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Effect of early Class II treatment on the incidence of incisor trauma

David R. Chen,[a] Susan P. McGorray,[b] Calogero Dolce,[c] and Timothy T. Wheeler[d]
Sacramento, Calif, and Gainesville, Fla

Introduction: Many researchers have examined the prevalence of dental injuries in children and adolescents. The purpose of this study was to examine the prevalence and incidence of incisor trauma in subjects who participated in a randomized clinical trial designed to investigate early growth modifications in the treatment of Class II malocclusion. **Methods:** The subjects were randomized to 3 treatment groups during the initial phase of the study: (1) headgear or biteplane, (2) bionator, and (3) observation (no treatment). All 3 groups underwent phase 2 treatment with fixed appliances. Incisor injury was scored at every data collection point with the Ellis index by a blinded examiner using dental casts, intraoral photos, and panoramic and periapical x-rays. **Results:** Twenty-five percent of the subjects had incisor trauma at the baseline examination, and 28% experienced new or worsening maxillary incisor injury during the study. No significant differences were found with regard to sex and prevalence of injury at baseline. No differences in incidence of trauma were found between the 3 treatment groups throughout the study ($P = 0.19$); however, boys were more likely to experience maxillary incisor injury (odds ratio estimate, 2.37; 95% CI, 1.33, 4.21), and those with an injury at baseline were more likely to experience an additional injury (odds ratio estimate, 1.81; 95% CI, 1.03, 3.17). **Conclusions:** Early orthodontic treatment did not affect the incidence of incisor injury. The majority of the injuries before and during treatment were minor; therefore, the cost-benefit ratio of orthodontic treatment primarily to prevent incisor trauma is unfavorable. (Am J Orthod Dentofacial Orthop 2011;140:e155-e160)

Dental injuries are common and are an important dental public health problem. Many epidemiologic studies during the last 3 decades have estimated the prevalence of dental injuries in children and adolescents.[1-8] The occurrence of dental injuries in a population can be defined by its prevalence and incidence. The prevalence of incisor injury has been reported to range from 6% to 34%.[9-11] Falls, collisions, sporting activities, and traffic accidents are the main causes of most dental injuries.[12,13] Variables such as age, sex, socioeconomic status, and behavioral problems might also influence the frequency of dental trauma. Bauss et al[12] and Caliskan and Turkun[13] found that patients aged 8 to 11 years had the highest prevalence of dental trauma. It has been shown that incisor injuries occur more frequently in boys.[14,15] Socioeconomic influences can also have a significant effect on a child's experience with dental injuries.[16,17] Studies have shown a positive correlation between the frequency of incisor trauma with increased protrusion,[18,19] Class II malocclusion,[3,20] increased overjet,[21-24] and lip incompetence.[19,25] Early orthodontic treatment for children with such characteristics has been recommended to prevent incisor trauma and its sequelae.[22,25] Nguyen et al[23] suggested the incorporation of overjet as a malocclusion item into orthodontic treatment indexes because of its potential correlation with dental trauma.

Although the indications for early orthodontic treatment to diminish the likelihood of trauma to permanent incisors have been presented by several authors, Koroluk et al[26] found that most injuries were minor and easily treated at low cost and with good long-term prognoses. They concluded that early growth modification might have some effect on the incidence of trauma, with the expected cost of trauma per child to be less for those who had 2-phase orthodontic treatment.

The efficacy of early intervention largely depends on the timing of treatment and the peak occurrence of injuries. Orthodontic intervention could be ineffective

[a]Private practice, Sacramento, Calif.
[b]Assistant research professor, Department of Biostatistics, University of Florida, Gainesville.
[c]Associate professor, Department of Orthodontics, University of Florida, Gainesville.
[d]Eminent scholar and chair, Department of Orthodontics, University of Florida, Gainesville.
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Reprint requests to: Susan P. McGorray, Department of Biostatistics, Box 117450, Gainesville FL, 32611; e-mail, spmcg@biostat.ufl.edu.
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with minimal benefits if dental trauma occurs before the start of treatment. Few reports are available regarding the effectiveness of early orthodontic treatment to reduce the incidence of incisor trauma.

The purpose of this study was to evaluate the prevalence and the effect on the incidence of incisor trauma in children who participated in a randomized clinical trial designed to investigate early growth modifications in the treatment of Class II malocclusion.

