

Magnitude and pattern of combination traumatic dental injuries: An institution based retrospective study in Nepal

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ABSTRACT

Introduction: Traumatic dental injuries can occur as combination injuries, where both fracture and luxation injuries occur concomitantly in the same tooth. The aim of this study was to evaluate prevalence of concomitant fracture and luxation injury (combination dental injuries) in permanent teeth. **Methods:** A total of 455 traumatized anterior teeth from 175 patients (131 males and 44 females; age ranged from 14 to 70 years), coming for treatment of traumatic dental injuries over a five-year period from January 2016 to December 2020 were included in the study. Patient's age and sex, type of injury, type and number of injured teeth were recorded from the clinical and radiographic examination records. Descriptive statistical methods were used for data analysis. **Results:** A total of 257 teeth (56.48%) had fracture injury only, while 150 teeth (32.96%) were found to have luxation injury only. The most common isolated fracture injury was enamel-dentin fracture (n=93; 22.85%) and the most common isolated luxation injury was subluxation (n=77; 18.91%). A low prevalence of combination injury was observed in 48 teeth (10.54%). Enamel-dentin fracture (52.08%) was the most common fracture injury type presenting with a concomitant luxation injury. Similarly, the most frequent luxation injury type presenting with a concomitant crown fracture injury was subluxation (56.25%). The most common combination injury was enamel-dentin fracture in combination with subluxation injury (n=15; 31.25%). **Conclusions:** The magnitude of combination injury was low in this study and was frequently observed in males of young age groups. The most common combination injury was enamel-dentin fracture in combination with subluxation injury.

Keywords: Combined fracture and luxation injury, concomitant, concurrent, dental trauma, traumatic dental injuries.

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INTRODUCTION

Traumatic dental injuries (TDIs) are classified into seven types of fracture injuries (injuries to the hard dental tissues and the pulp) and six types of luxation injuries (injuries to the periodontal tissues).¹ In addition, TDIs can occur as combination injuries, where both fracture and luxation injuries occur concomitantly in the same tooth.² Concurrent fracture and luxation injury is an important factor that influences the risk of pulp necrosis (PN) and other complications in a traumatized tooth, and also determines the prognosis and healing of a traumatized tooth.³⁻⁹

Prevention of infection is important for healing, since healing of the dental pulp is highly dependent on the presence or absence of bacteria.^{3,4} Hence, prevention of bacterial penetration into the dental pulp is a significant factor that determines the prognosis of a traumatized tooth and is equally important for preserving pulp vitality.⁹ Similarly, the presence of an intact pulp neurovascular supply is important for the healing and defense mechanism of the dental pulp.³ The pulp's defense mechanism is compromised and becomes less effective when the neurovascular supply is damaged after luxation injury.^{3,6,10,11} The risk of bacterial penetration through

the exposed dentinal tubules into the pulp is increased when there is simultaneous fracture and luxation injury.^{9,10} Therefore, the presence of concomitant fracture and luxation injury significantly increases the risk of PN.^{3,9,10,12-16} As a result, complications are more commonly found in teeth with combination injuries.¹²⁻¹⁴

A combination injury has complex healing, since more tissues are involved in concurrent fracture and luxation injuries.¹⁰ Therefore, the prognosis and healing of a tooth with a combination injury is difficult to predict. Additionally, the presence of combination injury can create difficulty in the diagnosis of such injuries and can also complicate their management.² Since the prognosis of the traumatized tooth depends on correct diagnosis and treatment, identification of combination injuries is important for a favorable outcome. Although there are numerous studies reporting the prevalence and incidence of dental trauma, only few studies have discussed about combination dental injuries.¹⁷⁻²¹ These studies have demonstrated that concurrent fracture and luxation injuries are relatively common.^{3,17} Similarly, even though many studies have been conducted on TDIs, information related to the frequency of combination dental injuries is lacking in Nepal.^{22,23} Therefore, the purpose of the present study was to evaluate prevalence of concomitant fracture and luxation injury (combination dental injuries) in permanent teeth.

