Lower third molar eruption following orthodontic treatment

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بزوغ السن الثالثة في الفك السفلي بعد المعالجة السنية التقويمية

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الخلاصة: قامت هذه الدراسة بتقييم أثر قلع الضاحكة الأولى أو الاحتفاظ بها، على بزوغ السن الثالثة في الفك السفلي. وقد تم تقييم السجلات السريرية للمعالجة السنية التقويمية بين عامَيْ 1993 و1995 قبل المعالجة وبعدها، وبعد مرور ثماني إلى تسع سنوات على معالجة ثلاث مجموعات من المرضى: اثنان وثلاثون منهم تم قلع السن الأولى لهم في الفكين العلوي والسفلي، واثنان وثلاثون لم يتم قلع السن الأولى لهم ولكن تم إجراء المعالجة السنية التقويمية لهم، وثمانية وأربعون مجموعة شاهداً بدون قلع للسن ولكن مع معالجة سنية تقويمية للفك العلوي فقط. كما تم تقييم البزوغ الناجح للسن الثالثة أيضاً. وكان هناك اختلاف يعتد به إحصائياً في معدَّلات البزوغ الناجح تتراوح بين (42٪) فيمن أجري لهم قلع السن، و(12٪) بدون قلع للسن، و(20٪) في الشواهد. وتدل النتائج على أن قلع السن الأولى يزيد من فرص بزوغ السن الثالثة مما يؤدي إلى انخفاض معدَّلات وقوع المضاعفات الصحية والاقتصادية.

ABSTRACT This study assessed the effect of extraction and preservation of the 1st premolar on lower 3rd molar eruption. Orthodontic clinic records from 1993 to 1995 were evaluated before and after treatment and 8–9 years after treatment for 3 groups of patients: 32 with extraction of 1st premolars in both jaws, 32 with no extraction but orthodontic treatment and 48 controls with no extraction but orthodontic treatment in the upper jaws only. Successful eruption of 3rd molars was evaluated. There was a significant difference in the rates of successful eruptions in the extraction (42%), non-extraction (12%) and control (20%) groups. The findings indicate that 1st premolar extraction may increase the chance of 3rd molar eruption, leading to a lower incidence of health and economic complications.

Éruption de la troisième molaire inférieure suite à un traitement orthodontique

RÉSUMÉ Cette étude a évalué les effets de l'extraction et de la préservation de la première prémolaire sur l'éruption de la troisième molaire inférieure. Entre 1993 à 1995, les dossiers cliniques d'orthodontie de trois groupes de patients ont été évalués avant et immédiatement après traitement, puis 8-9 ans plus tard. Ces groupes étaient composés de 32 patients ayant subi une extraction des premières prémolaires sur les deux mâchoires, 32 n'ayant pas subi d'extraction mais ayant reçu un traitement orthodontique et 48 témoins n'ayant pas subi d'extraction, mais ayant reçu un traitement orthodontique sur la mâchoire supérieure uniquement. L'éruption des troisièmes molaires a été évaluée. Il existait une différence significative entre les taux d'éruption dans les groupes avec extraction (42 %), sans extraction (12 %) et dans le groupe témoin (20 %). Les conclusions indiquent que l'extraction de la première prémolaire peut augmenter les chances d'éruption de la troisième molaire, ce qui diminue l'incidence des complications de santé et les conséquences économiques.

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Introduction

Impaction of the 3rd molar is a high incident problem occurring in up to 73% of young adults in Europe [*1*]. Such impactions are reported to be associated with complications ranging from simple caries, root resorption, localized periodontal problems, pericoronitis and infection to cysts and neoplastic lesions [*2,3*]. These pathologic processes, along with the possible association between eruption of the lower 3rd molar and increases in lower incisor crowding, are the rationales given for the extraction of the 3rd molar by surgical procedures [*4*]. However, such surgery is associated with a variety of possible risks, including fracture of the mandible or tooth during surgical removal and inferior alveolar or lingual nerve dysfunction [*5–7*].

A number of factors affect the proper eruption of the 3rd molar. Some authors have shown that extraction of the premolars or molar mesial to the 3rd molar during orthodontic treatment may increase the chance of proper eruption of the 3rd molar [*8–11*]. However, some orthodontists believed that even if the molars or the 1st premolars were extracted, mandibular 3rd molars might still remain impacted [*12,13*].

Several studies assessed the effect of the 1st premolar extraction on 3rd molar eruption [*8–10*]. In those studies, however, the sample of patients was not adjusted for intervening factors in the 3rd molar eruption including the growth pattern of the face [*14*], 3rd molar angulation [*1,8*], pretreatment crowding [*12*], mandibular growth and space available [*8,15*]. This lack of adjustment might have acted as a confounding factor influencing the findings and interpretation of those studies. To avoid such a shortcoming, the present study adjusted for the above-mentioned variables.

The complications arising from impaction of the 3rd molar are associated with serious health and economic burdens. For example, the costs of 3rd molar surgery in the United States and United Kingdom were reported to be US$ 425 and US$ 75 respectively, representing 50% of the cost of all oral surgeries [*16*]. As far as we know, there is no study investigating the incidence of 3rd molar impaction and the cost of its extraction in the Islamic Republic of Iran. However, the only published report in Farsi indicates that the surgical extraction of impacted 3rd molars was the most frequent surgical procedure done in the country [*17*]. With its high rate of occurrence, it seems reasonable to suggest that impaction of the 3rd molar has high cost implications for the Islamic Republic of Iran as well.

