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ORIGINAL ARTICLE

Dental injuries in patients associated with fracture of facial bones

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Abstract

Purpose To assess different types of dental injuries associated with facial bone fractures.

Method One hundred dentate patients were selected randomly of all age and gender who had maxillofacial trauma only and having dental injury in association with facial bones fractures were included. They were thoroughly examined for injury/fracture to facial region as well as for dental injuries (teeth). Tooth injuries were noted according to Ellis classification. The data was collected, compiled, and put to statistical analysis.

Results Dental injuries were more in females than males found to be statistically significant with ($p < 0.05$).Crown fracture of maxillary teeth was more as compared to mandibular except molars found to be statistically significant ($p < 0.05$). Root fracture was more in maxillary incisors followed by canine as compared to mandibular incisors and canines found to be insignificant. Avulsion, extrusion and luxation were more in maxilla as compared to mandible found to be significant.

Conclusion Different types of tooth injuries associated with facial bone fracture found more in females and maxillary teeth.

Keywords Dental · Injuries · Fracture · Facial bone

Introduction

Traumatic dental injuries are the most important public health dental problem due to frequency, cost factor, occurrence at young age, and burden of treatment that may occur throughout the life of patient [1]. Face constitutes the major point of contact in several human interpersonal encounters, thus injuries to the facial structures may have a very traumatic impact on the affected person [2]. Road traffic accidents (RTA), assaults, falls, domestic violence, and sports injury are the commonly reported factors that are responsible for dental injuries and trauma [2]. Apart from bruises, hematoma, and wounds, the most common is dental injury that occurs on facial region [3]. Among dental injuries, subluxation of maxillary anterior teeth in primary dentition and crown fracture mostly occurs in permanent dentition [4].

Percentage frequency of various dental injuries in permanent teeth include fractured crowns 47%, fractured roots 4%, subluxed/displaced teeth 36%, and avulsion 7%. Percentage frequency of various types of dental injuries in deciduous teeth include crown fractures 25%, root fracture 3%, subluxated/displaced 60%, and complete avulsion of tooth 10%. Common predisposing factor of trauma to maxillary incisor is class II division I type of malocclusion [5]. Good occlusion remains the main goal in fracture management but dental injuries may complicate the treatment procedures [6].

Dental trauma in primary teeth in early childhood may result in serious damage to the permanent dentition including hypoplasia of enamel or complete malformation of the crown and tooth [7]. This type of malformation can cause aesthetic problems. It has been observed that there is positive association between consumption of alcohol and the occurrence of facial bones fracture. The aim of this study was to assess the incidence, types of dental injuries associated with facial fractures, and also to find out whether the occurrence of dental injury correlates with gender, age, trauma mechanism, type of facial fracture, and alcohol consumption.

Materials and methods

Source of data

For this prospective study, due clearance was obtained from the institutional research and ethics committee. This prospective study included randomly selected 100 dentate patients of all

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age and gender who had maxillofacial trauma only and having dental injury in association with facial bones fractures not older than 15 days. The study excluded the patients, who declined to participate, having neurological injury, not willing to appear for evaluation during the study period, have dental and periodontal diseases and obvious psychiatric disorder, i.e., depression, anxiety, or having history of psychotic episode. Written informed consent for evaluation during study period was obtained either from subject or the subject's legal guardian with consent.

Method of study

The included maxillofacial trauma patients were examined. All patients with facial injury and lacerations were thoroughly cleaned with normal saline, povidone- iodine 5%, and also with hydrogen peroxide 3%. Intraoral suctioning was performed and foreign particles were removed to clear the breathing airway and to examine the oral cavity for any kind of injury or fractures. After giving primary management, once the patient was stabilized, then they were thoroughly examined for injury/fracture to facial region as well as for dental injuries (teeth) or any other laceration/injury to face. Mouth opening was evaluated for any kind of fracture. Occlusion was checked for any discrepancy. All teeth were examined to find out any injury to tooth structure. Tooth injuries were classified according to Ellis classification.

