The association between orthodontic treatment need and maxillary incisor trauma, a retrospective clinical study

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Objectives: Identifying risk factors for dental trauma in children is important. The main aim of this retrospective study was to investigate the association between maxillary incisor trauma (MIT) and variables such as gender, malocclusion complexity, and orthodontic treatment need (OTN).
Study design: ICON (Index of Complexity, Outcome and Need) scores were calculated in 502 schoolchildren (253 girls and 249 boys, aged 11-14-years). Subjects were categorized into 5 ICON complexity groups (easy to very difficult) and into 2 groups according to OTN (ICON >43, ICON <44). Logistic regression was performed to test for any differences in risk of MIT among subjects in different ICON complexity groups and to estimate the predictive value of gender, OTN, and ICON scores for MIT.
Results: Nine percent experienced incisor trauma (93.4% maxilla, 6.6% mandible). Enamel fracture was the most common type (6.2%) of dental trauma. Boys had greater odds of MIT compared with girls (odds ratio [OR] 2.16, 95% confidence interval [CI] 1.11-4.21). Subjects with OTN showed greater odds of MIT compared to those without (OR 2.37, 95% CI 1.21-4.64). Only subjects presenting with difficult complexity grade (64 < ICON < 77) showed significantly higher odds of experiencing MIT (OR 3.16, 95% CI 1.25-8.01) compared with the easy complexity group (ICON <29).
Conclusion: The higher risk of experiencing MIT in malocclusions with difficult complexity warrants more vigilant screening of this group before and during dental or orthodontic treatment. **(Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2011;112:e75-e80)**

Incisor trauma is an important clinical problem in children and adolescents and can result in pain, disfigurement, and speech and psychologic problems.[1] Population-based studies and studies of representative groups of schoolchildren clearly support these observations.[2-16] Males suffer more incisor trauma than females,[17-25] though 2 studies failed to detect a gender difference in dental trauma experience.[9,26] Most injuries involve 1 tooth,[27] and maxillary central incisors are the most frequently affected in both primary and permanent dentition injuries.[4,5,6,10,13,20,21] Among maxillary incisors, maxillary central incisors are more often affected than lateral incisors.[3,4,10,13,15,20,21,28] Correcting the increased overjet is one of the main reasons for seeking orthodontic treatment, and therefore, many occlusal indexes aimed at measuring the severity of malocclusion have a component to assess the overjet.[29,30]

Uncertainty surrounds the effectiveness of preventive measures to normalize the overjet. Some investigators have suggested that overjet is of minimal significance as a risk factor for maxillary incisor trauma (MIT).[2,26,31,32] However, others have observed increased trauma risk in subjects with overjet >3.5 mm.[9,19,20] There is also some evidence that overjet >6 or 7 mm increases the risk and that the risk increases with increase in overjet values.[7,28,33] Information on the increased risk of maxillary incisor injury in subjects with inadequate lip coverage is contradictory. Although some researchers have demonstrated increased risk of MIT in subjects with inadequate lip coverage[7,9,19,20,26] others have observed no association between MIT and inadequate lip coverage.[2,21,28]

These findings suggest that an increased overjet may contribute to a higher risk of receiving MIT because of increased protrusion of maxillary incisors. There is limited information in the English-language literature on the prevalence of incisor trauma in Iranian schoolchildren, and there is a need for further research into dental trauma and risk factors to establish a baseline for future preventive and trauma management strategies. The primary objective of the present study was to carry

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Table I. The ICON scoring method and its components[36]

		Score						
	Component	*0*	*1*	*2*	*3*	*4*	*5*	*Weight*
1	Esthetic assessment	Score 1-10						7
2*	Upper arch crowding	<2 mm	2.1-5 mm	5.1-9 mm	9.1-13 mm	13.1-17 mm	>17 mm	5
	Upper arch spacing	<2 mm	2.1-5 mm	5.1-9 mm	>9 mm		Impacted teeth	5
3	Crossbite	No crossbite	Crossbite present					5
4†	Incisor open bite	Edge to edge	<1 mm	1.1-2 mm	2.1-4 mm	>4 mm		4
	Incisor overbite	<1/3lower incisor coverage	1/3 to 2/3 coverage	2/3 up to fully covered	Fully covered			4
5‡	Buccal segment A-P	Cusp to embrasure only, class I, II, or III	Any cusp relation up to but not including cusp to cusp	Cusp to cusp				3

*The difference between the sum of mesiodistal tooth diameters and the available arch circumference in the upper arch is recorded in a 5-point score. Impacted teeth (score 5) must be unerupted and either ectopic or have <4 mm of space between adjacent permanent teeth. Retained deciduous teeth (without permanent successor), erupted supernumerary teeth, or lost teeth due to trauma are counted as space, unless they are to be maintained and obviate the need for prosthetic replacement or space is maintained for a prosthetic replacement (i.e., tooth lost in trauma).
†If both anterior open bite and deep bite are present, only the highest score is counted.
‡Quality of buccal segment interdigitation, not Angle classification, is measured in both sides and then added together.

out an epidemiologic study in 11- to 14-year-old Iranian schoolchildren to provide preliminary information on prevalence and severity of incisor trauma and to determine the reasons for injury. The secondary aim of this study was to investigate the association between the MIT and variables such as gender, malocclusion complexity, and orthodontic treatment need.

