Causes of TDI in children aged 7-18 at RSU SI.

The causes of TDI were registered during the primary examination of the patient by the author of the present thesis and by collecting history data from children and their parents. All types of falls that happened due to non-specific reasons were classified into one group (falls while playing, running, tripping over objects, sliding, etc.). Falls from a bicycle, rollerblades, and falls in a swimming pool were classified into separate groups. The most frequent TDI causes registered during the research were falls of a non-specific character – 30% of all trauma causes.Image 5 summarises the most frequent types of TDI damage.

Image 5 Causes of children's dental traumas (n 118).

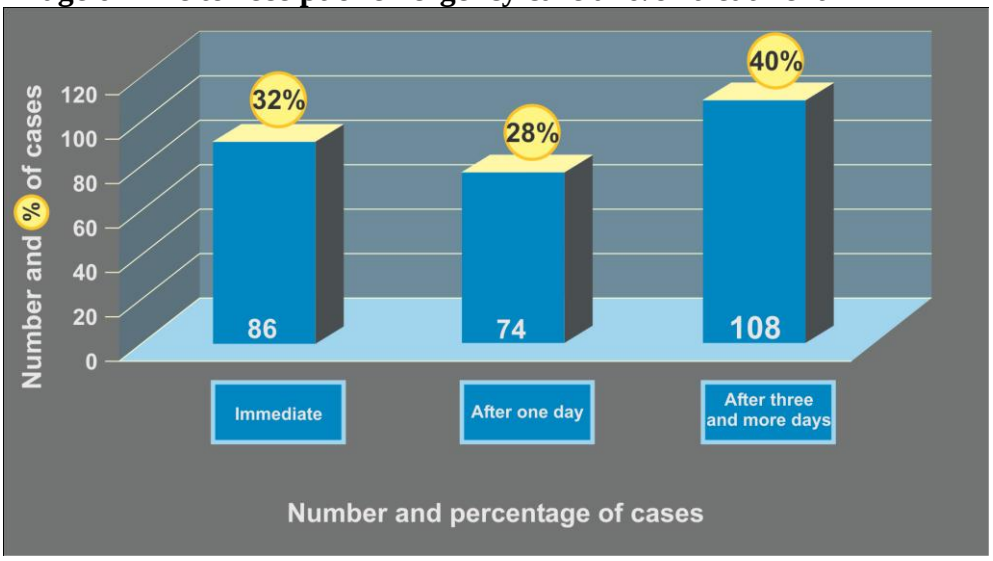


Summary of all types of falls as a cause of TDI raised their proportion to 47%. The next most frequent cause of TDI according to the research performed is sports trauma 14%, followed by blows with/against objects 12%. Fights take a medial position with 10%, while the least frequent causes of dental trauma include car crashes 3% and falling from rollerblades 2.5%.

The time interval before receipt of the emergency care or treatment for all (268) traumatised teeth.

The time interval was registered during the initial examination and classified according to the provisions of IADT guidelines. Image 6 summarises the registered time interval before receipt of treatment for all traumatised teeth included in the research. Immediate (within 24 hours after the trauma) treatment and/or emergency care was received by one third (1/3) of all traumatised teeth (86; 32%).

Image 6 Time to receipt of emergency care and/or treatment

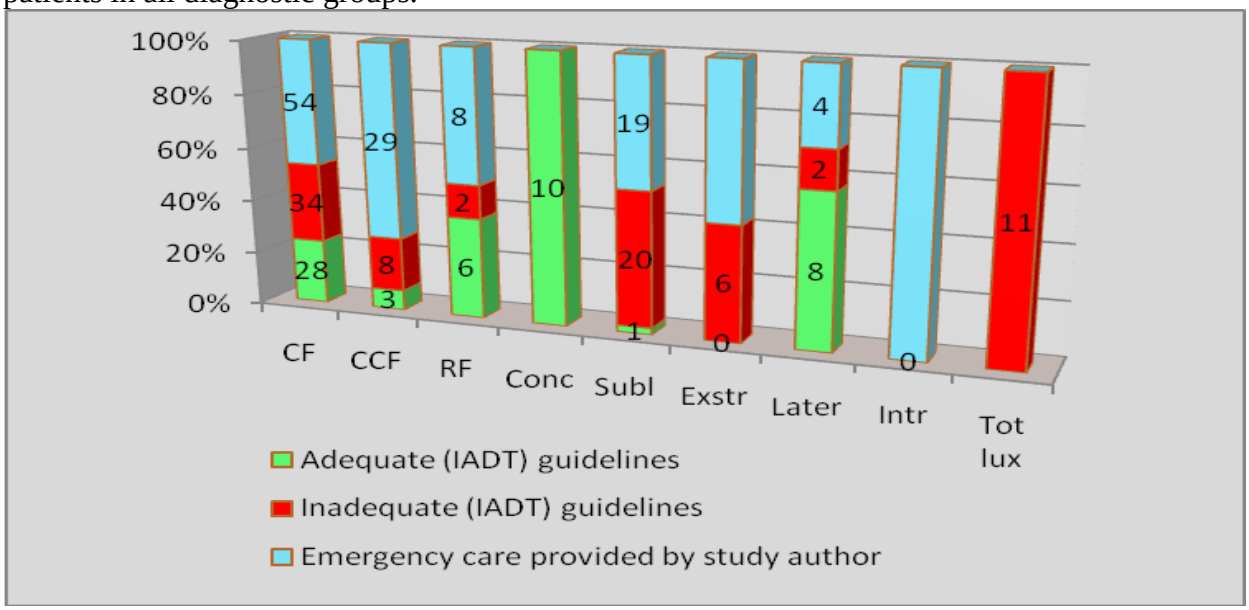


Assessment of the compliance of the received emergency care to IADT guidelines.

At the beginning of the research the traumatised teeth were classified into groups after clinical assessment of the correspondence of the type of the emergency care provided to IADT guidelines for all patients referred from other medical institutions or patients,who primarily applied to any other expert at the Children's Department and registered as adequate or inadequate according to IADT guidelines following primary examination of the patient according to certain principles (see the material and methods sections). The emergency care for the traumatised teeth and treatment thereof for patients who primarily applied to the author of the present research was initially commenced pursuant to IADT guidelines (123; 46%).

As Image 7 shows, 56 (24%) of the traumatised teeth received emergency medical care according to the guidelines.Emergency care received has to be assessed as inadequate for 83 teeth (30%). Assessment of the correspondence in the diagnostic groups shows rather high correspondence to guidelines in the group with concussions, as well as intruded and laterally or extrusively luxated teeth.

Image 7 Assessment of the correspondence of the emergency care to IADT guidelines for the patients who received emergency care outside SI and number and percentage ratios of the first-time patients in all diagnostic groups.