Then, CT scan (3D) and intraoral periapical (IOPA) radiographs were done systematically in all the patients to rule out maxillofacial fractures and tooth injury respectively. Dental Injuries mainly tooth injuries were categorized according to the system mentioned by Ellis.

Classification by Ellis 1970 [8]

It is a simplified classification, which groups many injuries and allows for subjective interpretation by including broad terms such as simple or extensive fractures.

Class I - Simple crown fracture with little or no dentin affected

Class II - Extensive crown fracture with considerable loss of dentin, but with the pulp not affected

Class III - Extensive crown fracture with considerable loss of dentin and pulp exposure

Class IV - A tooth devitalized by trauma with or without loss of tooth structure

Class V - Teeth lost as a result of trauma

Class VI - Root fracture with or without the loss of crown structure

Class VII - Displacement of the tooth with neither root nor crown fracture

Class VIII - Complete crown fracture and its replacement

Class IX - Traumatic injuries of primary teeth

Maxillofacial fractures were categorized under two groups such as group A (Middle 3rd) that includes maxilla, nasal bone, and zygomatic complex and group B (Lower 3rd) that includes mandible. Mechanism of injury again subdivided into various categories such as assault, road traffic accidents, falls, sports, and violence. Type of fracture was classified and radio graphically analyzed by using PA view mandible, PNS view, OPG, and CT Scan 3D.

A predesigned structured Performa was utilized for collecting data comprising of the following:

1. Age and gender
2. Alcohol involvement
3. Mechanism of injury
4. Type of facial fracture
   a) Middle 3rd fracture
   b) Mandible fracture
5. Dental injuries are further divided in deciduous/permanent and the type of injuries:
   a) Avulsed tooth
   b) Intruded tooth
   c) Luxation
   d) Crown fracture/Ellis classification
6. Associated soft tissue injury (laceration)

Results

Present study was conducted on 100 patients, among them are 61 males (61%) and 39 females (39%). Mean age was 26.84 with standard deviation of ± 14.13. The maximum subjects belonged to age group of 21–30 years were 31, both males and females (31%), followed by 11–20 years 29, both males and females (29%), and minimum subjects belonged to the age group of 61–70 years 3, both males and females (3%), followed by 51–60 years 4, both males and females (4%). Mechanism of injury was associated maximum with 31 road traffic accident (31%) and minimum with 2 animal attack (2%) of total patients found to be statistically significant with ($p < 0.03$). Alcohol involvement was reported in 22 patients (22%). The middle third and lower third facial fracture was found in 57 patients (57%) and 51 patients (51%), respectively (Table 1).

Crown fracture of teeth was more in maxilla as compared to mandible except molars. Among maxillary and mandibular teeth, crown fracture was reported maximum in 52 maxillary incisors (52%) followed by 43 mandibular incisors (43%) then 25 maxillary canines 25% followed by 8 mandibular canine 8%; when compared statistically, it was found to be statistically significant $p < 0.05$. Root fracture was found in 6 maxillary incisors (6%) and 2 canines (2%) and in case of mandible, it was reported in 2 incisors (2%) and 3 canines (3%). When compared statistically, found to be insignificant. Avulsion, extrusion, and luxation were

Table 1 Descriptive analysis of the study subjects

Variables	*N*	%
Gender		
Male	61	61%
Female	39	39%
Age group (in years): mean ± SD	26.84	14.13
1–10	8	8%
11–20	29	29%
21–30	31	31%
31–40	17	17%
41–50	8	8%
51–60	4	4%
61–70	3	3%
Mechanism of injury		
Falls	25	25%
Sports	19	19%
Assault	13	13%
RTA	31	31%
Violence	10	10%
Animal attack	2	2%
Alcohol involvement		
Yes	22	22%
No	78	78%
Facial fracture (middle third, group A)		
Present	57	57%
Absent	43	43%
Facial fracture (lower third, group B)		
Present	51	51%
Absent	49	49%

more in maxilla as compared to mandible; when compared statistically, found to be significant (Table 2).

