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**DENTAL TRAUMATOLOGY**

# Prevalence of traumatic injuries to the permanent incisors in candidates for orthodontic treatment

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Abstract – The dental records made on presentation of 1367 consecutive patients (731 females and 636 males) for orthodontic treatment at a private orthodontic practice between 1998 and 2002 were examined for data relating to trauma to the permanent incisors. The results showed that 10.3% of these patients had suffered from dental trauma before the onset of orthodontic treatment. The highest prevalence of dental trauma was determined in the 11–15 years age group, corresponding to the dental developmental stage of the late mixed dentition. The most frequently affected teeth were the maxillary central incisors (79.6%), and the most common types of trauma were fracture of enamel–dentin without pulpal involvement (42.7%) and fracture of enamel (33.8%). Compared to patients with normal overjet and adequate lip coverage, the frequency of dental trauma was significantly higher in patients with increased overjet and adequate lip coverage ($P = 0.028$) or with increased overjet and inadequate lip coverage ($P = 0.003$). The results of the present study indicate that a significant percentage of candidates for orthodontic treatment, and especially those with increased overjet and inadequate lip coverage, suffer trauma to their permanent incisors before the onset of orthodontic treatment. It might also be concluded that preventive orthodontic treatment of such patients should be initiated and completed before the age of 11, i.e. in the early to middle mixed dentition.

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Epidemiologic studies indicate that traumatic dental injuries are a serious dental public health problem (1–10). The majority of dental injuries involve the maxillary incisors (1, 2, 11–15). Previous investigations also suggest that increased overjet and inadequate lip coverage might represent significant predisposing factors to traumatic injuries of the upper incisors (1, 7, 16–20). As these two predisposing factors are frequent findings in subjects with an orthodontic treatment need, a high prevalence of traumatized permanent incisors might be assumed in candidates for orthodontic therapy. However, little information is available on the frequency of dental trauma in patients referred for orthodontic treatment, especially to a private orthodontic practice.

As the combination of trauma with orthodontic treatment seems to render the teeth more susceptible to complications (20–23), knowledge of the prevalence of previous dental trauma in patients referred for orthodontic treatment is of paramount importance to the planning and success of any individual orthodontic treatment. One aim of the present study was therefore to obtain epidemiologic data concerning the prevalence of previous traumatic injuries to permanent incisors in candidates for orthodontic treatment, and to analyze their distribution according to

gender, age, type of tooth, type of trauma, etiology, and extent of overjet or type of lip coverage. It was hoped that this might focus more attention on this subject and emphasize the importance of a meticulous history taking and clinical examination procedure with respect to previous dental trauma in patients presenting for orthodontic treatment.

In addition, orthodontic treatment of increased overjet to prevent incisor trauma has been recommended by various authors (17–19, 24). However, the efficacy of such treatment is questionable if most traumas occur before the onset of orthodontic treatment in the middle to late mixed dentition. Consequently, knowledge of the peak occurrence of dental trauma in patients with increased overjet and inadequate lip coverage may also be an important factor in the planning and timing of orthodontic services. A further objective of this study was therefore to compare the prevalence of dental trauma in orthodontically untreated patients with increased overjet and inadequate lip coverage in various age groups. Thus, this study was also aimed at helping to select the optimal treatment timing for these patients and at providing further knowledge in the interests of both the treatment and the prevention of dental trauma.

## Materials and methods

The collective for this study was drawn from 1523 consecutive patients that had presented for orthodontic treatment at a private orthodontic practice between January 1998 and December 2002. The principles underlying the referrals had been the diagnosis of malocclusion with an orthodontic treatment need (Class I, II, or III malocclusion, open or deep bite, cross-bite, etc.; 25). Subjects without at least one upper or lower permanent incisor were excluded, as were cases with incomplete baseline documentation (questionnaire, results of the pretreatment clinical examination, pretreatment study models or photographs). Thus, a total of 156 subjects had to be excluded from further investigation. None of them, however, had suffered dental trauma. The sample remaining for examination therefore consisted of 1367 patients (731 females and 636 males), with a mean age of 14.8 years (range 6.0–55.5 years; Table 1).