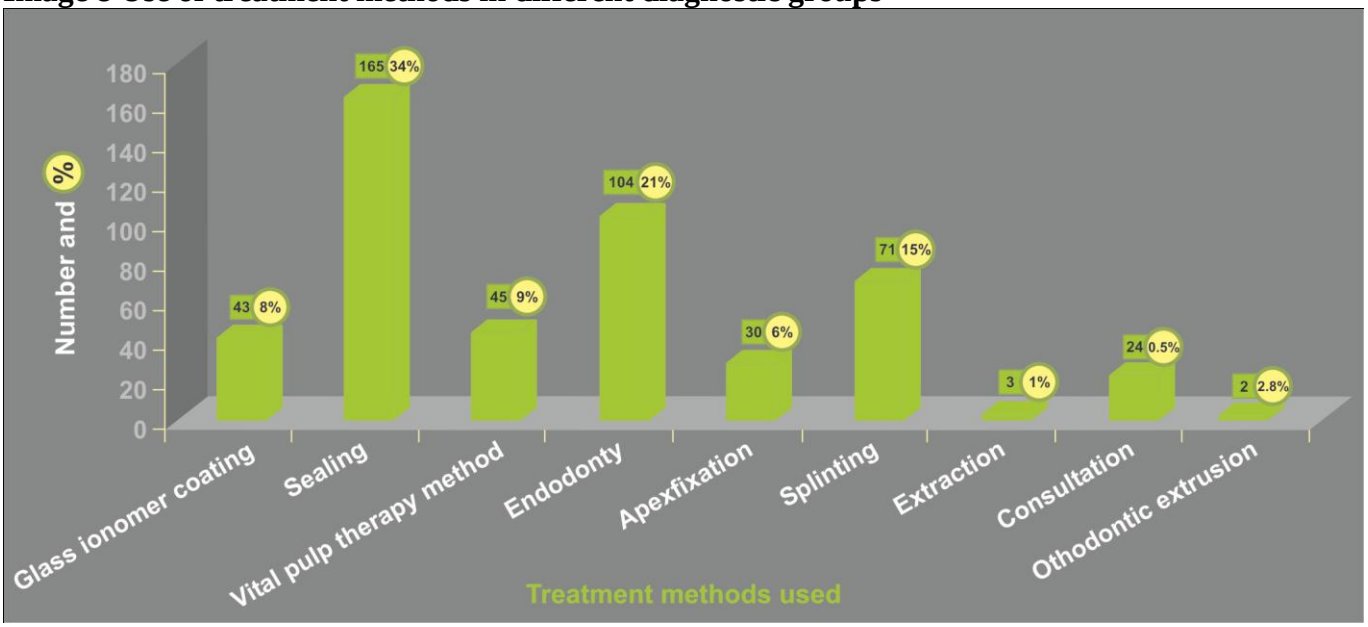


100% inadequate emergency care was received by totally luxated teeth (100%), as well as subluxated (50%) and extruded (43%) teeth. Crown fractures and complicated crown fractures have average and practically equal percentages (21%, 27%).
The summary shows that the number of teeth for which the quality of the emergency care has to be assessed as corresponding to IADT guidelines was 185 traumatised teeth(70%), while inadequate care was received in the case of 83 teeth (30%).

Therapy methods, duration of treatment, total duration of treatment and observation period for all 268 traumatised teeth included in the research.

The most frequently used treatment method was restoration of the traumatised teeth using light-polymerised composite material sealant, which logically corresponds to the most frequent type of TDI – uncomplicated and complicated crown fractures. Glass ionomer coating and vital pulp therapy methods were used with equal frequency in 43 (8%) and 45 (9%) respectively, which is graphically represented in Image 8.

Image 8 Use of treatment methods in different diagnostic groups



The next treatment method by frequency is endodontic root canal treatment (104; 21%), which is a devital pulp therapy method. Splinting was used slightly less frequently – in 71(15%) of cases. One of the least frequent treatment methods was orthodontic extrusion of the traumatised tooth in 2 (2.8%) of the cases.The most frequently used treatment method during the whole research was tooth restoration with light-polymerised composite material sealant and endodontic root canal therapy.
During the analysis of the average treatment duration in all TDI groups registered pursuant to WHO classification, a pronounced link between the type of the trauma and average treatment duration in weeks.Treatment duration in all diagnostic groups varies from one day (CF, RF, Bruise, Subluxation) up to two years (Intr.)If the treatment duration is assessed in relation to the severity of the trauma, the shortest average duration of treatment in weeks is for light traumas – uncomplicated crown fractures without accompanying subluxation, bruises, subluxation (0.1-25.7 ± SD 3.53). As the severity degree of the trauma increases, treatment duration increases as well - for extrusive and lateral luxation the average treatment period was 13.1 weeks (3.0 - 54.0 ± SD 10.67).
In the highest severity trauma group – intrusions and total luxations the longest average treatment period of 44 weeks was observed (1.7-104.0 ± SD 32.67).
The conclusion can be drawn that as the severity degree of trauma increases, the treatment duration has a tendency to extend.

Total duration of treatment and observation period for all diagnostic groups.

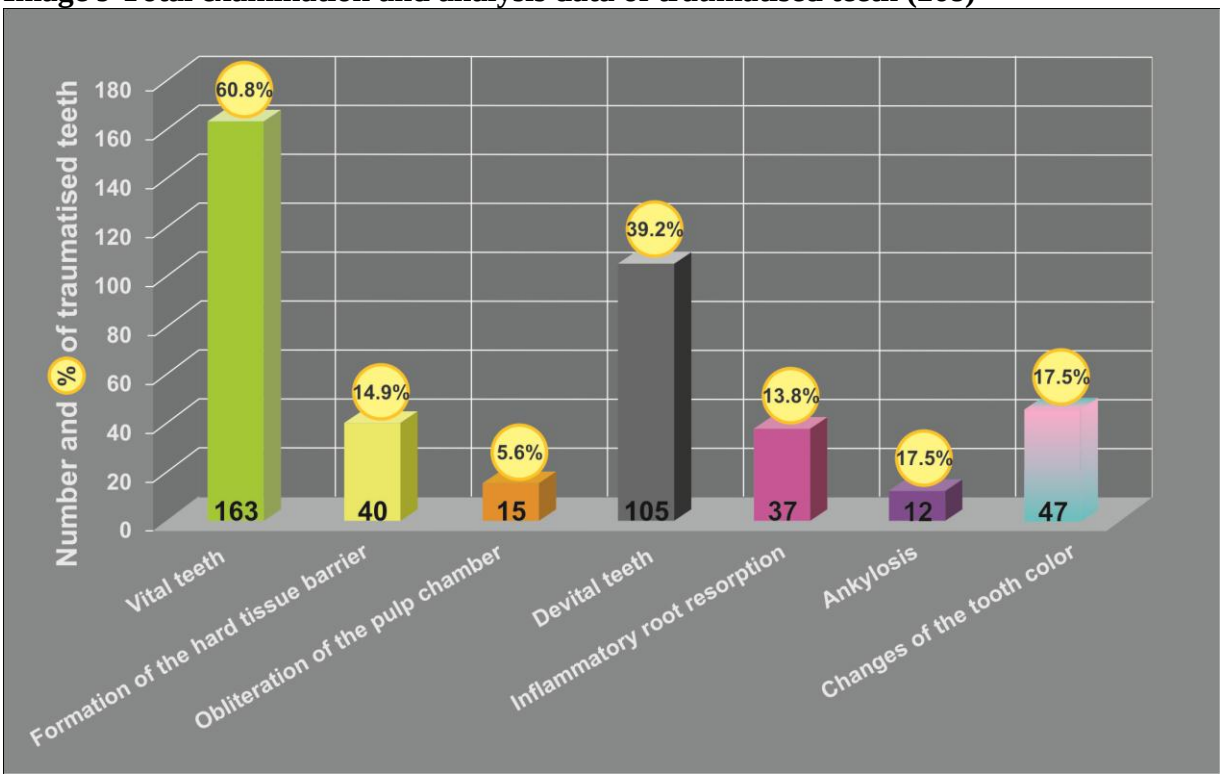
The total duration of the treatment period for each tooth was registered as of the moment of the initial trauma examination until the last control visit.

The shortest duration of the treatment and observation period was registered after bruises with a minimum value of 8 months and maximum of 1.3 years. Traumas of the hard dental tissue (CF, CCF, RF) were treated and observed for 1.5 years on average (minimum period of one year, maximum period of 2.5 years, ± SD 4.7 months). Traumas of periodontal tissues or luxations had a slightly longer average treatment and the observation period in comparison with hard dental tissue traumas and was assessed to be approximately 2 years (Average of 1.9 years for subluxation, 2 years for extrusion, lateral luxation, 2.3 years for total luxation). The longest total treatment and observation time corresponds to the character of pathologically heaviest trauma – intrusion ~ 3.5 years. To sum up: duration of the average treatment and observation period in all diagnostic groups varied from a minimum of 11 months (SD=2.6), to 3.5 years (SD=2.3).

4.2. Post-traumatic examination results in all diagnostic groups

This section summarises the results of analysis and examination of all traumatised teeth included in the research which are based on the clinically-diagnostic criteria described in the material and methods section. Pulp tissue sensitivity tests were performed, colour changes registered, x-ray images assessed (presence of periapical pathology, obliteration of the root canal, resorption of the inflammation root) for each tooth. Image 9 summarises the results of examination of all traumatised teeth at the end of the research (average of 20.1 months ± SD of 5.5 months).