Dental injuries was present in 33 males (54.09%) and 29 females (74.36%) found statistically to be significant ($P < 0.04$). Dental injuries age group wise statistically insignificant. Dental injuries encountered in 22 road traffic accidents (70.97%), 17 falls (68%), 12 sports (63.16%), 5 violence (50%), 6 assault (46.15%), and 0 animal attack (0%) respectively. When dental injuries were compared statistically with different mechanism of injuries, it was found to be statistically significant ($p < 0.03$). Among 100 patients, 22 were alcoholic (22%) and 78 non-alcoholic (78%). Dental injuries were present in 11 alcoholic patients (50%) and in 51 non-alcoholic patients (65.38%). There was statistically no significant association of alcohol involvement in dental injuries. Middle third and lower third facial fractures with dental injuries were found to be statistically non-significant (Table 3).

Ellis class II fracture was present in 34 maxilla (34%) and 26 mandible (26%), Ellis class I in 26 maxilla (26%) and 18 mandible (18%), Ellis class III in 11 maxilla (11%) and 2 mandible (2%), Ellis class IV in 4 maxilla (4%) and 0 mandible (0%), and class V fracture in 3 maxilla (3%) and 2 mandible (2%). Ellis class II was the most common fracture followed by class I then Ellis class III among both maxilla and mandible. Ellis class IV and class V fracture was least in mandible and maxilla respectively. When different classes of Ellis fracture were compared statistically between maxilla and mandible, it was found to be insignificant (Table 4).

Table 2 Descriptive analysis of crown, root fracture, avulsion, extrusion, intrusion, and luxation among maxilla and mandible

Variables	Maxilla				Mandible			
	Present		Absent		Present		Absent	
	N	%	*N*	%	*N*	%	*N*	%
Crown fracture								
Incisor	52	52	48	48	43	43	57	57
Canine	25	25	75	75	8	8	92	92
Premolar	02	02	98	98	0	0	100	100
Molar	01	01	99	99	4	4	96	96
Fisher exact test	3.99							
p value	0.044*							
Root fracture								
Incisor	06	06	94	94	2	2	98	98
Canine	02	02	98	98	3	3	97	97
Premolar	0	0	100	100	0	0	100	100
Molar	0	0	100	100	0	0	100	100
Fisher exact test	1.47							
p value	0.67							
Avulsion	15	15	85	85	6	6	94	94
Chi square	4.31							
p value	0.04*							
Extrusion	3	3	97	97	1	1	99	99
Chi square	1.02							
p value	0.31							
Intrusion	0	0	100	100	0	0	100	100
Chi square	0							
p value	1							
Luxation	8	8	92	92	2	2	98	98
Chi square	3.87							
p value	0.045*							

*Statistically significant

Discussion

In today's world, dental trauma is a type of injury to teeth as well as to oral cavity that is usually sudden, circumstantial, and accidental, often sometimes requires immediate attention. Trauma to dental structures occurs

Table 3 Dental injuries and association with different variables

Variables	Dental injuries				Chi square	*p* value
	Present		Absent			
	N	% of *n*	*N*	% of *n*		
Gender						
Male (61)	33	54.09	28	45.91	4.15	0.04*
Female (39)	29	74.36	10	25.64		
Age groups						
1–10 (8)	6	75	2	25	3.94	0.466
11–20 (29)	20	68.97	9	31.03		
21–30 (31)	16	51.61	15	48.39		
31–40 (17)	10	58.82	7	41.17		
41–50 (8)	4	50	4	50		
51–60 (4)	4	100	0	0		
61–70 (3)	2	66.67	1	33.33		
Mechanism of injury						
Falls (25)	17	68	8	32	4.78	0.03*
Sports (19)	12	63.16	7	36.84		
Assault (13)	6	46.15	7	53.85		
RTA (31)	22	70.97	9	29.03		
Violence (10)	5	50	5	50		
Animal attack (2)	0	0	2	100		
Alcohol involvement						
Yes (22)	11	50	11	50	1.72	0.18
No (78)	51	65.38	27	34.62		
Facial fracture (middle third, group A)						
Present (57)	38	66.67	19	33.33	1.22	0.26
Absent (43)	24	55.8	19	44.2		
Facial fracture (lower third, group B)						
Present (51)	35	68.63	16	31.37	1.94	0.16
Absent (49)	27	55.1	22	44.9		