METHODS

This retrospective observational study included patients who came for treatment of TDIs over a five-year period from January 2016 to December 2020. The sample was collected through purposive sampling method. The study was conducted at the Department of Conservative Dentistry and Endodontics, School of Dental Sciences, Chitwan Medical College, Bharatpur, Nepal. The following information was recorded by the principal investigator from the clinical and radiographic examination records: patient’s age and sex, type of injury, type and number of injured teeth. Traumatized anterior teeth were only included while traumatized posterior teeth and teeth with avulsion injury were excluded in this study. TDIs were classified according to the modification of the WHO classification.¹ Informed consent was not required since the data were collected from the past records. The study was conducted with the ethical approval of the Institutional Review Committee No. (Ethical Clearance No: CMC-IRC/078/079-019).

After considering inclusion and exclusion criteria, 455 samples were taken from past records of a total of 560 teeth. The collected data was recorded in MS Excel sheet.

Descriptive statistical methods were used for data analysis. Percentage and frequency were calculated. The distribution of concomitant fracture injuries among the types of luxation injury types was analyzed. Statistical analysis was done with Statistical Package for the Social Sciences (SPSS, version 22.0 IBM SPSS).

RESULTS

A total of 455 traumatized anterior teeth from 175 patients (131 males and 44 females) were included in the study. Males were commonly affected than females. Male: Female ratio of 2.97. TDIs were most commonly observed in the 16 to 20 (n = 43; 24.57%) year-old age group followed by the 21 to 25 (n = 42; 24%) year-old age group (Table 1).

Table 1: Age and sex distribution of the participants (N= 175)

Age distribution	Male	Female	Total
14-15	3 (2.29%)	4 (9.09%)	7 (4%)
16-20	33 (25.19%)	10 (22.72%)	43 (24.57%)
21-25	33 (25%)	9 (20.45%)	42 (24%)
26-30	23 (19%)	8 (18.18%)	31 (17.71%)
31-35	17 (17.55%)	3 (6.81%)	20 (11.42%)
36-40	8 (6.10%)	2 (4.54%)	10 (5.71%)
41-45	6 (4.58%)	4 (9.09%)	10 (5.71%)
46-50	3 (2.29%)	2 (4.54%)	5 (2.85%)
51-55	4 (3.05%)	1 (2.27%)	5 (2.85%)
56-60	0 (%)	1 (2.27%)	1 (0.57%)
61-70	1 (0.76%)	0 (%)	1 (0.57%)
Total	131 (74.85%)	44 (25.14%)	175 (100%)

A total of 257 teeth (56.48%) had fracture injury only, while 150 teeth (32.96%) were found to have luxation injury only. Furthermore, the most common isolated fracture injury was enamel-dentin fracture (n=93; 22.85%) and the most common isolated luxation injury was subluxation (n=77; 18.91%) (Table 2).

Table 2: Tooth distribution of isolated fracture and luxation injury (n=407)

Tooth	13	12	11	21	22	23	33	32	31	41	42	43	Total
Enamel Infarction	0	1	1	1	1	0	0	0	0	0	0	0	4 (0.98%)
Enamel Fracture	2	6	6	3	7	2	0	0	0	0	1	0	27 (6.63%)
Enamel-Dentin Fracture	2	10	19	29	8	7	1	4	4	4	4	1	93 (22.85%)
Enamel-Dentin Pulp Fracture	1	14	25	22	14	3	2	4	2	1	2	1	91 (22.38%)
Crown-Root Fracture with No Pulp Exposure	0	0	2	0	0	0	0	0	0	0	0	0	2 (0.49%)
Crown-Root Fracture with Pulp Exposure	0	1	4	3	2	0	0	1	0	0	0	0	11 (2.70%)
Root Fracture		2	10	4	2	1	3	1	3	1	1	1	29 (7.12%)
Concussion	2	6	8	5	2	1			2	2	1		29 (7.12%)
Subluxation	1	10	13	16	17	2	1	3	6	4	3	1	77 (18.91%)
Lateral luxation	0		5	5	3	0	0	0	0	0	0	0	13 (3.19%)
Extrusive luxation	0	1	9	9	3	0	0	1	1	2	0	0	26 (6.38%)
Intrusive luxation	0	1	1	2	0	1	0	0	0	0	0	0	5 (1.22%)
Total	8 (1.96%)	5 (1.22%)	103 (25.30%)	99 (24.32%)	59 (14.49%)	17 (4.17%)	7 (1.71%)	14 (3.43%)	18 (4.42%)	14 (3.43%)	12 (2.94%)	4 (0.98%)	407 (100%)