MATERIAL AND METHODS

The subjects participated in a prospective, longitudinal, randomized clinical trial designed to examine the effectiveness of early treatment with headgear or biteplane or with bionator in children with Class II malocclusion and compare the results with changes over a similar time period in an observation group. The design, subject selection, and progression through the study were previously described in detail.[27,28] The inclusion criteria included bilateral greater than or equal to one-half-cusp Class II molars or unilateral greater than one-half-cusp Class II molars, fully erupted permanent first molars, not more than 3 permanent canines or premolars, positive overjet and overbite, and good general and dental health. A stratified block randomization procedure was used to assign a treatment protocol (headgear or biteplane, bionator, and observation) during phase 1. Strata were defined by the severity of the Class II malocclusion (mild, bilateral half cusp; moderate, at least 1 side three quarters cusp; severe, at least 1 side full cusp), the need for preparatory treatment, mandibular plane angle, race, and sex. After completing phase 1, all groups underwent fixed appliance treatment in phase 2, followed by a retention or a follow-up period.

Incisor injury was assessed at all data collection (DC) points by using the modified Ellis classification (Table I). Maxillary and mandibular incisors were scored. Study models, intraoral and extraoral photos, x-rays (lateral cephalograms, panoramic radiographs, and periapicals taken during phase 2) obtained at each DC point were used to inspect incisor injuries. Any existing or new restorations on the teeth were noted. One trained and reliability-tested examiner (D.R.C.) recorded all injuries. The records for all DC points of each subject were evaluated at the same time to eliminate the chance of recording errors over time.

Overjet was assessed for each subject at all DC points by using the lateral cephalograms taken at each DC period.

Statistical analysis

Statistical comparisons considered intervals defined by the time points at baseline (DC 1), end of phase 1 active treatment (DC 3), end of phase 1 observation (DC 5), beginning of phase 2 (DC 7), and end of phase 2 (DC F). Relationships between outcomes and covariates were examined with the chi-square and Fisher exact tests. The Pearson correlation coefficient was used to examine the relationship between initial overjet and trauma. A generalized linear mixed model was used to examine the effect of multiple factors on new or increased injuries. Variables included in this model were incisor injury at baseline, treatment group, sex, time point, lagged overjet, and treatment group by time interaction. The lagged overjet variable used the previous time interval's overjet measurement to examine the role of overjet at the start of a time interval on the occurrence of trauma during that time period. The treatment group by time interaction allowed for differences between treatment groups over time (eg, incidence could differ during the time interval of DC 1 to DC 3, with the observation group incurring more trauma, but then be similar for later time periods). As a secondary analysis, we examined the potential impact of a sex by treatment group interaction. For all analyses, a P value less than 0.05 was considered statistically significant.

Table I. Modified Ellis injury classifications

Score	*Injury description*
0	Noninjured tooth
1	Fracture of the crown involving enamel only
2	Fracture of the crown involving enamel and dentin
3	Fracture of the crown involving pulp (untreated, pulp cap, pulpotomy, root filling)
4	Nonvital without crown fracture
5	Root fracture
6	Loss due to trauma
7	Missing tooth

RESULTS

Table II presents the subjects' characteristics by treatment group. At DC 1, 64 of the 261 participants (25%) had some incisor trauma (bionator, n = 27 [31%]; headgear or biteplane, n = 18 [19%]; observation, n = 19 [23%]). The differences in the proportion of subjects with trauma by treatment group were not statistically significant ($P = 0.18$). Figure 1 shows the distribution and severity of injuries to maxillary and mandibular teeth. The majority (80%) of the injuries were scored as minor fractures involving enamel only. Fractures involving enamel and dentin accounted for 19%, and only 1 subject had trauma with pulpal exposure. The maxillary incisors had the most injuries (77%), with central incisors the most common. The prevalence of incisor trauma at DC 1 did not significantly differ between boys

Table II. Baseline characteristics by treatment group

Characteristic	*Bionator (n = 87)*	*Headgear or biteplane (n = 93)*	*Observation (n = 81)*	*P value**
Sex (% female)	40	38	38	0.93
Race (% white)	87	95	93	0.20
Initial molar classification				0.95
% Mild	26	31	30	
% Moderate	26	23	26	
% Severe	47	46	44	
Age (y) at DC 1, mean (SD)	9.6 (1.1)	9.7 (0.8)	9.5 (0.8)	0.72
Overjet (mm) at DC 1, mean (SD)	6.0 (2.8)	5.4 (2.4)	5.6 (2.6)	0.41

*Chi-square tests used for categorical variables and analysis of variance (ANOVA) for continuous variables.