Image 9 Total examination and analysis data of traumatised teeth (268)



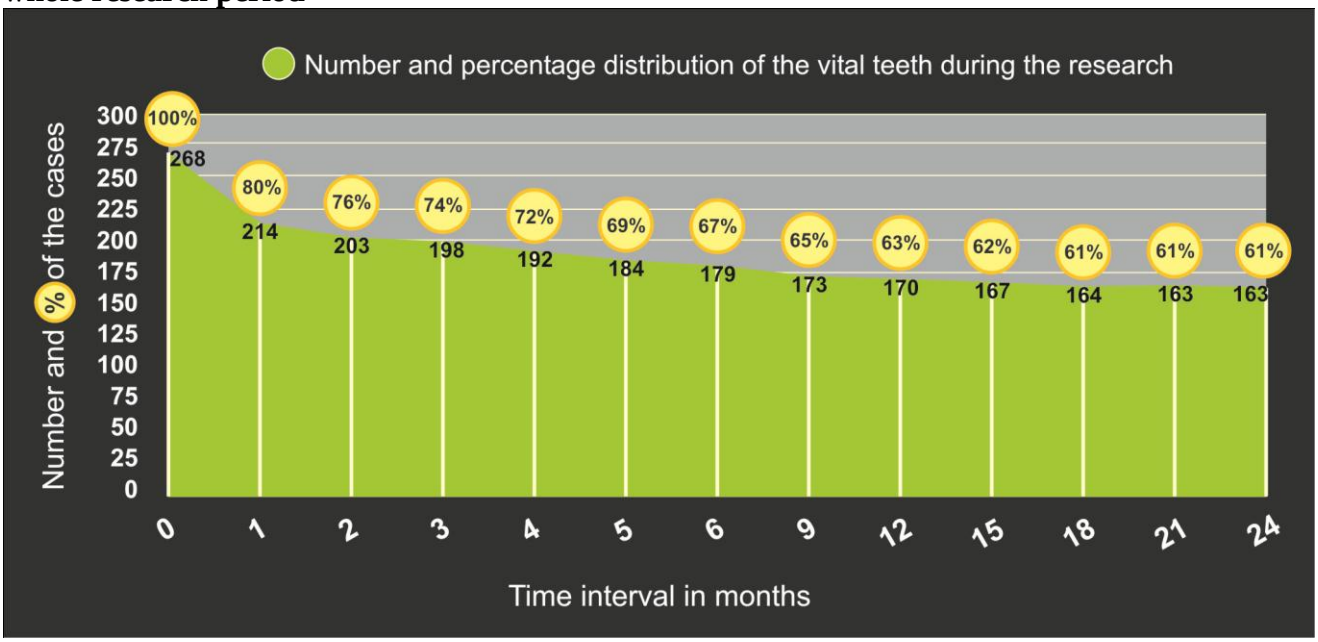
The percentage of vital teeth is the highest, reaching 60.8%, while the percentage of devital teeth is lower – 39.2%. When registering signs of healing in the pulp tissue after trauma such as hard tissue barrier or obliteration of the pulp chamber, they were observed in 21% of the traumatised teeth. Complications such as resorption of the inflammation, ankylosis or changes of the tooth colour were observed in 37% of the traumatised teeth.

On the whole, it can be concluded that out of the total treated and observed 268 teeth in children aged 7-17, the number of vital teeth two years after the trauma exceeded the number of devital teeth.

4.2.1. Dynamics of vital teeth during the two year research period in all diagnostic groups.

At the beginning of the research, all 268 (100%) of the traumatised teeth were registered as vital (intact traumatised central incisors were included in the research). The steepest decline in vitality was observed within the first month, when 54 (20%) of the teeth included in the research lost their vitality. This circumstance has to be linked with commencement of preventive endodontic treatment of the traumatised teeth with high pulp necrosis risk, as well as primary endodontias in teeth with complicated crown fractures and completed root growth development. For graphical interpretation of the data, see Image 10.

Image 10 Number and dynamics of the vital teeth for all types of dental trauma during the whole research period



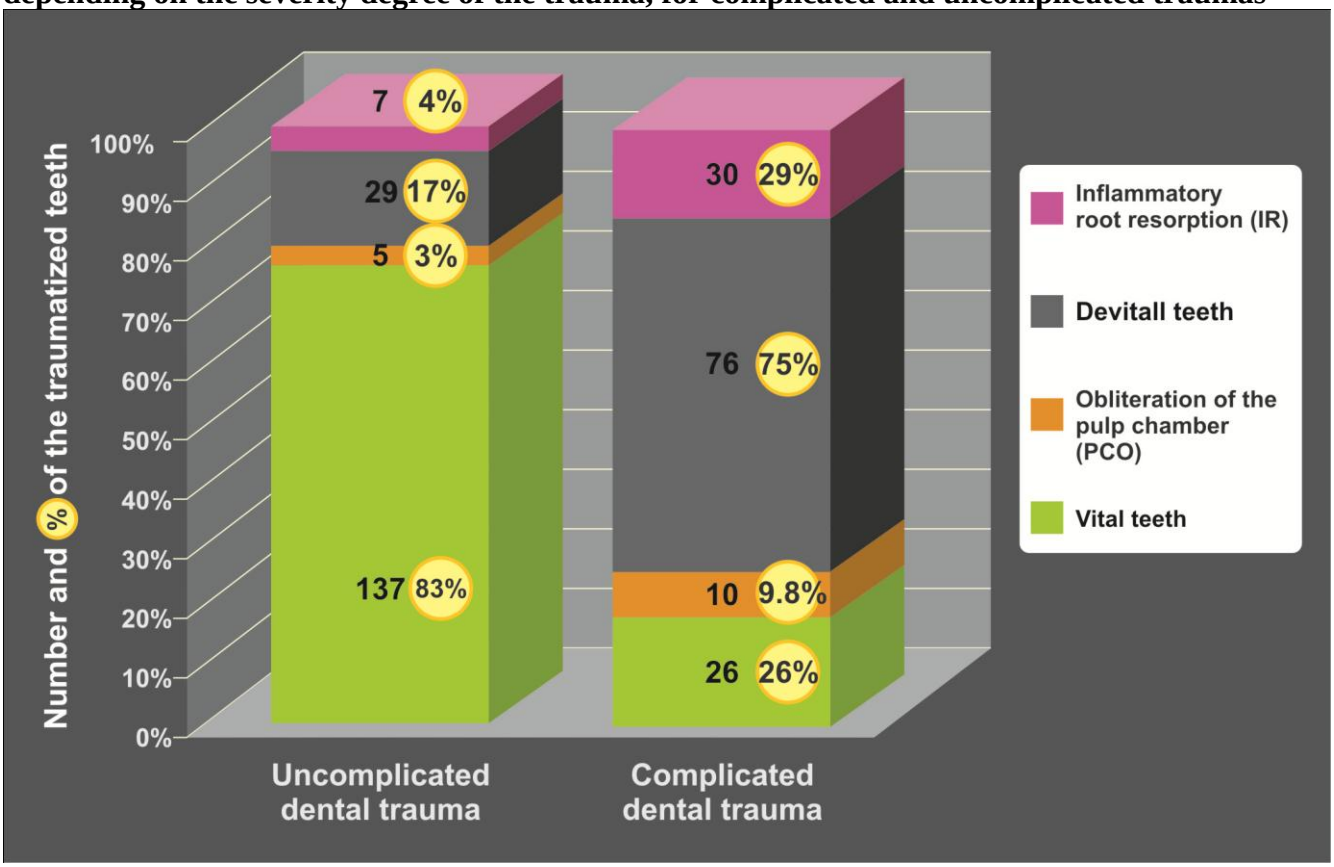
A similar decline of intensity is observed during the first through sixth month. 24 (9%) of the teeth lose vitality during this period. The lowest number of devital teeth amounting to n 7 (2.6%) was registered during months 12 – 24.
In general, the steepest decline in number of vital teeth was observed during the first six months after the trauma, amounting to 98 (93%) of the total 105 (100%) of devital teeth.

