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PROFILE OF COMPLICATED/UNCOMPLICATED CROWN FRACTURES AND HEALING COMPLICATIONS IN PERMANENT TEETH - A RETROSPECTIVE STUDY

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ABSTRACT

Purpose: This retrospective study analyses the profile of uncomplicated/complicated crown fractures in permanent teeth, the frequency of healing complications, and types of treatment methods.
Methods: The trauma forms of patients who were registered with uncomplicated/complicated crown fractures from 2016 to 2019 were evaluated. Long-term treatment outcomes were analyzed from patient radiographs using the Periapical Index. The relationship between categorical variables was tested with the Chi-square test. Logistic regression analysis was performed to search for an association between the type of fracture, length of follow-up period, and presence of healing complications. $P<0.05$ was considered significant.
Results: In this study, a total of 361 teeth of 228 patients aged between 6-14 years old were evaluated. While 243 (67.3%) of these teeth were evaluated as uncomplicated crown fractures, 118 (32.7%) were classified as complicated crown fractures. The relationship between the treatment and the fracture type was found to be statistically significant ($p=0.001$). When the effect of the length of follow-up period and the fracture types on treatment success was examined by logistic regression analysis, it was found that the follow-up period ($p=0.460$) and the fracture type ($p=0.058$) had no effect on healing complications.
Conclusion: Retrospective studies help define prognostic factors. When the relationship between crown fracture types and healing complications was examined, it was observed that healing complications were more common in complicated fractures.

KEYWORDS: Dental Trauma, Crown Fractures, Complications, Periapical Index.

INTRODUCTION

TDI (Traumatic Dental Injuries) is a worldwide problem that occurs frequently. TDI is especially common in early childhood and school-age children. It affects oral health and social life as much as dental caries, and its treatment might take years. Information that sheds light on this subject is obtained from of the retrospective information provided by the patients, detailed examination of the treatment and follow-up of the patient, plus the evaluation of the results.

The majority of dental trauma in both the primary and permanent dentition involved the anterior teeth. The maxillary central and lateral incisors were the most common teeth injured.[1]

Treatment of TDI is not a routine occurrence in dental practice. The outcome of treatment is highly correlated with the dentist's knowledge and skill, as well as immediate first aid at the injury site. Therefore, it has been reported that not only dentists, but also parents, teachers and sports coaches should have basic knowledge of the emergency management of TDI.[2]

Different classification and treatment protocols have been created over time for TDI. In particular, the results of retrospective studies have guided the formation of protocols for treatments administered to patients. Although, the patient's cooperation is a very important factor in the success of the treatments, classification, accurate clinical and radiographic observation and the experience of the physician plays a major role.[3]

Uncomplicated crown fractures in the permanent dentition are the most common type of injury. This has ramifications for epidemiological studies as many of these injuries are not perceived as requiring treatment. As such, the prevalence of dental trauma is likely to be underestimated.[4]

The aim of this study was to conduct a retrospective review of the diagnosis and treatment of complicated/uncomplicated crown fractures obtained from the trauma records from the department of Pediatric Dentistry between 2016-2019.

Due to the importance of traumatic dental injuries in public health, the aim of this study was to inspect complicated/uncomplicated crown fractures in permanent teeth, the frequency of healing complications, treatments and predisposing factors.

METHODS

This study was a retrospective analysis of patient records available at the Pediatric Dentistry Department at Marmara University Faculty of Dentistry between 2016-2019. The sample size was calculated to estimate the expectation of 95.12% success with 5% certainty and 95% confidence in the analysis, and the minimum required number of patients was determined as 72.

Ethics: Ethical approval was obtained from Marmara University Clinical Studies Ethical Committee with protocol no: 2020-411. Informed consent was not required, because the analysis was based on electronic records of patients who were registered to Pediatric Dentistry. Clinics

Study Population: Patients who had experienced uncomplicated/complicated crown fractures and their treatments were examined.