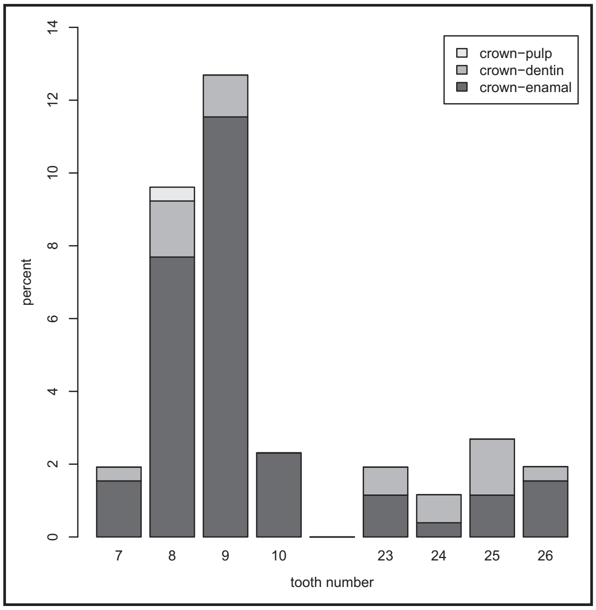

Fig 1. Amount and type of incisor injury at baseline (DC 1).

Table III. Incidence of maxillary incisor injuries (percentages with new or worsening injuries, and samples size in parentheses)

Time interval	*Bionator*	*Headgear or biteplane*	*Observation*	*P value*
DC 1-DC 3	13.8 (87)	12.9 (93)	13.6 (81)	0.98
DC 3-DC 5	11.7 (77)	7.1 (85)	12.5 (80)	0.46
DC 5-DC 7	4.3 (69)	1.4 (74)	6.7 (60)	0.25
DC 7-DC F	3.2 (62)	2.9 (68)	10.9 (55)	0.13
DC 1-DC F	28.4 (67)	22.5 (71)	33.3 (69)	0.36

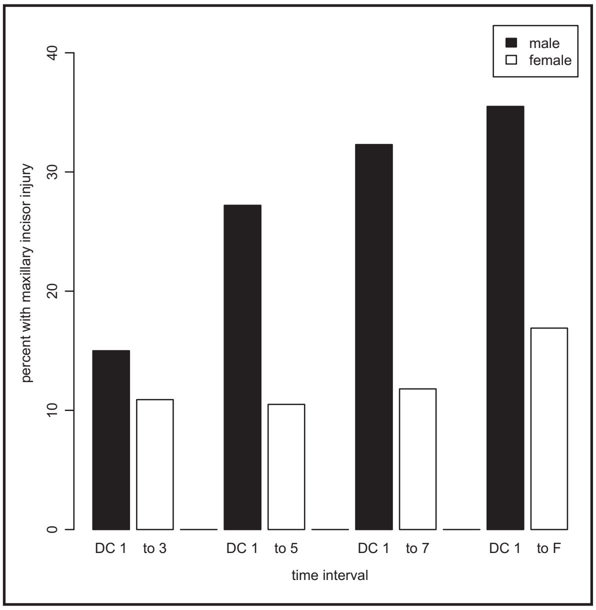

Fig 2. Incidence of maxillary incisor injury, boys vs girls, throughout the study. Significant differences (P <0.05) were detected for all time intervals.

and girls ($P = 0.27$), with 21% of the girls and 27% of the boys having some incisor trauma.

Since most injuries occurred in the maxilla, further analysis focused on the incidence of maxillary incisor injury. As shown in Table III, there were no differences in the incidence of new trauma between treatment groups during any time interval. As seen in Figure 2, there was a significantly higher incidence of trauma in boys compared with girls during the entire study. During the study, only the observation group showed a significantly higher incidence of trauma in boys than in girls (Fig 3).