Similarly, combination injury (concomitant fracture and

luxation injury) was found in 48 teeth (10.54%). Enamel-dentin fracture (52.08%) was the most common fracture injury type presenting with a concomitant luxation injury followed by enamel-dentin pulp fracture (complicated crown fracture) (18.75%). Half of the combination injury included an enamel-dentin fracture. Similarly, the most frequent luxation injury type presenting with a concomitant crown fracture injury was subluxation (56.25%) followed by concussion (29.16%) (Table 3).

Table 3: Distribution of combination injury (n= 48)

Type of injury	Concussion	Subluxation	Lateral Luxation	Extrusive Luxation	Intrusive Luxation	Total
Enamel Infarction	2	0	0	0	0	2 (4.16%)
Enamel Fracture	1	1	0	1	0	3 (6.25%)
Enamel-Dentin Fracture	8	15	1	1	0	25 (52.08%)
Enamel-Dentin Pulp Fracture	3	4	0	2	0	9 (18.75%)
Crown-Root Fracture with No Pulp Exposure	0	1	0	0	0	1 (2.08%)
Crown-Root Fracture with Pulp Exposure	0	1	0	0	0	1 (2.08%)
Root Fracture	0	5	1	1	0	7 (14.58%)
Total	14 (29.16%)	27 (56.25%)	2 (4.16%)	5 (10.41%)	0	48 (100%)

Both the maxillary central incisors (n= 16 each; 33.33%) were the most commonly involved teeth in combination luxation injury. More than half of the teeth (n=27; 56.25%) were found to have been involved in combination subluxation injury. Both the maxillary and mandibular canines were not found to have combination injury. Similarly, none of the tooth were found to have combination intrusive luxation injury. Majority of the teeth (n=41; 85.41%) were found to be involved in minor combination luxation injury after further evaluation (Table 4).

Table 4: Tooth distribution of combination luxation injury (n=48)

Tooth	13	12	11	21	22	23	33	32	31	41	42	43	Total
Concussion	0	2	6	3	2	0	0	1	0	0	0	0	14 (29.16%)
Subluxation	0	4	6	11	3	0	0	0	2	1	0	0	27 (56.25%)
Lateral luxation	0	0	1	0	0	0	0	0	0	1	0	0	2 (4.16%)
Extrusive luxation	0	0	3	2	0	0	0	0	0	0	0	0	5 (10.41%)
Intrusive luxation	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	6 (12.5%)	16 (33.33%)	16 (33.33%)	5 (10.41%)	0	0	1 (2.08%)	2 (4.16%)	2 (4.16%)	0	0	48 (100%)

Maxillary central incisors (n= 16 each; 33.33%) were the most commonly injured teeth in combination fracture injury. More than half of the teeth (n=25; 52.08%) were found to have been involved in combination fracture injury (enamel-dentin fracture). Upon analysis, most of the teeth (n=30; 62.49%) were found to have been involved in combination uncomplicated fracture injury (Table 5).