Table 1. Distribution of patients according to age and gender

| Age (years) | Male *n* (%) | Female *n* (%) | Total *n* (%) |
|---|---|---|---|
| <11 | 109 (17.1) | 111 (15.2) | 220 (16.1) |
| 11–15 | 288 (45.3) | 329 (45.0) | 617 (45.1) |
| 16–20 | 195 (30.7) | 239 (32.7) | 434 (31.8) |
| >20 | 44 (6.9) | 52 (7.1) | 96 (7.0) |
| Total | 636 (100) | 731 (100) | 1367 (100) |

### Evaluation of traumatized teeth

The frequency of previous dental trauma to the permanent incisors at the time of referral was determined retrospectively from the dental records made at baseline. These included a standardized questionnaire, the results of the pretreatment clinical examination, and pretreatment study models and photographs.

The questionnaire, which had been filled in by the patients during their first visit to the orthodontic practice, covered the patient's age, gender, and medical history, together with the incidence, cause, and location of previous dental traumas. In cases of trauma to the permanent incisors, the dentist, oral surgeon, or endodontist, who had first treated the injured teeth, had been contacted in order to obtain further details. These details comprised initial diagnosis, classification, number and location of traumatized teeth, and kind of treatment performed, as well as the intraoral radiographs taken at the time of injury. All this information had also been added to the baseline dental records. Furthermore, as part of the pretreatment clinical examination of the referred patients, the permanent incisors of all patients had been examined for evidence of traumatic injury.

### Classification of dental traumas

All dental traumas were classified according to type, cause, and location. The classification of Andreasen (1) was adapted to divide the dental traumas into the following categories:

1. Fracture of enamel, including enamel chipping
2. Fracture of enamel–dentin without pulpal involvement
3. Fracture of enamel–dentin with pulpal involvement
4. Fracture of root
5. Crown-root fracture
6. Concussion
7. Subluxation
8. Intrusion
9. Luxation (extrusive or lateral luxation)
10. Avulsion.

In cases of more than one type of injury to the same tooth, only the most serious one was registered. The causes of accidents were divided into five categories: falls, traffic accidents, collisions, sports activities, and violence. The accident locations were also divided into five categories: home, street, school, sport, and other.

### Overjet and lip coverage

Original overjet and lip coverage of the incisors before orthodontic treatment were assessed for each patient. Using a ruler, original overjet was measured on the patients' pretreatment study models to the nearest

0.5 mm. Overjet was calculated from the labial surface of the mandibular incisors to the incisal edge of the most prominent maxillary incisor, with the ruler being held parallel to the occlusal plane and radial to the arch (18). The overjet measurements were divided into two categories: normal overjet (0–3.0 mm) and increased overjet (>3.0 mm). Lip coverage of the upper incisors before orthodontic treatment was estimated with reference to photographs showing the pretreatment facial view of the patient. If the lip covered the upper incisors in the rest position, lip coverage was rated as adequate. If the greater part of the crown height of the upper incisors was exposed and clearly visible, lip coverage was rated as inadequate (18).

The patients were divided into three groups according to the extent of overjet and type of lip coverage. Patients with normal original overjet and adequate lip coverage were assigned to Group 1, patients with increased original overjet and adequate lip coverage to Group 2, and patients with both increased original overjet and inadequate lip coverage to Group 3.

### Statistical analysis

Data analysis included descriptive statistics (frequency distribution and cross-tabulation). Statistical significance for the association between incidence of dental trauma and gender, extent of incisal overjet, and type of lip coverage was tested using the Chi-squared test. The significance level was set at $P < 0.05$. Statistical analysis was performed with SPSS 11.0 (SPSS, Inc., Chicago, IL, USA).