4.2.2. Treatment and observation results for complicated and uncomplicated TDI.

The number and percentage of vital teeth among teeth with uncomplicated trauma is almost five times higher than in the group of teeth with complicated trauma; 137 (83%) > 26 (26%). Meanwhile, the proportion of devital teeth with uncomplicated trauma is considerably (almost three times) lower than that of teeth with complicated trauma; 29 (17%) < 76 (75%). Thus it can be concluded that the severity degree of the trauma affects the number of vital and devital teeth in the groups. The image represents a graphic interpretation of the described values

Obliteration of the pulp chamber (PCO) is observed rather infrequently, only in 15 of all traumatised teeth and was observed twice as frequently in the complicated trauma group than in uncomplicated trauma group; n10 (67%)> n5 (33%). Resorption of the inflammation root has a medium incidence frequency as a post-traumatic complication. It was observed in 14% of the traumatised teeth and with considerably higher frequency in teeth with complicated trauma (30; 81%) in comparison to the teeth in uncomplicated trauma group (7; 19%).These data has been exposed at image 11.

Image 11 Number of vital and devital teeth, obliteration of pulp chamber, resorption of the inflammation root in all traumatised teeth (268) during the last examination and control visit, depending on the severity degree of the trauma, for complicated and uncomplicated traumas



4.3. Analysis results of the TDI diagnostic groups, general characteristics, number of vital and devital teeth. Factors affecting vitality in hard dental tissue traumas.

For uncomplicated crown fractures

Uncomplicated crown fractures comprised 43% of all dental traumas, making it the most common diagnosis during the whole research. Uncomplicated crown fractures without subluxation were diagnosed 2.5 times more frequently than CF with subluxation. See table 4 for general summary of CF data.

Table 4. Demographical data of uncomplicated crown fractures and duration of treatment.

Description of diagnosis	Number of teeth	% of the total number	Age of children in years	Gender				Treatment duration in weeks
				Girls		Boys		
				No.	%	No.	%	
Uncomplicated crown fractures without subluxation	82	51.25	Average: 11,2 Within the limits 7-17 SD = 3.14 N = 59	16	27.12	43	72.88	Average: 1.9 Within the limits 0.1-11 SD = 2.67 N = 56
Uncomplicated crown fractures with subluxation	34	21.25	Average: 9.9 Within the limits 7-16 SD = 2.99 N = 24	8	33.30	16	66.70	Average: 3.9 Within the limits 0.1-7 SD = 2.99 N = 25

Treatment time differed considerably in both groups with the treatment time in the group of CF with subluxation being one month longer on average. This must be linked with the high pulp necrosis risk and following endodontic treatment of non-complicated crown fractures with accompanying subluxation.

During research of the root forming degrees of the traumatised teeth with reference to post-traumatic teeth vitality indicators, the number of vital and devital teeth in uncomplicated crown fractures without accompanying subluxation (A-group) and in uncomplicated crown fractures with accompanying subluxation (B-group) was assessed, as shown in Table 5

Table 5 Classification of uncomplicated crown fractures in groups according to the crown formation degree and posttraumatic teeth vitality indicators

Group	Description of diagnosis	Root development and formation degree	Vital		Devital	
			Number	%	Number	%
A	Uncomplicated crown fractures **without** subluxation	Stage – (5) formed	47	60.26	4	7.48
		Stage – (4) incompletely formed	24	30.77	0	0.00
		Stage – (3) incompletely formed	7	8.97	0	0.00
Total number of traumatised teeth		**82**	Vital		Devital	
			95.12		4.88	
B	Uncomplicated crown fractures **with** subluxation	Stage – (5) formed	4	10.18	9	64.29
		Stage – (4) incompletely formed	2	20	4	28.50
		Stage – (3) incompletely formed	11	50	1	7.14
Total number of traumatised teeth		**34**	Vital		Devital	
			20	58.82	14	41.18

In crown fractures without accompanying subluxation, vital teeth were found in 95.12% of cases and pulp necrosis in 4.88% of cases. In CF with accompanying subluxation, vital teeth were found in 58.82% of cases and the percentage of necrosis reached 41.18%. Presence of accompanying subluxation considerably facilitates development of necrosis in pulp tissue from 4.88% to 41.18% ($p<0,002$).General trauma-related factors such as gender, age, and root formation degree do not affect pulp quality indicators directly.6. The table summarises factors affecting vitality with proven statistical significance

Table 6 Linear regression analysis of local factors affecting pulp vitality after uncomplicated crown fractures.

Factors	Quotient	t (test value)	p > | t |
Root development degree	**0.2**	**4.8**	**0.05**
Depth of fracture in the tissue	**0.3**	**6.2**	**0.001**
Accompanying subluxation	**0.3**	**5.4**	**0.01**

The multivariate regression model showed influence on the pulp vitality indicators exerted by mutual interaction of such factors as accompanying subluxation, root development degree and depth of damage in the tissue. The results of the statistical analysis of the data are summarised in Table 7.

Table 7 Multvariate regression model of local factors affecting pulp vitality after crown fractures.

Factors	Quotient	Standard error	t (test value)	p > | t |
Degree of root formation	**0.03**	**0.01**	**2.92**	**0.01**
Depth of fracture in the tissue	**0.34**	**0.06**	**5**	**0.001**
Accompanying subluxation	**0.38**	**0.07**	**5**	**0.01**

Complicated crown fractures, treatment results, factors affecting post-traumatic teeth vitality

44 teeth with CCF were observed during the research, the average age of the children was 10.4 (SD = 2.76). The average treatment duration for CCF without subluxation was less than that for CCF with subluxation (see Table 8). Vitality was preserved in 13 of the traumatised teeth (30%) after CCF, while considerably more 31 (70%) were diagnosed as devital.

Table 8 Demographical data of complicated crown fractures and duration of treatment.

Description of diagnosis	Number of teeth	% of the total number	Age of children in years	Gender				Treatment duration in weeks
				Girls		Boys		
				No.	%	No.	%	
Complicated crown fractures **without** subluxation	**33**	**20.63**	**Average: 10,9 Within the limits 7-17 SD = 2.87 N = 26**	**9**	**34.6**	**17**	**65.4**	**Average: 3.7 Within the limits 2-8 N = 33**
Complicated crown fractures **with** subluxation	**11**	**6,88**	**Average: 10.0 Within the limits 7-15 SD = 2.74 N = 9**	**2**	**22.2**	**7**	**77.8**	**Average: 4.5 Within the limits 2-7 N = 11**

Boys sustained three times more complicated crown fractures than girls, the average treatment time in weeks for complicated crown fractures (CCF) without subluxation was longer than that for CCF with accompanying subluxation. The single factor linear regression model while analysing teeth with CCF in comparison with uncomplicated CF disclosed two more important factors – correspondence of the provided emergency care to IADT guidelines and the importance of the time interval before receipt of treatment (table 9.).

Table 9 Linear regression analysis for the factors affecting pulp status after complicated crown fractures.

Factors	Quotient	Standard error	t	p > | t |
Gender	**0.15**	**0.16**	**0.9**	**N.S.**
Age	**0.06**	**0.02**	**2.4**	**0.02**
Emergency care received	**0.01**	**0.06**	**2.3**	**0.05**
Time to receipt of treatment	**0.19**	**0.07**	**2.61**	**0.01**
Degree of root formation	**0.23**	**0.06**	**3.7**	**0.001**
Depth of fracture in the tissue	**0.2**	**0.13**	**1.5**	**N.S.**
Accompanying subluxation	**0.24**	**0.15**	**2.5**	**N.S.**

The multivariate regression model of the table 10, explains the importance of the mutual interaction of the factors discovered - time to receipt of treatment, age and root development degree.

Table 10 Multivariate regression model of factors affecting pulp vitality indicators after complicated crown fractures.

Factors	Quotient	Standard error	t (test value)	p > | t |
Time to receipt of treatment	**0.2**	**0.08**	**2.6**	**0.014**
Age	**0.06**	**0.02**	**2.52**	**0.017**
Degree of root formation	**0.23**	**0.06**	**3.71**	**0.001**

Root fractures, treatment and observation results.