Overjet measurements were used to determine whether overjet correlated with trauma. The mean overjet values at baseline were 5.81 mm (SD, 2.77; range, 0.87-13.2) for boys and 5.48 mm (SD, 2.30; range, 0.51-11.2) for girls. No correlation was found between initial overjet value and the amount of maxillary incisor trauma at baseline (Pearson correlation coefficient, 0.02; $P = 0.75$). When evaluating baseline overjet and change in maxillary incisor injury as continuous variables throughout the study, a borderline significant correlation of 0.23 ($P = 0.0549$) was found in the observation group, but not in the headgear or biteplane and the bionator groups (correlations, −0.11 and −0.06, respectively). The patterns of change in overjet for the 3 treatment groups are shown in Table IV.

In the generalized linear mixed model analysis, there was no evidence of an effect of lagged overjet

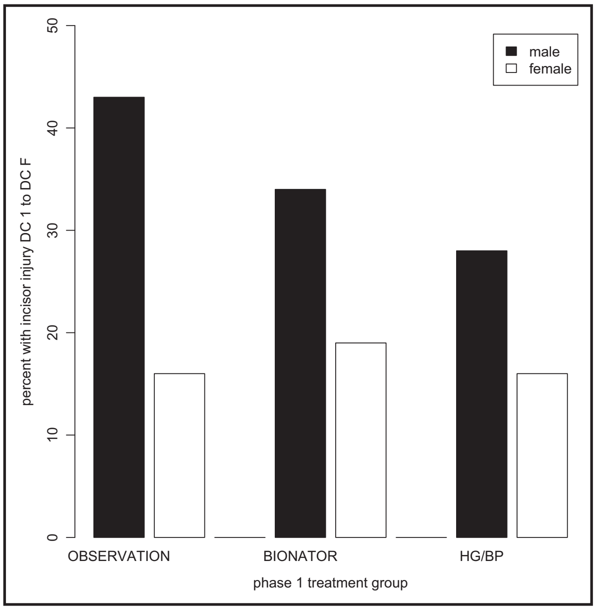

Fig 3. Incidence of maxillary incisor injury by treatment group, boys vs girls. A significant difference (P = 0.0213) was detected for the observation group, but not for the bionator group (P = 0.19) or the headgear or biteplane (*HG/BP*) group (P = 0.21).

(P = 0.62), nor was the treatment group by time interaction significant (P = 0.65). These variables were not considered in the final model. In the final model, treatment group was not significant (P = 0.19), but factors significantly affecting the incidence of injury were sex (P = 0.0035; male compared with female odds ratio estimate of 2.37 [95% CI, 1.33, 4.21]), time point (P = 0.0008), and baseline injury (P = 0.0381; those with baseline injury compared with no baseline injury odds ratio estimate, 1.81 [95% CI, 1.03, 3.17]). For time points, the odds ratios were all reduced, relative to the DC 1 toDC 3 time interval, indicating fewer incisor injuries as the children aged. As suggested by bivariate analysis, we examined whether the addition of treatment group by sex interaction terms would improve the above model; it did not (P = 0.55).

DISCUSSION

In this study, we found that 25% of the subjects had some incisor trauma at the baseline examination; this is in the range of previously reported prevalences of incisor injury of 6% to 34%.[9-11] This shows that a significant number of children already had some dental trauma during early childhood. In a study of Brazilian preschool children from birth to 6 years old, 35.5% already had signs of dental trauma.[29] Therefore, if orthodontic early treatment is to have any effect on the incidence of this early incisor trauma, orthodontic treatment would most likely need to begin soon after the eruption of the permanent incisors. Determination of the initial onset of trauma would be pertinent to prevention.

The prevalence of incisor injury at baseline was not statistically different between boys and girls at the mixed dentition stage. This is similar to the results of Koroluk et al.[26] Marcenes et al[30] also found no difference in prevalence between boys and girls at 9 years of age living in Syria. However, we observed that boys had a higher incidence of trauma during treatment. This finding is consistent with those of several investigators.[12,14,15] This could be due to boys' increased activity at this age.

Throughout the trial, the incidence of incisor trauma did not differ significantly between the treatment groups. All 3 groups showed a trend of decreased incidence over the course of phases 1 and 2 of treatment. Bauss et al[12] and Caliskan and Turkun[13] both found that children aged 8 to 11 years, when phase 1 treatment usually occurs, had the highest prevalence of dental trauma. Children at these ages might have greater risk-taking behaviors and physical leisure activities such as school sports, thereby increasing the risk of injury during treatment.[31] Nonetheless, the decrease in incidence over time might lessen the potential benefit of early treatment to reduce risks of trauma later.