### Error of the method

Registration of the original overjet was repeated on 50 pretreatment study models within a 4-week interval by the same observer. The measurement error ($\tau$) was determined according to Dahlberg (26) and was found to be 0.27 mm. Lip coverage of the incisors before orthodontic treatment was re-evaluated on 50 pretreatment frontal photographs, with agreement in 100% of the double ratings being confirmed.

## Results

A dental trauma before the onset of orthodontic treatment was determined in 141 of the 1367 examined patients (10.3%), and multiple traumatic episodes were determined in 5.7% of the affected patients ($n = 8$). In 128 cases, previous dental trauma had been recorded in the questionnaire. In all these patients, immediate treatment of the dental trauma had been carried out by dental practitioners or at dental clinics. In addition, 13 patients with untreated dental traumas had been identified during the clinical examination.

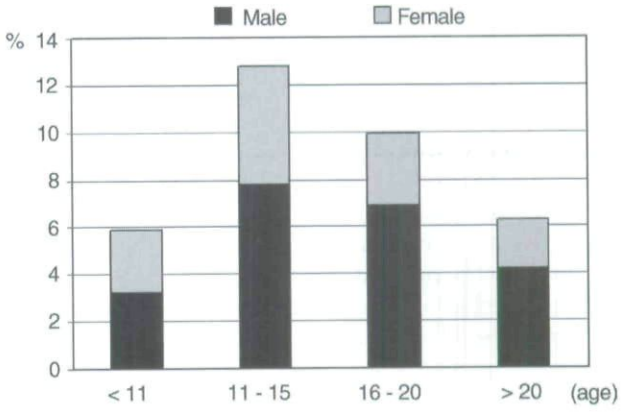


*Fig. 1.* Prevalence of dental injuries according to gender and age group.

All 13 revealed minor hard tissue injuries (enamel chipping or fracture of enamel).

Eighty-nine of the subjects with injured teeth were boys (63.1%) and 52 were girls (36.9%). As the overall M:F ratio was 1.7, the gender difference in the number of trauma cases was statistically significant ($P < 0.001$). The prevalence of dental traumas increased from 5.9% ($n = 13$) in the <11 years age group to 12.8% ($n = 79$) in the 11–15 years age group, followed by a decrease in the next two age groups (16–20 years: 9.9%, >20 years: 6.3%; Fig. 1).

The total of 225 injured teeth represented a mean of 1.6 teeth per accident. Most injuries involved one tooth (53.9%), with only 1.4% involving four teeth or more (Table 2). Maxillary teeth were involved in 96% ($n = 216$) and mandibular teeth in 4% ($n = 9$) of all cases. The most frequently affected teeth were the maxillary central incisors ($n = 179$; 79.6%), followed by the maxillary lateral incisors ($n = 37$; 16.4%). No significant difference was observed between the right ($n = 118$; 52.4%) and the left side ($n = 107$; 47.6%) of the dental arch (Fig. 2).

One hundred and seventy-five of the dental injuries were classified as hard tissue injuries (77.8%) and 50 as periodontal tissue (22.2%) injuries. The most common type of trauma was fracture of enamel–dentin without pulpal involvement ($n = 96$; 42.7%), followed by fracture of enamel ($n = 76$; 33.8%), subluxation ($n = 19$; 8.4%), and luxation ($n = 15$; 6.7%). No cases of fracture of root or of crown-root fracture were recorded in this sample (Fig. 3).

The major causes of dental trauma were falls ($n = 70$; 49.6%), traffic accidents ($n = 24$; 17.0%), and

Table 2. Number and percentage distribution of injured teeth per individual

| | Number of injured teeth | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 or more |
| Cases *(n)* | 76 | 50 | 13 | 2 |
| (%) | 53.9 | 35.5 | 9.2 | 1.4 |

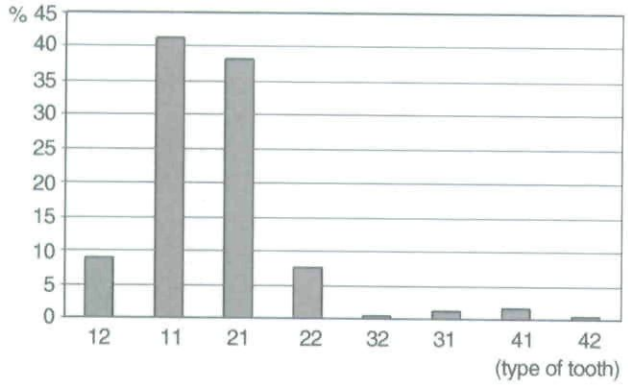


*Fig. 2.* Distribution of traumatic injuries according to type of tooth.