Root fractures (horizontal and oblique crown-root fractures, complicated and uncomplicated) were registered for 16 traumatised teeth (6% of the total number) during the research.
The average age of the child at the moment of trauma was 11.7 ± SD 3.4 years.
Duration of treatment in comparing uncomplicated and complicated crown fractures was 6 and 5 times longer respectively – on average 19.6 weeks (CF average of 2.9 weeks and CCF average of 4.1 weeks).
Duration of splinting amounted to an average of one month – 4.2 weeks ± SD 2.24 weeks.
The total treatment and observation period was 1.5 years on average (minimum period - one year, maximum period 2.8 years), see table 11.

Table 11 General demographic characteristics of teeth with horizontal and vertical root fractures, duration of treatment and total observation period, as well as post-traumatic examination results.

Diagnosis	Number of teeth	% of the total number (n268)	Age of children in years	Treatment duration in weeks	Duration of splinting in weeks	Total duration of treatment and observation period (months)	Post-traumatic examination and analysis results for traumatised teeth during the last control visit
Root fractures	16	6%	Average: 11.7 Within the limits of: 7.0-17 SD = 3.4	Average: 19,6 Within the limits: 0,1-72.0 SD = 20.01	Average: 4.2 Within the limits of: 3.0-8.6 SD = 2.24	Average: 17.9 Within the limits: 10.4-33.5 SD = 5.0	Vital – n5(31%) Devital n11(69%) PCO – n5 (31%) Inflammation resorption – n4 (25%)

Complications in the post-traumatic examination and observation period prevailed over the results representing healing processes in pulp tissue, respectively, devital teeth ~ 11(69%) > vital 5(31%), resorption of the inflammation root 4 (25%) < pulp chamber obliteration 5 (31%).

4.3.2. Luxations.

Results of clinical examination and analysis, vitality of the traumatised teeth and factors affecting vitality.

Concussion and subluxation

The principles observed in this section, which describes treatment results after trauma of periodontal tissue of the tooth, are similar to those used in the description of hard dental tissue traumas where general treatment and observation results for each diagnostic group were primarily depicted, followed by vitality affecting factor analysis in the diagnostic groups with sufficient number of traumatised teeth for statistical analysis (subluxation, extrusive and lateral luxations).
General data on bruised and subluxated teeth are summarised in Table 12.

Table 12 Duration of the total observation period of subluxated and bruised teeth, as well as post-traumatic examination and observation results.

Diagnosis	Number of teeth	% of the total number (n268)	Age of children in years	Post-traumatic examination and analysis results for traumatised teeth during the last control visit
Concussion	10	4%	Average: 10.4 Within the limits of: 7-17 SD = 4.4	Vital – n10 (100%) Devital – n(100%) PCO – n0(0%) Inflammation resorption n0(0%)
Subluxation	40	15%	Average: 11.5 Within the limits of: 7-16 SD = 3.1	Vital – n29 (73%) Devital – n1(28%) PCO – n5 (13%) Inflammation resorption n2 (5%)

The number of subluxated teeth (40) exceeds the number of bruised teeth (10) by four times. The average age of the children at the moment of trauma for subluxated teeth was higher. The total duration of treatment and observation period for subluxations was on average two times higher for subluxations in comparison with bruises (10.6 ± SD2.6 > 20.6± SD3.6).

All teeth in the bruised teeth group were assessed as vital during the last examination and control visit. Meanwhile, after subluxation, devital teeth were found in 28% of cases, pulp chamber obliteration – in 13% and inflammation root resorption in 5% of the cases.

Further on, see the results of statistical analysis of factors affecting subluxated teeth,as summarised in Table 13.

Table 13 Summary of factors affecting vitality of subluxated teeth, classification and statistical analysis results.

Factor classification	Factors	p = value
Pre-traumatic factors	Age of the child	0.02
	Formation degree of the root of the traumatised tooth	0.002
General factors linked to the moment of trauma	Time to receipt of treatment	N.S.
	Compliance of the received emergency care with IADT guidelines.	0.01
Local factors linked to the moment of trauma	Horizontal mobility	0.05
	Horizontal and vertical mobility	0.03
Treatment (intervention) factors	Duration of splinting in weeks	N.S.
	Type of the splint	0.006
Post-traumatic factors	Changed colour of the tooth after the trauma	0.002

Statistically significant influence of almost all factors summarised in table 38 which may possibly affect post-traumatic vitality indicators of subluxated teeth has been found, except for such factors as time to receipt of treatment and duration of splinting. This table summarises total results of all factors affecting vitality of the subluxated teeth, the detailed type and direction of influence of each factor is reviewed in the doctoral thesis.

Extrusive and lateral luxation

Number and percentage (%) of extrusively and laterally luxated teeth in both groups were exactly the same (14; 5%).
The average age of children who sustained extrusive luxations was higher (12.3) than that for laterally luxated teeth (9.1). Duration of treatment for extrusively luxated teeth was 3.6 weeks longer on average than that for laterally luxated teeth.
Total duration of treatment and observation period in both diagnostic groups was practically the same, with the minimum period of a year (11.9 months) and a maximum period of 3.9 years (46.7 months) ± SD 4.9 months.
Proportion of vital teeth in the group of laterally luxated teeth was considerably higher than that of extrusively luxated teeth, 5 (36%) > 2(14%). In contrast, devital teeth prevailed considerably among the extrusively luxated teeth in comparison with laterally luxated teeth - 2(86%) < ~ 9(64%).
Obliteration of the pulp channel (PCO) was observed only in laterally luxated teeth, obliteration of the pulp channel (PCO) was not observed in extrusively luxated teeth, which is connected with the high proportion of devital teeth in the group.
Resorption of the inflammation root was considerably more frequently observed among the extrusively luxated teeth in comparison to laterally luxated teeth 7(50%) > 3(21%).
Further on, see the results of statistical analysis of the factors affecting vitality of laterally and extrusively luxated teeth as summarised in Table 14.

Table 14 Results of statistical analysis of the factors affecting vitality of laterally and extrusively luxated teeth

Factor classification depending on time	**Factors**	**Lateral luxation**	**Extrusive luxation**
		p - value	**p - value**
Pre-traumatic factors	Age of the child	0.01	0.01
	Degree of root formation	0.01	0.01
General factors at the moment of trauma	Time interval before treatment	0.01	0.05
	Compliance of the emergency care with IADT guidelines.	N.S.	N.S.
Local factors at the moment of trauma	Degree of dislocation	0.06	0.001
Intervention factors	Type of splinting	N.S.	0.05

For lateral luxation there were two factors that did not have a statistically significant effect on post-traumatic tooth vitality – correspondence of the emergency care to the guidelines and type of splinting. Meanwhile, for extrusively luxated teeth, such statistical significance was not demonstrated for one factor only – correspondence of emergency care to IADT guidelines. All the other factors shown in the table have to be considered statistically significant in relation to post-traumatic vitality indicators of the traumatised teeth. More detailed type and direction of the influence of each factor can be found in the doctoral thesis.

Intrusive and total luxation.

11 totally luxated and 3 intruded teeth were treated and observed during the research. The average age of the children in the group of intrusively luxated teeth was 8, which is the lowest average age during the research. The average age of children in the group of totally luxated teeth was 11. The maximum figure of devital teeth was observed in this group during the whole duration of the research - all teeth in this group were assessed as devital at the end of the research. Resorption of the inflammation root was found in 90% of the totally luxated teeth. Prevalence of complications in the group of totally luxated teeth was assessed as very high, with 3 teeth extracted at the end of the research, it is planned to extract 6 more teeth.
General data of totally luxated and intruded teeth and treatment results are summarised in Table 15.