During early childhood, several nondental factors might also play roles in affecting dental trauma and should be considered. Socioeconomic influences can also have a significant effect on a child's experience with dental injuries.[17] Nicolau et al[16] found that adolescents who experienced adverse psychosocial environments, such as nonnuclear families, paternal punishment, and poor school performance had more traumatic dental injuries than did their counterparts who had more favorable environments. Mercenes et al[17] discovered a higher incidence of incisor injury in children from mothers with higher educational backgrounds. Odoi et al[32] associated

Table IV. Overjet measurement by treatment group and time point (means and standard deviations in millimeters)

	Bionator	*Headgear or biteplane*	*Observation*
Baseline (DC 1)	6.0 (2.8)	5.4 (2.4)	5.7 (2.6)
End of phase 1 (DC 5)	3.8 (1.8)	4.0 (2.3)	5.4 (2.7)
Start of phase 2 (DC 7)	4.1 (1.9)	4.2 (2.4)	5.3 (2.8)
End of phase 2 (DC F)	2.6 (1.1)	2.4 (1.4)	2.5 (1.1)

behavioral problems such as peer relationship problems, hyperactivity or inattention, and emotional distress with traumatic dental injuries. Perheentupa et al[33] attributed increased tooth trauma to high alcohol consumption and being overweight.

We observed that approximately 78% of total incisor injuries occurred in the maxillary incisors, with only 22% in the mandibular incisors. Most injuries involved the maxillary central incisors followed by the maxillary lateral incisors. This agrees with previous studies.[12,13,34] It is likely that the susceptibility of teeth to trauma is related to their position in the dental arch. Maxillary incisors are usually the most anteriorly positioned teeth; therefore, it is to be expected that they will have the highest frequency of trauma.

A number of scoring systems have been proposed to measure dental trauma.[35] We selected the modified Ellis classification as best suited for our data, with high reproducibility. However, this classification does not assess injury to the periodontal ligament, such as luxations, so it might underestimate incisor injuries.

Some studies found enamel-dentin fractures without pulpal involvement to be the most common form of injury.[4,13] Other investigations, in contrast, reported enamel fracture or luxation to be the most common fracture type.[1,5,6] We found that most trauma events consisted of enamel fractures. Only 19% of the injuries involved dentin, and only 1 subject had trauma with pulpal exposure. Fortunately, this shows that the majority of trauma is minor and can be repaired with composite restorations with a good long-term prognosis.[36] Therefore, the cost of treating an injured tooth with a restoration vs the cost of orthodontic prevention must be considered to determine the optimal cost-benefit ratio.

The reports on whether increased overjet might be a significant predisposing factor for incisal trauma are conflicting. Bauss et al[12] found a higher prevalence of trauma in subjects with overjet values greater than 3 mm. Jarvinen[24] attributed increased trauma to overjet values of 6 mm or greater. However, some studies found that increased overjet might not be positively correlated with the risk of dental injury.[37] Koroluk et al[26] found no differences between mean overjet values of patients with and without incisor trauma at baseline. In this study, we found no significant correlation between initial overjet and the prevalence of trauma. In addition, we found no significant relationship between the amount of overjet and the incidence of trauma throughout treatment. The conflicting results in the literature could be due to several factors such as trauma classification, dentition studied, and geographical and behavioral differences between study locations and countries.

CONCLUSIONS

1. We found that a significant number of children already had some incisor injury before early orthodontic treatment. Early treatment would need to be initiated at the eruption of the permanent incisors to determine its effectiveness in preventing dental trauma.
2. No correlation was found between initial overjet and the prevalence of trauma.
3. Early orthodontic treatment, begun on average between the ages of 9 and 10, did not significantly affect the incidence of trauma. Most injuries before and during treatment were minor and consisted of enamel fractures. Most injuries occurred in the maxillary central incisors.
4. Multivariate longitudinal analysis indicated that during the time periods of phases 1 and 2, boys were more likely than girls to incur trauma. Those with previous trauma were more likely to incur more, and the incidence of trauma decreased over time.

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