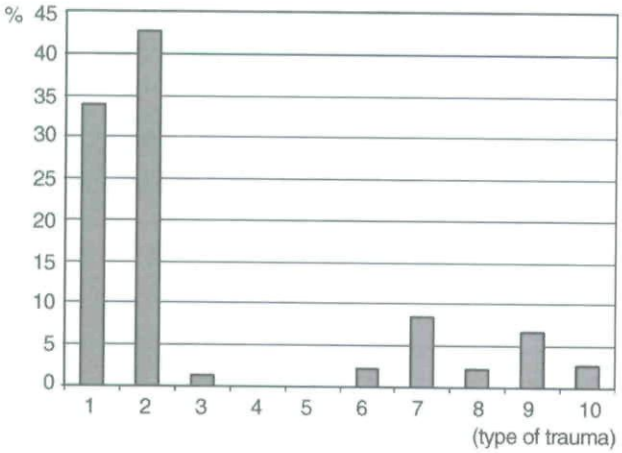


*Fig. 3.* Distribution of traumatized teeth according to type of trauma: 1, fracture of enamel including enamel chipping; 2, fracture of enamel–dentin without pulpal involvement; 3, fracture of enamel–dentin with pulpal involvement; 4, fracture of root; 5, crown-root fracture; 6, concussion; 7, subluxation; 8, intrusion; 9, luxation (extrusive or lateral luxation); 10, avulsion.

sports activities ($n = 20$; 14.2%; Fig. 4). Most accidents had occurred at home ($n = 68$; 48.2%), in the street ($n = 24$; 17.0%), or at school ($n = 19$; 13.5%; Fig. 5). The cause and location of accidents were unknown in 5.0% of the patients ($n = 7$), all presenting only slight injuries (enamel chipping or fracture of enamel).

A normal original overjet (0–3.0 mm), with adequate lip coverage (Group 1), was registered in 493 patients (36.1%), an increased original overjet (>3.0 mm) with adequate lip coverage (Group 2) in 532 patients (38.9%), and an increased original overjet in combination with inadequate lip coverage (Group 3) in 342 patients (25.0%). A previous dental trauma was recorded in 7.1% of the patients in Group

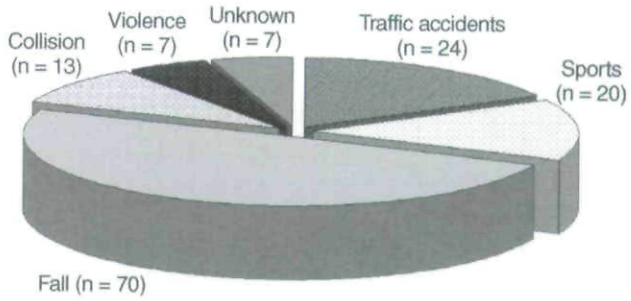


*Fig. 4.* Etiology of traumatic injuries.

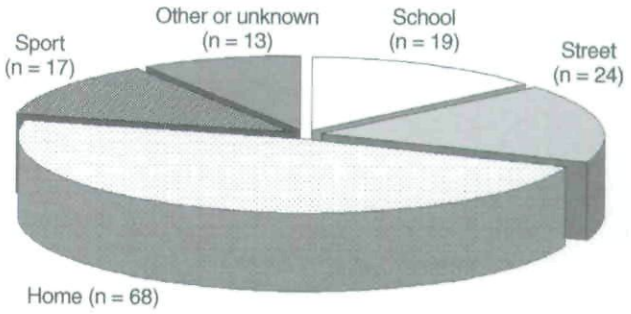


*Fig. 5.* Location of accidents.