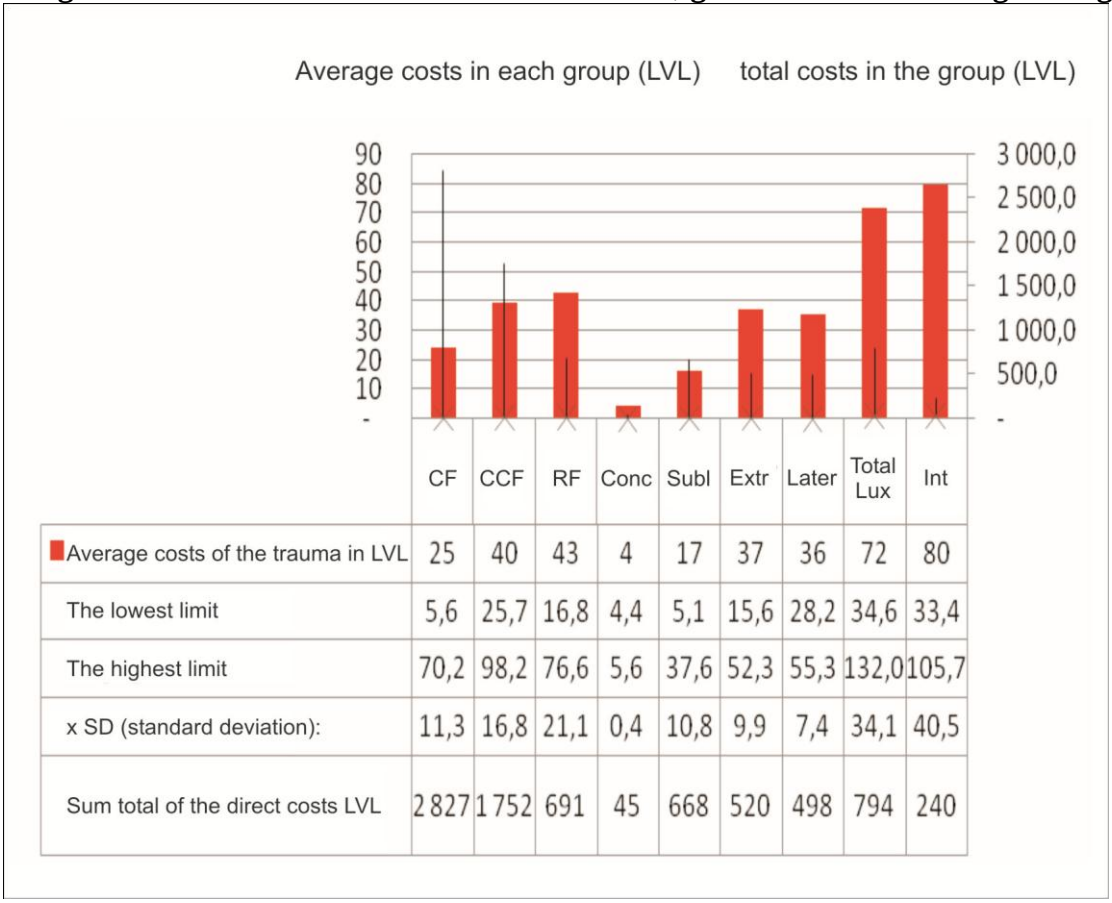
Table 15 General demographic characteristics of intruded and totally luxated teeth, duration of treatment and total observation period, as well as post-traumatic examination results.

Diagnosis	Number of teeth and % no(n268)	Treatment duration in weeks	Duration of splinting in weeks	Total duration of treatment and observation period (months)	Post-traumatic examination and analysis results for traumatised teeth during the last control visit
Total luxation	11(4%)	Average: 20.3 Within the limits of: 1.7-52.7 SD = 19.21	Average: 1.7 Within the limits of: 0.7-2.0 SD = 0.59	Average: 26.0 Within the limits of: 13.8-39.5 SD = 9.5	Vital – 0(0%) Devital-11(100%) Inflammation resorption – 10(90%) Ankylosis – 8(73%)
Intrusion	3(1%)	Average: 67.7 Within the limits of: 3.0-104.0 SD = 56.14	**Orthodontic extrusion 3-weeks**	Average: 27.8 Within the limits of: 23.7-27.8 SD = 3.6	Vital - 1 Devital - 2 PCO - 1 Inflammation resorption - 2 Ankylosis - 2

4.4. Direct costs of treatment of TDI in all diagnostic groups, factors affecting the costs

Within the two-year research period, 188 patients with 268 traumatised teeth were treated and observed at RSU SI with total direct costs of treatment (calculated according to the national Health Payment Centre pricelist of 2005 and 2006) amounting to 8035.00 LVL during the research. Minimum, maximum and average costs of each diagnostic group are summarised in Image 12.
Average direct treatment costs for bruises were 4.40 LVL (SD = 0.4), which is the least severe of all WHO classification diagnoses. Slightly higher average costs were observed for treatment of subluxated teeth, which fall within the same group of trauma degree severity.
The average direct treatment costs for uncomplicated crown fractures reached 25 LVL (SD = 11.3), the comparatively high standard deviation represents increased costs in teeth subject to endodontic therapy.
The observed costs for complicated crown fractures with the average treatment costs amounting to 40 LVL (SD = 16.8) were very similar to root fractures 43.00 LVL (SD = 21.1), for which the significant value of the standard deviation depended on endodontic treatment, i.e. use of apex fixation. Similar costs were observed for extrusive and lateral luxations, which fall within the same group of severity degree.

Image 12 Total amounts of direct treatment costs, general costs in all diagnostic groups



	CF	CCF	RF	Conc	Subl	Extr	Later	Total Lux	Int
Average costs of the trauma in LVL	25	40	43	4	17	37	36	72	80
The lowest limit	5,6	25,7	16,8	4,4	5,1	15,6	28,2	34,6	33,4
The highest limit	70,2	98,2	76,6	5,6	37,6	52,3	55,3	132,0	105,7
x SD (standard deviation):	11,3	16,8	21,1	0,4	10,8	9,9	7,4	34,1	40,5
Sum total of the direct costs LVL	2 827	1 752	691	45	668	520	498	794	240

The highest direct treatment costs within the two year observation period were registered for intrusively and totally luxated teeth, which correspond to the most severe TDI damage.
The average treatment costs in the group of complicated trauma are 3.5 times higher than those for uncomplicated trauma. The statistical test results while researching average value difference in the groups proved that the average treatment costs in the group of complicated trauma had a statistically significant p = 0.0001difference from the average costs in the group of uncomplicated traumas.
Uncomplicated traumas – 15.25 LVL < Complicated traumas – 51.31 LVL.