*Statistically significant

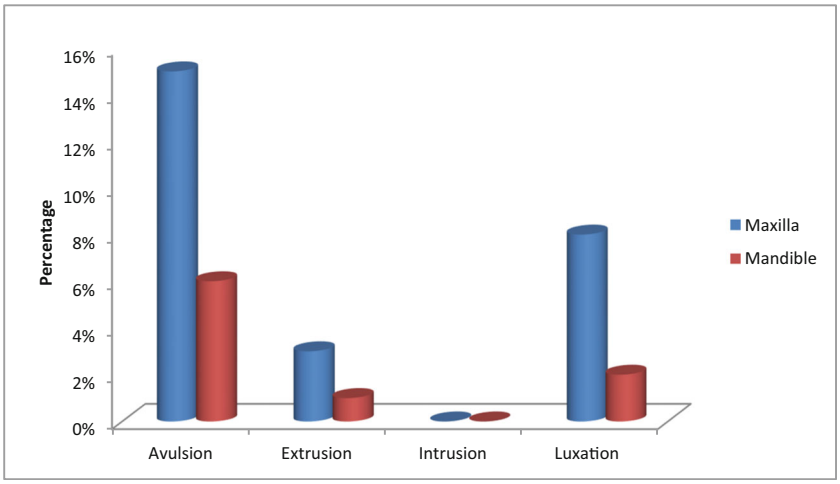
at any age but occurs most commonly in children and teenagers. The oral region constitutes 1% of the total body area, but still reports 5% of bodily injuries.

Table 4 Distribution of dental fracture according to Ellis classification among maxilla and mandible

Ellis fracture type	Maxilla		Mandible	
	N	%	*N*	%
I	26	26%	18	18%
II	34	34%	26	26%
III	11	11%	2	2%
IV	4	4%	0	0
V	3	3%	2	2%
Chi square	4.35			
p value	0.35			