1, in 11.3% of those in Group 2, and in 13.5% of those in Group 3 (Table 3). No intergroup differences were observed with respect to the type of trauma. Patients in Group 1 revealed a significantly lower frequency of dental trauma than those in Group 2 ($P = 0.028$) or Group 3 ($P = 0.003$; Fig. 6). In all the three groups, significant differences in the frequency of dental trauma were observed between the age groups of <11 and 11–15 years. However, these differences were found to be slightly more pronounced in patients with increased overjet (Groups 2 and 3; Fig. 7).

## Discussion

The results of the present study indicate that a significant percentage of the candidates for orthodontic treatment had suffered trauma to their permanent incisors before the onset of such treatment. Dental trauma to the permanent incisors was determined in 10.3% of the investigated patients presenting for orthodontic therapy, a figure comparable with those reported in previous epidemiologic studies based on samples of schoolchildren (9, 10, 13, 18). In contrast, the frequency of multiple dental trauma episodes in the investigated sample (5.7%) was clearly below the rate of 16–30% reported in the literature (4, 27, 28).

Table 3. Prevalence of dental trauma according to extent of overjet and type of lip coverage

| Examination groups | Dental trauma *n* (%) | No dental trauma *n* (%) |
|---|---|---|
| Normal overjet (0–3.0 mm) and adequate lip coverage | 35 (7.1) | 458 (92.9) |
| Increased overjet (>3.0 mm) and adequate lip coverage | 60 (11.3) | 472 (88.7) |
| Increased overjet (>3.0 mm) and inadequate lip coverage | 46 (13.5) | 296 (86.5) |

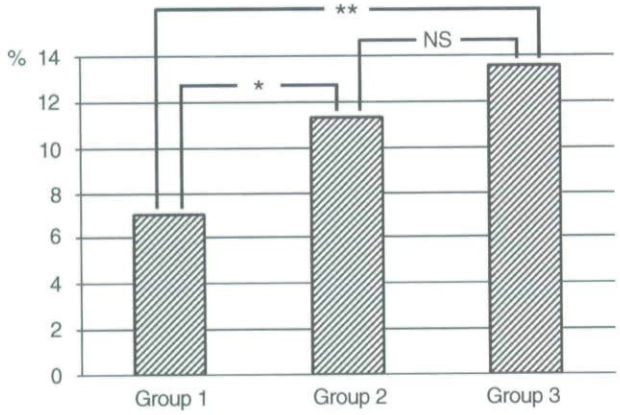


*Fig. 6.* Intergroup differences with respect to frequency of dental trauma. Group 1, normal overjet and adequate lip coverage; Group 2, increased overjet and adequate lip coverage; Group 3, increased overjet and inadequate lip coverage. NS, not significant; ★, $P < 0.05$; ★★, $P < 0.01$.

This discrepancy might be attributed to differences in sample composition deriving from the places where the studies were conducted.

The highest prevalence of dental trauma was found in the 11–15 years age group, which corresponds with the age distribution reported in earlier studies (11, 13, 14). The gender-related difference in the number of cases of trauma was statistically significant ($P < 0.001$), confirming the general impression that males suffer more dental traumas than females (2, 3, 6, 15). However, other authors have reported similar trauma figures in males and females (9), a finding that may reflect an increasing number of dental injuries in girls because of their growing participation in contact sports (15, 29).