MATERIAL AND METHODS

The present cross-sectional study was originally carried out to provide preliminary information on prevalence of malocclusions and occlusal traits in an urban Iranian population.[34] After approval by the Ethical Committee of Isfahan University of Medical Sciences, Faculty of Dentistry, we selected the present sample of 11- to 14-year-old Iranian schoolchildren (average age 12.4 years old) according to a stratified cluster sampling method, defining the students in 6 public schools as 6 strata. For this cross-sectional study, 249 boys and 253 girls were examined, including 6 subjects who were wearing an orthodontic appliance at the time of the survey (1 female and 5 male). The examinations were performed in a well lit room. Each maxillary and mandibular incisor was scored for presence and type of traumatic injury according to the following criteria: 0 = no evidence of trauma; 1 = trauma limited to enamel; 2 = trauma involving enamel and dentin; 3 = trauma involving enamel, dentin, and pulp; 4 = discoloration due to trauma (verified by interview); and 5 = avulsed tooth due to trauma (verified by interview). This scoring system was based on clinical nonradiographic evidence of tooth injury. One examiner (Ali Farahani) performed the clinical examination. A mouth mirror, ruler, and a digital sliding caliper were used. The examination comprised an extraoral examination of skeletal relationship[35] and an intraoral examination of the teeth and occlusion.

The Index of Complexity, Outcome, and Need

There are several orthodontic treatment need indexes available to assess and rate the malocclusion. The Index of Complexity, Outcome and Need (ICON)[36] was used to assess the complexity of malocclusions and to rank the subjects. The ICON consists of 5 components: 1) the esthetic component, similar to esthetic component of the IOTN index[29]; 2) upper and lower crowding/spacing assessment; 3) presence of a crossbite; 4) degree of incisor open bite/overbite; and 5) fit of the teeth in the buccal segment in terms of the anterior-posterior relationship. Each component of the ICON can be measured on study casts as well as on patients (Table I). The practical application of the index is simple and takes ~1 minute for each case.[36] To rank the subjects for severity of malocclusion, an orthodontist (Ali Farahani) who had been formally trained and calibrated in the use of the ICON conducted the clinical examination. The ICON is multifunctional and determines which individuals require orthodontic treatment (ICON >43) while quantifying the degree of complexity of the malocclusion.[36]

After excluding the subjects who were wearing an orthodontic appliance (6 subjects), the 496 remaining

Table II. Gender distribution of subjects with incisor traumatic injuries to maxillary and mandibular incisors

	Gender		
Incisor trauma severity	*Male*	*Female*	*Total*
Trauma*	30 (12%)	15 (5.9%)	45 (9%)
Enamel fracture	21 (8.4%)	10 (4%)	31 (6.2%)
Dentoenamel fracture	5 (2%)	2 (0.8%)	7 (1.4%)
Fracture of enamel, dentin, and pulp	2 (0.8%)	2 (0.8%)	4 (0.8%)
Discoloration due to trauma	1 (0.4%)	1 (0.4%)	2 (0.4%)
Tooth avulsed	1 (0.4%)	0	1 (0.2%)

*Fisher exact test; n = 502; $P < .05$.

subjects were categorized into 5 groups according to ICON complexity grades: easy, mild, moderate, difficult, and very difficult. The sample was also divided into 2 groups according to orthodontic treatment need: 1) subjects in need of orthodontic treatment (ICON >43); and 2) subjects without orthodontic treatment need (ICON <44).

Statistical analysis

Percentages of subjects with incisor trauma were calculated for the whole sample. Fisher exact test was performed to determine any gender differences in trauma experience. The logistic regression was performed to test for any differences in risk of MIT among subjects in the different ICON complexity groups. Logistic regression was also used to estimate the predictive value of gender, orthodontic treatment need (ICON >43), and ICON scores for MIT. The data were collected and entered in the SPSS 17 program for statistical analysis (SPSS, Chicago, IL). Any *P* values of <.05 were interpreted as statistically significant.