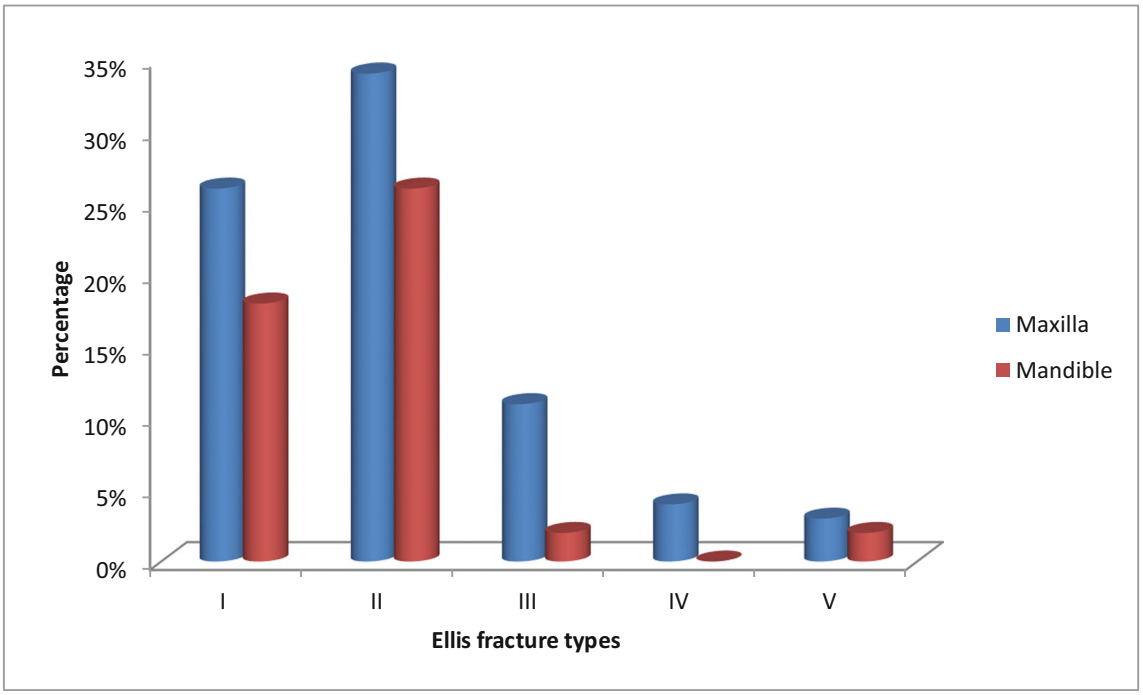
Seventeen percent of oral injuries occur in preschool children among bodily injuries [9]. Dento-alveolar injuries generally include avulsion of tooth, tooth fracture. It has been observed that there is positive association between consumption of alcohol and the occurrence of fracture of facial bones.

In this prospective study, facial fractures were divided into two categories, i.e., mid face fractures and lower third mandible fractures. Results are prepared according to descriptive analysis and statistical analysis was done using Chi square test and Fisher test. According to the conducted study, sample size consisted of 100 patients in whom 61% were males and 39% were females. Mean age was 26.84 ± 14.13. The maximum subjects belonged to age group of 21–30 years (31%) followed by 11–20 years (29%) and minimum subjects belonged to the age group of 61–70 years (3%) followed by 51–60 years (4%). According to our study, the most common cause of injury associated with maxillofacial fractures was the road traffic accidents 31%, and found to be statistically significant (p value < 0.03). Similar study was done by Subashraj K et al. in 2007 [9] at Chennai and found that road traffic accidents were most common causes for maxillofacial trauma in the age group between 19 and 30 years. Another study was done by Cavalcanti Leite et al. in 2010 [2] in Brazil also found that most frequent cause of injury was road accidents which showed higher incidence at 19–28 years of age. According to a study, fracture of the middle 3rd was more frequently fractured area followed by mandible (lower 3rd) in RTA. Similar study was done by Goldschmidt et al. 1995 [10] and found that maxilla was the most commonly fractured area followed by mandible. According to a study done by Bataineh A.B et al. 1998 [11], same results were found that maxilla was most affected site. A study done by Oginni FO et al. 2006 [12] in Brazil showed that middle 3rd was more prone to fracture than other areas during accidents. Olivier Lieger et al. in 2009 [4] found similar result, midface was fractured more, but Cavalcanti A.L in 2010 [2] found that mandible (lower 3rd) was more prone to fracture than middle 3rd. In our study, crown fracture were more common in maxilla and most affected teeth were the maxillary incisors followed by mandibular incisors. When crown fracture sites in maxilla and mandibular were compared statistically, it is found to be significant ($p < 0.05$). Maxillary teeth are more vulnerable to fracture than mandibular teeth especially the maxillary incisors due to more labial inclination. High speed motor vehicle accidents might produce more dental fractures than low-impact injuries. Roccia F et al. 2013 [13] study showed the similar results. Ruslin M et al. 2015 [14] also found similar results in his research. In our study, root fracture was least found in maxilla followed by the mandible. When both maxillary and mandibular root fractures were compared, it was found to be insignificant. Schatz J.P. et al. 1994 [15] found similar result that maxillary crown and root fracture were