Most of the trauma cases involved only one tooth (53.9%), the most frequently affected teeth being the maxillary central incisors (79.6%), followed by the

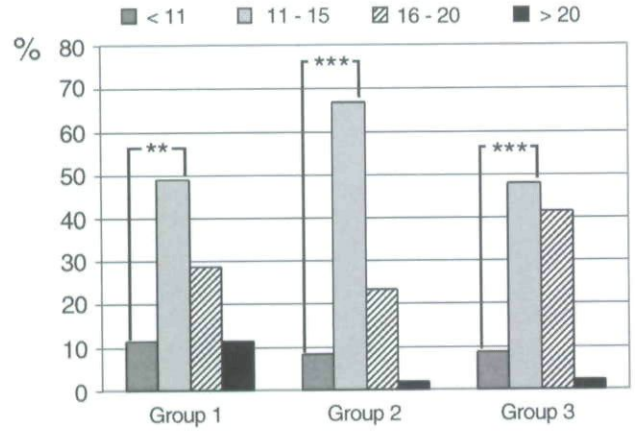


*Fig. 7.* Distribution of dental traumas according to age category in the different groups. Group 1, normal overjet and adequate lip coverage; Group 2, increased overjet and adequate lip coverage; Group 3, increased overjet and inadequate lip coverage. ★★, $P < 0.01$; ★★★, $P < 0.001$.

maxillary lateral incisors (16.4%). This finding is in agreement with various other investigations (7, 11, 14), but is inconsistent with other studies reporting most injuries to involve two or more teeth (6, 12) and the second most affected teeth to be the mandibular central incisors (8, 17). With respect to the number of affected teeth, a correlation between age and number of traumatized teeth has been suspected, with a higher frequency of multitooth injuries in very young patients and in patients older than 14 years (11, 12). In contrast to a previous investigation (8), no significant difference was observed between trauma on the left and on the right side of the dental arch.

Enamel–dentin fractures without pulpal involvement were the most common injuries recorded, which is in accordance with the results reported by various authors (6, 14, 30). Other investigations, in contrast, report enamel fracture or luxation to be the most common fracture type (2, 7, 8, 10). Again, differences concerning the sample composition and the location of treatment may account for these discrepancies.

No teeth with fracture of root or with crown-root fracture were detected in the examined sample. However, as root fractures are difficult to diagnose even on high quality intraoral radiographs, particularly in patients with proclined upper incisors, intraoral radiographs taken in several directions are mandatory. Intraoral radiographs were unavailable for the 13 patients with untreated dental trauma, and intraoral radiographs had been confined to one direction in many of the remaining cases. There is thus an obvious risk that the prevalence of root fractures may have been underestimated in the present study. Another explanation for the absence of root fractures in the examined sample might be that dental practitioners refrain from referring such patients for orthodontic treatment, even though orthodontic movement of teeth with root fractures is fundamentally feasible (20, 31).

Several studies found falls to be the main cause of dental injuries (6, 14, 15), which is in agreement with the results of the present investigation. Most of our patients had suffered dental trauma at home or in the street (combined total 65.2%). Marcenes et al. (9) also reported that nearly half of the injuries in their collective had occurred at home (48.3%). In contrast to our findings, however, they showed violence to be the main cause of dental trauma to the permanent incisors. As the study was carried out in Damascus, Syria, local social structures may account for the observed differences.

Reports on whether increased overjet represents a significant predisposing factor to traumatic dental injury are contradictory (9, 10, 32, 33). A significant relationship between extent of overjet and traumatic dental injury was detected in the present investigation, which is in accordance with the findings of numerous

previous studies (7, 16–19). In addition, patients with increased overjet in combination with inadequate lip coverage revealed the highest prevalence of dental trauma, which highlights the importance of lip coverage as a predictor of traumatic injury (18). As previous investigations have shown that orthodontic retraction of maxillary incisors reduces the extent of overjet and the interlabial gap (18, 34), the results of the present study also indicate that orthodontic treatment of patients with increased overjet and inadequate lip coverage will diminish the likelihood of trauma to the permanent incisors in these patients (18, 19).

Furthermore, early or two-stage orthodontic treatment has been advocated to prevent dental trauma in patients with increased overjet (17–19, 24, 35), a recommendation supported by the results of the present investigation. As significant differences in the frequency of dental trauma were found between the age groups of $<11$ and 11–15 years, the findings of this study might also suggest that such preventive orthodontic treatment should be initiated and completed before the age of 11, i.e. in the early to middle mixed dentition (17, 35).

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