Inclusion criteria for the study were to be between the ages of 6-14, having experienced complicated or uncomplicated crown fractures of permanent teeth, having no additional soft tissue injuries and no splints, the availability of diagnostic, treatment, and follow up panoramic and periapical radiographs. Detailed (medical and social) anamnesis and trauma patient registration forms obtained from the parents of the children were evaluated. Demographic information of the patients (admission date, age, gender), diagnosis, type of crown fracture, treatment applied, follow-up periods, tooth numbers, and numbers were evaluated retrospectively. Patients admitted to the clinic were classified as complicated and uncomplicated crown fractures, according to the Andreasen Classification of Dental Injury[5].

Evaluation: Periapical radiolucency, pulp prognosis, and success of treatment parameters were evaluated using the Periapical Index Scale (PAI)[6] from the periapical radiographs taken from the patients for follow-up. Periapical radiographs of 361 teeth from 228 children were examined by two observers and classified according to PAI. Score 1 was assessed as successful, while all other scores were classified as unsuccessful.

Statistics: Descriptive statistics are given as mean ± standard deviation and median (minimum-maximum) for numerical variables, and numbers and percentages for categorical variables. The conformity of the numerical variables to the normal distribution was tested with the Shapiro Wilk test. The relationship between categorical variables was tested with the Chi-square test, and the concordance was tested with the Kappa coefficient. Logistic regression analysis was performed to analyze the risk factors affecting failure. SPSS 22.0 Windows version package program was used in the analysis. $P<0.05$ was considered significant.

RESULTS

Children which attended Pediatric Dentistry Clinics in the time period from 2016 to 2019 were evaluated, subsequently, complicated and uncomplicated crown fractures were observed in 228 children.

A total of 228 children (361 teeth) affected by crown fractures, 140 (61.4%) male and 88 (38.6%) female, were included in this study. Males were more susceptible to this type of dental trauma. 361 crown fractures were analyzed and separated into two groups as complicated and uncomplicated crown fractures.

The age of the patients ranged from 6 to 14 years, with a mean age of 9.75 ± 1.7 years at which crown fractures occurred. The ages of the children who applied to the clinic most frequently with the complaint of crown fracture were determined as 10 and 11 years. Boys

Crown fractures in permanent teeth were more to occur at home, which was followed with school and then outdoors. The most common reason for crown fractures was found to be falling at the rate of 70.5%.

Complicated and uncomplicated crown fractures were separated according to the clinical classification of Traumatic Dental Injuries. While 243 (67.3%) of 361 teeth were classified as uncomplicated fractures, 118 (32.7%) were classified as complicated fractures.

Composite restorations were the most common treatment choice for uncomplicated crown fractures at 88.9%. The relationship between crown fracture types and treatments applied is shown in Table 1. The relationship between the treatment applied and the type of fracture was statistically significant (p=0.001).

Table 1 *(The Relationship Between Crown Fracture Types and Treatments Applied.)*

	Trauma Type				
	Uncomplicated		**Complicated**		
Treatment Type	n	%	n	%	P

Pulpotomy	1	0.4	14	12.0	0.001*
Composite Restoration	216	88.9	0	0	
Endodontic Treatment	26	10.7	98	83.8	
Regeneration	0	0	5	4.3	

** Significant at the p<0.05 level, Chi-square test*

The mean follow-up period of the patients was found to be 25.1 months. It was determined that the patients were followed for at least 1 month and at most 60 months. While 177 (77.6%) patients were followed up after treatment; 51 (22.4%) patients were excluded from the study because they did not have follow-up radiographs after treatment. When the effect of the length of follow-up period and the fracture types (uncomplicated and complicated) on treatment success was examined by logistic regression analysis, it was found that the follow-up period (p=0.460) and the fracture type (p=0.058) had no effect on healing complications (Table 2).

Table 2 *(Effect of Follow-up Period and Fracture Types on Treatment Failure.)*

	P	OR	%95 Confidence Interval	
			Bottom	Top
Crown Fracture Type (Complicated vs. Uncomplicated	0.058	0.433	0.183	1.027
Follow-Up Period	0.460	1.012	0.981	1.043
Constant	0.001*	12.517		

** Significant at the p<0.05 level, Logistic regression analysis*

Excellent concordance was observed between the two observers when Kappa analysis was applied for the Periapical Index (PAI) (Ørstavik et al., 1986). The results according to the PAI scale were shown in Table 3.