RESULTS

Forty-five (9%) of the 502 subjects examined had ≥1 tooth with a positive score for incisor trauma. The observed prevalence was higher in boys (12%) than in girls (5.9%) (Fisher exact test; n = 502; $P < .05$). Among those with incisor trauma, 93.4% had MIT and 6.6% (3 subjects) had injuries to the mandibular incisors. Overall, 8.5% experienced MIT. Only 1 traumatized incisor was found in 88.8% (40 subjects), and 11.2% had ≥2 injured incisors. Enamel fracture was the most common incisor trauma (6.2%; Table II). The reason for injury was recalled by 62.2% (28 subjects): 53.6% (15 subjects) reported a fall or blow inside the home, 28.6% (8 subjects) had a fall or blow in school or outside, and 17.8% (5 subjects) reported sports or traffic accidents.

Male subjects had greater odds of experiencing MIT compared with female subjects (odds ratio [OR] 2.16, 95% confidence interval [CI] 1.11-4.21). Subjects with orthodontic treatment need (ICON >43) had greater odds of experiencing MIT compared with subjects with no orthodontic treatment need (ICON <44; OR 2.37, 95% CI 1.21-4.64). Univariate logistic regression showed that female gender reduced the risk of MIT by 46.2% [OR 0.462, effect −0.771 (SE 0.340), 95% CI 0.23-0.90] and that risk of injury increased by 1.2% for every unit increase in ICON scores [OR 1.012, effect 0.011 (SE 0.006), 95% CI 0.99-1.02].

Table III. The percentages of subjects with traumatic injuries to maxillary incisors in population-based sample of 502 (6 subjects with missing ICON scores) categorized into 5 different groups according to ICON complexity grades. The odds ratio (OR) and 95% confidence interval (CI) are relative to the group with easy complexity grade (ICON <29)

ICON complexity grade	*ICON score*	*n*	*% trauma*	*P value*	*OR*	*95% CI*
Easy	<29	167	5.4		1	
Mild	29-50	123	7.3	.503	1.386	0.53-3.60
Moderate	51-63	75	10.7	.145	2.096	0.77-5.66
Difficult	64-77	72	15.3	.015	3.166	1.25-8.01
Very difficult	>77	59	6.8	.694	1.277	0.37-4.31
Total		496	8.5			

The odds of experiencing MIT increased with increase of ICON complexity grade. However, a decrease in the odds of experiencing MIT for subjects with very difficult ICON complexity grade was observed. Only subjects with difficult complexity grade (64 < ICON < 77) showed significantly higher odds of experiencing MIT (OR 3.16, 95% CI 1.25-8.01) compared with subjects with easy complexity grade (ICON <29; Table III).

DISCUSSION

The prevalence of incisor injury varies in different studies, ranging between 4% and 49%.[21] The etiology of dental trauma is multifactorial, and incidence decreases with age.[37] In the present study, the prevalence of traumatic dental injuries was 9%, which is substantially lower than earlier reports in many countries, particularly in female subjects.[6,22,38,39] A possible limitation of the study is in using a nonradiographic clinical scale for classification of dental trauma, which might mask root fracture or periapical pathology if it existed. The retrospective nature of the present study, unfortunately, did not allow investigating and recording some oral injuries, such as alveolar fractures and soft tissue injuries, if they were not present at the time of the clinical examination. Earlier injury could be missed if

signs and symptoms did not exist at the time of the examination. Another shortcoming of retrospective studies is the accuracy of the patient's recall of the injury if the accident occurred months or even years before examination. The relative lack of winter sports activities among Iranian schoolchildren combined with fewer female outdoor activities, particularly during the summer months, could lead to the lower prevalence of sports injuries in our study sample.

The present study confirmed that the prevalence of maxillary was higher than mandibular incisor trauma. This is in agreement with the findings of earlier studies.[4,5,6,10,13,20,21] Perhaps the nonrigid connection of the mandible to the cranial base dissipate the blows to the mandible,[40] and this, combined with a low prevalence of class III malocclusions, which offer natural protection of the mandibular incisors,[16] explains why maxillary is more frequent than mandibular incisor trauma.

Similarly to earlier studies,[17-25] we also found an increased risk of incisor trauma in boys. The prevalences of permanent incisor trauma and MIT in 11- to 14-year-old Iranian children were 9% and 8.5%, respectively. The prevalence of permanent incisor trauma in the present study was higher than the values for 6- to 18-year-olds in Valencia, Spain (6%)[41] and 12-year-old schoolchildren in south India (6%).[42] Our findings were similar to urban 16- (8.9%) and 18-year-old (10.5%) Albanians[43] and 6- to 12-year-old Turkish children (9.5%).[44] However, this was substantially lower than the previously reported occurrences.[6,22,38,39,45-48] For example, O'Brien[48] reported prevalence rates of 25% and 20% for 12- and 14-year-old boys, respectively. The dental trauma prevalence rate in our study was also lower than the values reported by Todd and Dodd,[6] who reported prevalences of 29% and 33% for 12- and 14-year-old boys, respectively.[6] Similarly, Hamilton et al.[22] reported a dental trauma prevalence of 34% in 11- to 14-year-old children in Greater Manchester. Our figure was also substantially lower than the prevalence of dental trauma in 12- to 14-year-old Saudi boys reported by Al-Majed et al.[38] Comparison of our findings with the earlier studies is difficult owing to different trauma classification systems and various age ranges used. As mentioned earlier, the cultural differences can partially explain the difference in the prevalence of incisor trauma.