Table 5: Tooth distribution of combination fracture injury (n=48)

Tooth	13	12	11	21	22	23	33	32	31	41	42	43	Total
Enamel Infarction		2											2 (4.16%)
Enamel Fracture		1	1		1								3 (6.25%)
Enamel-Dentin Fracture		2	10	8	3			1	1				25 (52.08%)
Enamel-Dentin Pulp Fracture			5	4									9 (18.75%)
Crown-Root Fracture with No Pulp Exposure				1									1 (2.08%)
Crown-Root Fracture with Pulp Exposure				1									1 (2.08%)
Root Fracture		1		2	1				1	2			7 (14.58%)
Total	0	6 (12.5%)	16 (33.33%)	16 (33.33%)	5 (10.41%)	0	0	1 (2.08%)	2 (4.16%)	2 (4.16%)	0	0	48 (100%)

DISCUSSION

One of the factors that influences the outcome of TDIs is injuries to the supporting periodontal structures. An associated luxation injury is an important clinical factor related to the extent of damage to the neurovascular supply and increased risk of PN after a crown fracture, according to Robertson et al.³ The prevalence of combination injures in different studies has been reported to range from 10 to 31.5%. In an earlier study, 28% of teeth were discovered with a combination of crown fracture and luxation injury.¹⁸ Similarly, Skaare et al. found a lower prevalence of combination injuries at 18% among school children.¹⁹ Combination injuries were also a frequent finding among traumatized teeth in a study by Lauridsen et al. A combination of a fracture and a luxation injury was seen in one-third (31.6%) of the traumatized teeth.¹⁷ In another study by Wang et al. 17.24% of teeth were found to have a combination of uncomplicated crown fracture and concurrent luxation injury.²⁰ A low prevalence of combination injury was also found among 10.2% of patients in a recent retrospective study.²¹ Likewise, the prevalence of combination injuries in this study was also found to be lower (10.54%) compared to other studies. Combination injury was observed in one-tenth of the traumatized tooth.

Fewer complications have been reported by several studies in teeth with crown fractures without concomitant luxation injury, which indicates that crown fracture as such has a low risk of PN.^{3,9,13} Hence, PN after uncomplicated crown fractures are rare and ranges between 2% to 5%.^{3,12,15,18} Although, the presence of concurrent luxation injury in teeth with uncomplicated crown fractures is an important risk factor for PN,²⁰ complications can result from bacterial penetration into the dentinal tubules even in the absence of simultaneous luxation injury.²⁴ As a result, teeth with deep enamel-dentin fractures are associated with an increased

rate of PN.⁹ The most common fracture injury type presenting with a concomitant luxation injury was enamel-dentin fracture (52.08%) followed by enamel-dentin pulp fracture (complicated crown fracture) (18.75%). Half of the combination injury comprised of enamel-dentin fracture in this study. In agreement with earlier studies, concomitant fracture injuries were more common in teeth with minor luxation injuries like concussion and subluxation.¹⁷⁻²¹ Likewise, the maxillary central incisors were most commonly involved in combination injuries and accounted for around two-thirds of tooth types.

Although the incidence of PN is low in teeth with concussion injury, a concomitant crown fracture significantly increases the risk of PN in such teeth.^{4,12} The chance of bacterial penetration through exposed dentinal tubules is increased when the defense mechanism of the pulp is affected by the concussion injury. Hence, the risk of PN is increased when a crown fracture occurs in combination with a concussion injury.¹² In an earlier study, concussion was found to be the second most common (28.84%) combination luxation injury.²⁰ Likewise, in the present study concussion was the second most common concurrent luxation injury comprising about one-third (29.16%) of combination injuries.

The defense mechanism of the dental pulp is compromised when the neurovascular supply is damaged due to subluxation injury.^{11,13,25} Even an uncomplicated crown fracture in teeth with subluxation injury can act as a pathway for bacterial penetration, which can lead to infection and PN.^{11-13,25} Concomitant subluxation has been found to have a significant effect on the prognosis and pulpal healing of uncomplicated crown fracture.^{3,9} Therefore, teeth with a subluxation injury and concomitant crown fracture are at a higher risk of PN. This is supported by a recent study where an increased incidence of PN was observed in teeth with crown fracture and concomitant subluxation.⁹ Even though subluxation and enamel-dentin fracture are mild injury having a low risk of PN, the risk of PN is highly increased when these two types of injury (concomitant crown fracture and subluxation injury) occur simultaneously.¹³