Table 3 *(Score Distribution for Periapical Index.)*

		n	%
Periapical Index Score	1	252	89,4
	2	20	7,1
	3	7	2,5
	4	3	1,1

When the relationship between the type of treatment and the periapical index was examined, no statistically significant relationship was found (p=0.159) (Table 4).

Table 4 *(Relationship of Treatment Applied with Periapical Index.)*

Treatment	**Periapical Index**								
	1		2		3		4		
	n	%	n	%	n	%	n	%	P
Pulpotomy	10	3.9	2	12.5	1	25	1	33.3	0.159
Composite Restoration	147	57.0	6	37.5	1	25	0	0.0	
Endodontic Treatment	96	37.2	8	50	2	50	2	66.7	
Regeneration	5	1.9	0	0	0	0	0	0	

** Significant at the p<0.05 level, Chi-square test*

When the predicted periapical pathology after complicated and uncomplicated crown fractures was evaluated radiographically, 165 (64.0%) of uncomplicated fractures and 93 (36.0%) of complicated fractures were found to be successful (Table 6). When the relationship between the predicted periapical pathology and fracture type after complicated and uncomplicated crown fractures was examined, it was found to be statistically insignificant (p=0.052).
A statistically significant correlation was found between the treatment applied and the periapical pathology encountered afterwards (p=0.017) (Table 5).

Table 5 *(Correlation of Crown Fracture Type and Treatment Applied with Radiographic Evaluation of Evaluated Periapical Condition.)*

Radiographical evaluation of periapical pathology	Successful	Failure	P
Crown Fracture Type			
Uncomplicated	165 (%64.0)	10 (43.5)	0.052
Complicated	93 (%36.0)	13 (56.5)	
Type of Treatment			
Pulpotomy	10 (%3.9)	4 (%17.4)	0.017*
Composite Restoration	147 (%57.0)	7 (%30.4)	
Endodontic Treatment	96 (%37.2)	12 (%52.2)	
Regeneration	5 (%1.9)	0 (0)	

** Significant at the p<0.05 level*

DISCUSSION

Many studies have reported that crown fractures without pulp exposure are the most common type of TDI in permanent dentition.[7,8,9] Toprak et al., found that the occurrence of enamel fractures were 8.5%, uncomplicated crown fractures were 20.5%, complicated crown fractures were 19.4%, and luxation injuries were 43.3% in their study population.[10]

According to many current sources, it has been reported that boys are more exposed to TDI than girls.[11,12,13,14] It has been stated that falling has been the most common cause of TDI by many different articles.[8,15,16,17] These statements are parallel with the results of our study.

According to the International Dental Trauma Guidelines, the recommended mean follow-up period is 1 year for complicated and uncomplicated crown fractures.[18]

When emergency department visits for TDI were analyzed, 42% of the patients returned to the dental clinic for follow-up after an emergency visit, but only 22% of these teeth were followed up for more than 6 months.19 In our study, similar to the study of Ritwik et al., 77.6% of the patients followed up, while 22.4% of the patients did not.

Our mean follow-up period was found to be 25.1 months. When logistic regression analysis of the effect of length of follow-up and fracture types (uncomplicated and complicated) on treatment success was performed, no statistically significant effect of follow-up time and fracture type on failure was found.

Especially in the follow-ups over a period of more than 1 year, it was observed that teeth with uncomplicated crown fractures lose vitality due to long-term untreated and bacterial contamination, and a transition from restorative treatment to endodontic treatment is experienced. It was thought that

this situation may be related to the low level of awareness of the parents about the importance of emergency intervention in cases of TDI.