Graph 1 Avulsion, extrusion, intrusion, and luxation among maxilla and mandible

more common in incisors. In our study, Graph 1 showed that avulsion as well as luxation occurred both in maxilla and mandible but was found to be more in case of maxilla followed by mandible. Results in both case of avulsion and luxation found to be significant ($p < 0.04$) and ($p < 0.045$) respectively. Atlay et al. 2001 [16] also showed avulsion most commonly occurred in case of upper maxillary incisors. Rahimi N R K 2014 [17] in his research found that avulsion was more than luxation in maxilla. Extrusion was more in case of maxilla followed by mandible found statistically not significant. Intrusion was not there in any case. In our study, fractures of the middle 3rd and lower 3rd were more common in case of males but dental injuries were present more in females as they had multiple tooth injuries as compared to males. When dental injuries were compared statistically between males and females, it was found to be statistically significant ($p < 0.04$). Study done by Oginni FO et al. 2006 [12] analyzed that females have higher incidence of injuries in age group of 10–19 years. Another study done by Ruslin M 2015 [14] also showed similar result that females were at higher risk of facial fractures and most commonly affected teeth were maxillary incisors. In the present study, most common cause was found to be RTA (70.97%) followed by falls (68%), sports (63.16%), violence (50%), assault (46.15%), and animal attack (0%). When dental injuries were compared statistically with different mechanism of injuries, it was found to be statistically significant ($p < 0.03$). Study done by Motamedi MHK 2003 [18] showed that traffic accidents were the most common



Graph 2 Ellis classification of fracture among maxilla and mandible

causes of dental injuries. Arangio P et al. 2013 [19] study showed similar result. Study performed by Caldas Jr. AF et al. 2001 [20] showed fall was the main cause of dental injuries. Another study by Rahimi-Nedjat R.K 2014 [17] showed that assault was the most frequent cause. In our study, alcohol involvement was least involved, 22% of all subjects. There is no statistically significant association of alcohol involvement. But according to another research which was done in Brazil by Cavalcanti et al. 2010 [2], it was found that there was major involvement of alcohol in case of facial fractures. In our study, dental injuries were present both in middle 3rd and lower 3rd fractured cases but showed no significant results. In present study, tooth injuries were described according to Ellis classification. Ellis class II most commonly occurred tooth injury found in both maxilla and mandible followed by class I. Ellis class III, class IV, and class V were least common as shown in Graph 2. Study performed by Vanka A et al. 2010 [21] showed Ellis class IV was the most common type of tooth injury. Another study done by Alkhadra T et al. 2016 [22] found that Ellis class I was more frequent followed by class II.

Conclusion

Road traffic accidents were the major leading causes of dental injuries followed by falls, assaults, and violence. Alcohol consumption did not play important role in dental injuries. Trauma was more in males, but dental injuries were found most commonly in females. Middle 3rd was the major point of injury than the lower 3rd of the face. Midface bones are more porous like matchbox and have tendency to get fractured. Maxillary anterior teeth with crown fracture and avulsion were found to be most common. The most frequent type of dento-alveolar fracture was Ellis II followed by class I, class III, class IV, class V, and class VI.

CT scans should be done in every case of maxillofacial trauma to reveal facial bone fractures and intraoral periapical films for dento-alveolar fractures and dental injuries (crown and root fractures) in both high and low impact accidents. One should take precautionary measurement for safety during driving like control on speed limit, avoid consumption of alcohol or drugs during driving, use of seat belt is must, pay attention to all sign boards, always use turn signals, be attentive and drive cautiously, use of goggles and helmet with face guard during two wheeler drive and playing, avoid violence, etc. Patient management considerations in maxillofacial trauma include management of medical emergencies, head injury component, spine injury, identification of the internal as well as external bleeder, thorough irrigation of wound for removal of foreign particles, and infusion of tetanus toxoid, anti-inflammatory, analgesic drugs.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent Informed consent was obtained from all individual participants included in the study.

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