Infarction injuries are easily unnoticed, and tend to be ignored. However, even infarction injuries should be identified and sealed as soon as possible. This is because when infarction occurs in conjunction with a subluxation injury, the risk of PN is increased.¹³ The most common combination luxation injury was subluxation (51.92%) in a previous study.²⁰ Subluxation was also the most common combination luxation injury found in this study. More than

half (56.25%) of the combination injuries comprised of subluxation injury. Likewise, similar to the present study, the most common combination injury was subluxation and uncomplicated enamel-dentin-fracture in another study.²¹ Enamel-dentin fractures in combination with subluxation injury was the most common combination injury type in this study and accounted for about one-third of combination injury. Similar to an earlier study,¹⁷ combination injuries were most commonly observed in teeth with subluxation followed by concussion injury. More than half (56.25%) of the combination injuries involved subluxation injury and about one-third (29.16%) of the combination injuries involved concussion injury in the present study.

Since a high incidence of complications are associated with lateral luxation injury, the occurrence of combined fracture and lateral luxation injury further increases the risk of PN. This was supported in a recent study, where the presence of concomitant crown fracture in teeth with lateral luxation significantly increased the risk of PN.¹⁴ However, concurrent crown fractures are uncommon in teeth with lateral luxation as found in the present and previous studies.^{10,20} Concomitant lateral luxation injury was observed in very few teeth (4.16%) in this study.

Concomitant crown fractures are also rare in teeth with extrusion injury.¹⁰ Only a few teeth (10.41%) had concurrent extrusion injury in this study. Teeth with extrusive luxation injury have a high incidence of PN due to increased chance of damage to the neurovascular supply.¹⁴ Therefore, teeth with an extrusion injury and a concomitant crown fracture have a significantly higher risk of PN.^{6, 14} According to Yu and Abbott, concurrent crown fractures are more frequent in teeth with intrusion injury.¹⁰ A high frequency of concomitant intrusion and fracture injury was also observed in a previous study.¹⁷ However, no concomitant intrusion injury was observed among tooth with fracture injury in this study. A recent study by Wang et al. also reported a very low frequency (4.80%) of intrusive luxation injury in teeth with uncomplicated crown fracture.²⁰ They also concluded that crown-fractured teeth with associated intrusion injury had a higher incidence of PN than other types of concurrent luxation injury.²⁰

PN is a common complication after luxation injury.^{4,6-8,14} Luxation injury may cause damage to the neurovascular supply of the dental pulp and hence, are associated with high rates of PN. As a result of compromised defense mechanism, bacterial infiltration becomes more rapid after concomitant luxation injuries in teeth with fracture injury.²⁶ The risk of PN is thus, further increased in teeth with concomitant crown fracture and luxation injury.¹⁴

Therefore, infractions should be sealed and crown fractures should be restored as soon as possible to reduce the risk of PN; more importantly in teeth with an associated luxation injury.^{9,12-14,24} Subluxation and Concussion were the most common types of luxation injuries observed in association with fracture injuries. This is in agreement with previous studies.^{17,20,21} Two-thirds of all combination injuries were found among minor luxation injuries like concussion and subluxation.

During clinical examination it is easy to overlook minor fracture injuries such as an infarction. Similarly, minor luxation injuries such as concussion and subluxation can easily be missed. The severity of TDIs can be underestimated when a concomitant injury is not identified during examination. This can affect the treatment and prognosis of the traumatized tooth.^{9,12-14} Therefore, identification of minor injuries such as infarction, enamel fracture, concussion and subluxation are important and should not be ignored. Likewise, clinical examination of TDIs must be done carefully, since teeth with combination injuries are associated with an increased risk of PN and other complications. Each type of crown fracture has a variable risk of PN when they occur in combination with various luxation injuries. Therefore, evaluation of the risk of PN in teeth with combination injuries may be conducted in future. Moreover, the findings of this study should be interpreted with caution since it was conducted in a single institution and involved only those patients seeking treatment for TDIs. Therefore, the results may not reflect the actual burden of combination TDIs in Nepal.

CONCLUSIONS

The most common combination injury was enamel-dentin fracture in combination with subluxation injury. Although the prevalence of combination injuries was low in this study, they are important to identify since the risk of PN and other healing complications is high in such teeth.

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