Another reason is the fact that patients who do not have soft tissue injuries or experience uncomplicated crown fractures generally do not seek treatment unless they feel pain.7 It was stated that it is very important to visit the dentist immediately after TDI and intervention to the injured tooth must be done immediately. Delay in treatment causes unwanted results in the long term.[20,22]According to many studies, it has been found that early or delayed treatment does not have a negative effect on the prognosis in crown fractures.[22,23,24,25] Among the factors affecting the success of the treatment; presence of concomitant luxation injury, pulp exposure status, uncomplicated or complicated fracture, and timing of treatment were found.26 Studies suggest that follow-up time of patients increase in cases where follow-up appointments are scheduled before the patient is discharged.16 In order to ensure the continuity of follow-up and increase the quality of care, it has been suggested that a similar system would be beneficial in pediatric patients who were registered to the emergency department with dental complaints.[19]

Wang et al.[27], stated that time intervals have no effect on pulp prognosis. In a study by Harran et al. on canine teeth, it was reported that no significant difference was observed between the 48th and 72nd hours and they stated that time intervals did not affect the pulp prognosis.28 In another study by Robertson et al., it was determined that time intervals had an effect on pulp prognosis.[29]

When the ideal treatment for teeth with complicated and uncomplicated crown fractures is debated, it is advised that materials that form the most perfect sealing with the tooth are able to prevent the bacterial micro-leakage.[30]

When the relationship between fracture type and treatment success was examined in our study, it was found that complicated fractures had a lower success rate. In a study conducted in 2021, it was revealed that restoration loss, healing complications, is a more common finding in complicated crown fractures, similar to our study. This finding is explained by the reason that complicated crown fractures have more severe hard tissue loss and require more extensive treatment than uncomplicated crown fractures.[31]

High success was found in restorative treatments applied to uncomplicated crown fractures.18 This result is consistent with our study. The success of direct composite restorations was found to be more successful than restorations done using the reattachment method, but it was thought that this finding should be interpreted carefully because the reattaching the tooth fragment is more minimally invasive and aesthetic.[31,32,33]It has been stated that a good prognosis for pulp healing can be expected when an early intervention such as pulp capping or pulpotomy is performed in teeth with exposed pulp and complicated crown fractures.[34,35,36]

In the case of more severe TDI`s and impaired apical vascular nutrition of the pulp, revascularization of the pulp may be possible. It has been stated that the recovery of this situation is primarily related to the size of the apical foramen and the prevention of infection of the pulp cavity.24 In our study, no permanent tooth was extracted during the follow-up period, in line with the studies examining the survival of crown fractures. This finding indicates that crown fractures result in a good prognosis.[26,30,31,37]

In our study, 89.4% of the teeth with crown fracture were evaluated as 1 score on the periapical index scale and were radiographically successful. No statistically significant correlation was found between the type of fracture and the periapical index. The key insight from a recent study was that crown fractures and their clinical management are often associated with acceptably high success rates. The highest pulp survival rate was determined as uncomplicated fractures that did not suffer any additional luxation injury, and then complicated fractures that did not receive any additional injury.[31]

Apart from the treatments, the patients may have a share in the complications that occur after the restoration is done. Loss of restoration can occur as a result of the patient's diet or can be a structural issue due to the deterioration of the restoration because of inadequate oral hygiene. Therefore, it is essential to inform the patients, provide oral hygiene education and motivation to increase the success of our treatment.[12] The survival rate of the pulp was found to be very low, especially when the restoration was lost in the first 6 months.[28]
Authors emphasize that longer follow-up periods are crucial in cases of trauma, especially when the matter is teeth with incomplete root development.

This study assesses the differences between complicated and uncomplicated crown fractures in permanent teeth to help dentists enhance a better understanding for patients who have had crown fractures. The findings of this study showed that the kind of fracture and the length of the follow-up period had no bearing on the presence of healing problems.

CONCLUSION

Crown fractures were mostly seen in boys, and composite restorations were the most sought out treatment option. In addition, the follow up period had no effect on the longevity of the treatment. Nevertheless, the treatments chosen for this trauma type were found to be successful radiographically. Retrospective studies are important for us because they present us with long term results that make us aware of different factors that may affect our prognosis and treatment options in the future.

Informed Consent
Assent for the treatment protocol was obtained from the patients and their parents, and informed consent was obtained from the parents.

Author Contributions
All authors contributed to the study conception and design. The treatment and follow-up of the case were performed by all authors. The first draft of the manuscript was written by M.O.U. and M.A.Y. and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Conflict of Interest
All authors declare that they have no conflicts of interest with this work.

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