The most prevalent dental trauma type in 11- to 14-year-old Iranian children was the fracture of enamel only, representing 69% of injured teeth. This is consistent with the findings of O'Brien[48] in the U.K. survey and the reports of several earlier studies.[2,38,39,49] The proportion of damaged teeth with fracture of enamel and dentin amounted to 15.5% of traumatized incisors in the present study, and this was close to earlier reports.[2,38,39,48,49] The fracture involving enamel, dentin, and pulp affected 8.8% of fractured maxillary incisors. However, this was greater than the value reported by Al-Majed et al.[38] Attempts to reduce a large overjet have been recommended for reducing the incidence of dental trauma in vulnerable teeth.[50] The effectiveness of this approach has been questioned, because most traumas occur in mixed dentition before start of orthodontic treatment.[51] One of the aims of the present study was to investigate the association between prevalence of MIT and malocclusion complexity or orthodontic treatment need (ICON >43). Current or past orthodontic treatment can alter the anatomic risk factors (such as increased overjet). Therefore, subjects with a history of such treatment were excluded from the study sample.

A higher odds of experiencing maxillary incisor trauma was observed in subjects with a definite need for orthodontic treatment (ICON >43), and they were 2.3 times more likely to experience MIT. Therefore, besides esthetic considerations, reducing the risk of experiencing incisor trauma by improving occlusal relationships could be an indication for orthodontic treatment. However, considering the retrospective nature of the present study, establishing a cause and effect relationship is difficult. Prospective randomized controlled trials are required to assess the social and behavioral variables and to determine if orthodontic treatment has a useful role in lessening the incidence of incisor trauma. In the present study, with an increase in ICON complexity grade, the odds of experiencing MIT increased. A possible explanation for this finding would be an increase in prevalence of subjects with occlusal traits, such as increased overjet, which is a known risk factor for incisor trauma.[7,9,19,20,28,33] Although overjet and reverse overjet are not measured directly in the ICON scoring system; the esthetic component of this index adequately represents the importance of these occlusal traits for assessing malocclusions.[36] Only subjects in the difficult complexity group (64 < ICON < 77) showed a significantly higher odds of experiencing MIT compared with subjects in the easy complexity group (ICON <29). We observed a relative decrease in the odds of experiencing trauma for subjects with very difficult ICON complexity grade compared with the subjects with difficult, moderate, or mild complexity grades. A possible explanation would be that a higher percentage of subjects representing occlusal traits, such as reverse overjet (in Class III malocclusions), severe crowding or impacted teeth, are in this group. These occlusal traits can attract a high ICON score, even though they are not risk factors for MIT.[16,21]

The incidence of dental trauma has been shown to increase between 2 and 4 years old in deciduous den-

tition for boys and girls and between 8 and 10 years old in permanent dentition for boys.[52] Prevention is difficult, because fewer than one-fifth of injuries occur during organized sports activities and most accidents occur before the age of 10-11 years.[5] The effectiveness of early orthodontic treatment in reducing the traumatic dental injuries in patients with increased overjet has yet to be confirmed by a randomized controlled trial.[53] Considering that most traumatic injuries to the maxillary incisors occur before the age of 10-11 years[5] and the age range of the present study sample (11-14 years), the findings of this study are not very helpful for preventive measurements. However during dental or orthodontic treatment, traumatized teeth may undergo external apical root resorption,[54-57] because of previous trauma, or go through the loss of vitality.[58] Within this context, more cautious screening (i.e., clinical examination, pretreatment radiographs) should be aimed at patients presenting with difficult complexity grade ($64 < ICON < 77$), as reflecting the highest odds of experiencing maxillary incisor injuries in this group.

CONCLUSIONS

In the present study, prevalence of incisor trauma was 9%. The prevalence of incisor trauma in this study was low compared with other studies. Female gender decreased the risk of MIT by 46.2%. Each unit increase in ICON score increased the risk of MIT by 1.2%. With increase in the ICON complexity grade, the odds of experiencing MIT also increased. Only subjects with difficult complexity grade ($64 < ICON < 77$) showed a significantly higher odds of experiencing MIT compared with the easy complexity group ($ICON < 29$). We observed a relative decrease in the odds of experiencing trauma for subjects with very difficult ICON complexity grade compared with subjects with difficult and moderate complexity grades. The current findings may be important for targeting and screening certain vulnerable groups during dental or orthodontic treatment.

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