Factors affecting direct costs common to all diagnostic groups

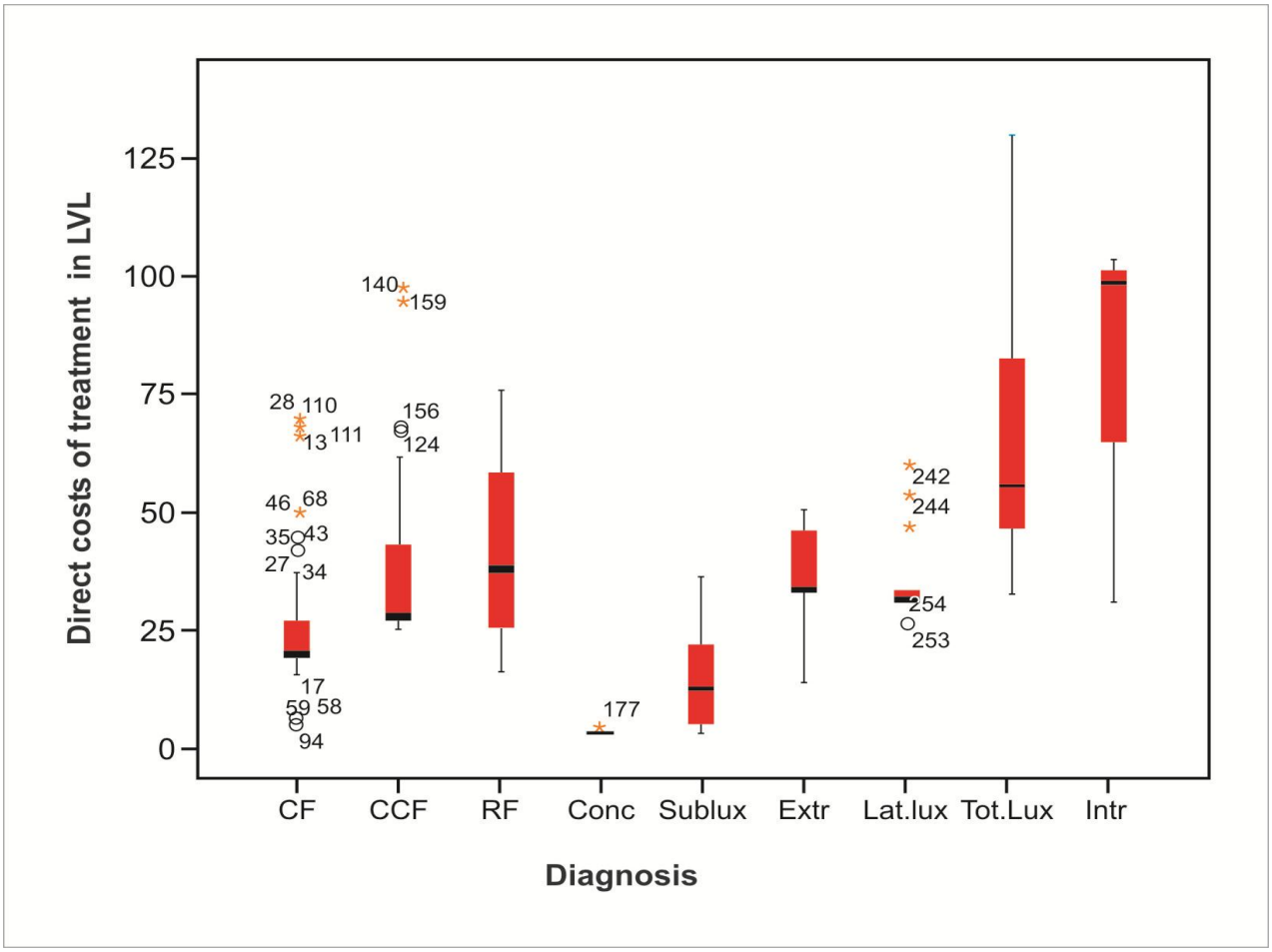
Diagnosis of the traumatised teeth (Table 16) influences direct costs of the therapy in a statistically significant manner F = 30.709 (8), p < 0.01. See expanded analysis matrix, i.e. difference of costs is statistically significant for different diagnoses in the result addendum. For graphical representation of significance of statistical differences in average treatment costs, see Image 13.

Table 16 Average treatment costs depending on type of diagnosis

Distribution source	SS	df	MS	F	p - value
Intergroup	52188.46	8	6523.55	30.70	0.0001
Within the groups	54807.45	258	212.43		
Total	106995.91	266			

As in previous graphs, Image 13 shows average treatment costs and the red contour around the average cost level in each group includes 70% of the average costs in the whole group. Circles and stars above each group, which are most characteristic of CF, CCF, Lat Lux, point to extreme values, which means that these values are not characteristic to the sample. Research of the causes of the extreme values showed that these are found when analysing apex fixation use in teeth with incompletely formed growth and development of the root which lost vitality in the post-traumatic observation period. This fact was proved by further research of interrelation of several factors and its influence on the result, i.e. teeth vitality after trauma.

Image 13 Significance of statistical differences of the direct treatment costs in box-plot graphical image.



Direct treatment costs depending on the correspondence of the emergency care provided to IADT guidelines.

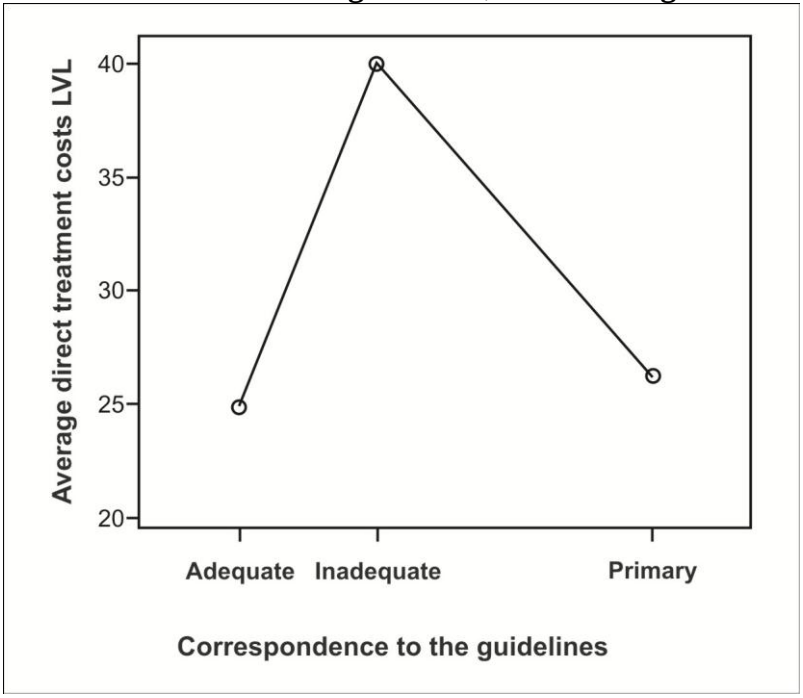
During testing of the differences in direct treatment costs, all traumatised teeth were divided into groups (*adequate*, *inadequate*) depending on the correspondence of the emergency care provided to IADT guidelines for the patients who received emergency care outside SI or under supervision of another doctor of the Children's Department. Patients who were primarily examined and according to IADT guidelines treated by the author of the research were placed in the group titled – primary.
Table 17 proves that failure of the emergency care provided to comply with IADT guidelines statistically significantly influenced growth of the direct treatment costs, where F = 10.59 and p = 0.0001

Table 17 Direct treatment costs depending on the correspondence of the emergency care provided to IADT guidelines.

Distribution source	SS	df	MS	F	p - value
Intergroup	11532.014	3	3844.005	10.59	0.0001
Within the groups	95463.903	263	362.981		
Total	106995.91	266			

Statistically significant cost differences between the groups of primarily admitted patients and patients who received emergency care according to IADT guidelines were not observed p = 1.0. For graphical representation of statistical analysis, see Image 14.

Image 14 Correspondence of costs to IADT guidelines, statistical significance



Direct treatment costs depending on the formation degree of the traumatised tooth and post-traumatic vitality indicators

During research of the mutual interrelation of several factors (insufficiently formed root of the traumatised tooth and loss of vitality after trauma) in respect of direct treatment costs, average treatment costs for vital and devital teeth after trauma with incompletely formed root growth and development were compared.

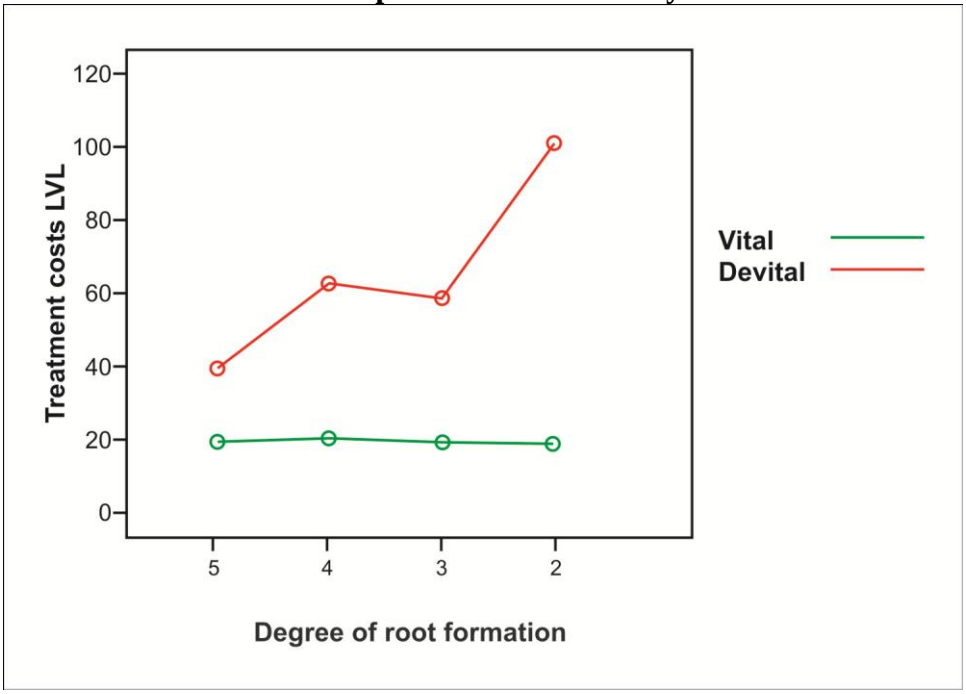
The results of the statistical analysis are summarised in Table 18 and graphically represent variations of costs shown in Image 15, where amount of costs does not change in teeth with insufficiently formed root development and preserved vitality after trauma in contrast to pronounced growth of direct treatment costs as the degree of root development reduces in traumatised devital teeth with insufficiently formed root development and growth.

Table 18 Direct treatment costs depending on the formation degree of the traumatised tooth and post-traumatic vitality indicators

Treatment outcomes	Number of traumatised teeth	Average costs (LVL)	Standard error for average values	Levene's test value		t-test value		
				F	p - value	t	p - value	confidence interval
Vital	94	19.60	0.84	36.81	**0.0001**	-17.4	0.0001	[-51.6-41.1]
Devital	28	66.01	3.39			-11.5	0.0001	[-54.6-38.1]

The following image 15.- graphically presents a representation of results of the statistical analysis

Image 15 Graphical statistical analysis image of cost dependence on the degree of root formation of the traumatised tooth and post-traumatic vitality indicators.



If average treatment costs for vital and devital teeth with insufficient formation of root growth and development are compared, the treatment costs for vital teeth after trauma with insufficiently formed roots are lower and the difference is statistically significant M = 19.6 < M = 66.01 , t = 11.52, p < 0.01 (considering that variations in both samples are not equal).

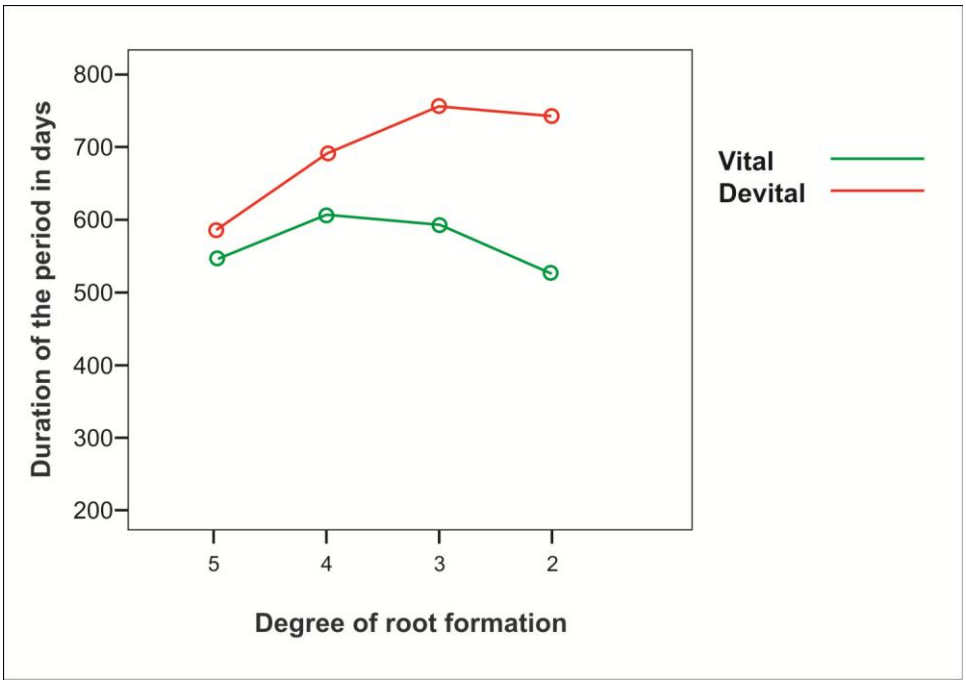
Root formation degree of the traumatised tooth and vitality loss after trauma individually do not influence the duration of treatment in a statistically significant way F = 4,47, F = 12,84, p = 0.002, p = 0.0001. Interaction of both does not influence F = 1.63, p = 0.182, see Table 19 and the graphical representation in the Image 15.

Meanwhile, the influence of root formation degree individually and tooth vitality loss after the trauma individually as well as interaction of both is statistically significant for the growth of direct treatment costs after the trauma.

Table 19 Mutual interaction of multiple factors and influence thereof on the duration of treatment and direct costs

	Dependent variable	**SS**	**df**	**F**	**p - value**
Model	Duration of the period in days Direct costs of treatment	786.200.(a) 65.409.(b)	8 8	3.29 50.72	0.001 0.0001
Degree of root formation	Duration of the period in days Direct costs of treatment	533695. 13914.	4 4	4.47 21.58	0.002 0.0001
Devital (after trauma)	ation of the period in days Direct costs of treatment	383341. 52074.	1 1	12.84 323.06	0.0001 0.0001
Degree of ro formation **Devital (aft trauma)**	Duration of the period in days Direct costs of treatment	146225. 13260.	3 3	1.63 27.42	0.182 0.0001

Image 16 Graphical representation of the statistical analysis of mutual interaction of several factors and its influence on the duration of treatment and direct costs



Find results of more detailed analysis of the factors affecting each diagnosis (according to WHO classification principles) with characterisation of the type of influence and its direction in the doctoral thesis.

Conclusions

1. All diagnostic groups and subgroups diagnosed pursuant to the World Health Organization (WHO) classification system were treated at the Children's Department of the Institute of Stomatology of Riga Stradiņš University (RSU SI).

2. The proportion of complicated and combined TDI was very high and made up one half of all tooth trauma registered during the research.

3. Uncomplicated crown fractures were the most frequent diagnoses in children aged 7 - 18 with the most common therapy method being restoration of the traumatised teeth using light-polymerised composite material.

4. Taumas of hard dental tissue are two times more frequent than luxations.

5. Throughout the whole period of the research, the frequency of traumas sustained by boys was twice higher than that among girls with a maximum TDI intensity figure reached at the age of 8.9.

6. The most important factors affecting vitality of the pulp tissue after crown fractures are the depth of the anatomical injury in the tissue, the presence of an accompanying subluxation, as well as the degree of root formation of the teeth at the moment of the trauma.

7. Factors such as degree of dislocation, root formation degree and type of splinting statistically significantly affected teeth vitality indicators after luxations.

8. Direct treatment costs within the two-year period ranged from 4.4 LVL (for bruise) to 132.00 LVL (for total luxation) per one traumatised tooth depending on the diagnosis.

9. Severity degree of the trauma, delayed commencement of the therapy, failure of the emergency care to comply with IADT guidelines are the most important general factors linked with growth of direct treatment costs.

10. The most significant post-traumatic growth of costs is observed during interaction of factors such as loss of the vitality of the tooth after dento-alveolar trauma and growth and development of insufficiently formed root.

11. Review of the intervention factor influence of the method of treatment in relation to the costs of treatment demonstrated the steepest rise of costs for teeth treated with apex fixation method, meanwhile vital pulp therapy methods (direct covering of the pulp, partial or cervical pulpotomy) considerably reduced the direct costs of treatment.

12. The duration of treatment registered during the whole duration of the research ranged from one day to 2.2 years on average, depending on the type of trauma.

13. The number of visits spent for treatment and observation of TDI varies from 2 - 3 visits in the groups of low or medium severity degree and reached 15 – 20 visits when treating dental traumas of severe and very severe degrees.

14. Inadequate emergency treatment received more than half of injured teeth included in this study.

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2. Viduskalne I., Care R. An audit of time to initial treatment and outcome in avulsion injures.7th Congress of BAMPS. 2010;68 -69.

3. Viduskalne I., Care R. Skolotāju zināšanas par neatliekamās palīdzības principiem pēc totālas zoba luksācijas. [Viduskalne I., Care R. Competence of the Teachers on the Principles of Emergency Care after Total Tooth Luxation.] RSU Scientific Conference theses 2009; 36-37

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