Considering the health and economic consequences of 3rd molar impaction and the lack of such studies in the Islamic Republic of Iran, this study aimed to evaluate the effect on 3rd molar eruption of 1st premolar extraction in orthodontic patients 8–9 years after the end of orthodontic treatment.

Methods

A total of 1000 records from skeletal class I patients treated at the authors' private dental clinics from 1993 to 1995 were reviewed and 360 records were selected. To decrease the effect of inter-clinician variability, the patients were randomly selected from the files of patients referring to both clinicians. The inclusion criteria for patients were: skeletal class I (ANB angle 0–4º, Wits appraisal 0–2 mm), normal growth pattern (GoGn–SN angle 29–33º, Jaraback index 61–66), age at the start of the study 18–22 years and orthodontic treatment time 18–24 months. The exclusion criteria were: pretreatment crowding more than 5 mm (the difference of arch perimeter from the mesial of one 1st molar to the other and summing the mesiodistal widths of the teeth from

one 2nd premolar to the other), presence of lower 3rd molar unilaterally, missing and supernumerary teeth in the mandible, or any other dental anomaly.

When patient selection was over, patients were assigned to 3 groups according to the type of treatment they had received.

- The extraction group were 32 patients (16 males, 16 females) who had had extraction of 1st premolars in both jaws.
- The non-extraction group were 32 patients (17 males, 15 females) who had had orthodontic treatment in both jaws but without any extraction.
- The control group were 48 patients (28 males, 20 females) who had had orthodontic treatment only in their upper jaws and no treatment in the lower jaws.

The patients' records (cephalometric films, panoramic radiographs and orthodontic casts) were examined before (time 1: T1) and immediately after the end of orthodontic treatment (time 2: T2). The following variables were noted:

- Axial inclination of 3rd molar: the angle between the longitudinal axis of the 3rd molar and the line vertical to the 2nd molar axis in the 1st cephalogram [*8*].
- Space available for 3rd molar eruption: the distance of the distal surface of the 2nd molar (M2) to the point Xi at the centre of the ramus (Xi–M2 distance) along the occlusal plane (Ricket's method) [*18*].
- Amount of mandibular growth: the difference of the Ar–Pog distances at T1 and T2 [*8*].
- Amount of mesial movement of the 1st molar: movement of the 1st molar after orthodontic treatment determined by superimposition of the cephalograms at T1 and T2 at the region of anterior and posterior border of the symphysis and along the mandibular canal. The vertical lines were drawn from distal surface of the 1st molars in the T1 and T2 cephalometric films to the mandibular plan. The distance between these 2 lines was taken as the mesial movement of the 1st molars [*12*].

Apart from the treatment they received, the selected patients were similar in terms of the criteria judged to have an effect on 3rd molar eruption [*8,12,18–20*]. Thus there were no statistically significant differences in terms of age, treatment time, amount of pretreatment crowding, differences of Ar–Pog distances at T1 and T2, axial inclination of the 3rd molar at T1, Xi–M2 distances at T1 and the amount of mesial movement of the 1st molar at T2 between the 3 groups (Table 1).

The patients whose records were selected were contacted 8–9 years after the end of orthodontic treatment in 2004 to 2005 (time 3: T3) and were examined for the eruption of the lower 3rd molars. Only 112 were accessible for follow-up. Eruption was considered successful when the occlusal surface of the teeth was not covered by the bone, and the mesial surface of the 3rd molar between the occlusal surface and its maximum mesial convexity was more distal to the maximum distal convexity of the 2nd molar.

The data were analysed using chi-squared or 1-way ANOVA followed by Tukey test. A P-value of < 0.05 was considered statistically significant.

Results

In the extraction group (32 patients), 42% had successful eruption. In the non-extraction group with orthodontic treatment (32 patients), 12% had successful eruption. In the control group with orthodontic treatment in the upper jaws only (48 patients),

Table 1 **Characteristics and dental profile of the 3 groups of patients: extraction (extraction of 1st premolars in both jaws), non-extraction (orthodontic treatment in both jaws without extraction), and control (orthodontic treatment in upper jaws, no treatment in lower jaw)**

Variable	Extraction (*n* = 32)		Non-extraction (*n* = 32)		Control (*n* = 48)	
	Mean	SD	Mean	SD	Mean	SD
Age (years)	20.00	1.58	19.78	1.58	20.10	1.57
Treatment time (months)	26.88	7.90	23.84	7.86	22.50	4.50
Crowding (mm)	4.75	1.93	1.56	1.50	–	–
Change of Ar–Pog length (mm)	6.47	2.56	6.66	2.58	6.53	2.53
Axial incline (degrees)	55.25	19.26	56.25	19.11	55.78	19.31
Xi–M2 length (mm)	22.91	3.30	22.53	3.45	22.34	3.70
M1–M2 length (mm)	4.60	1.58	–	–	–	–

SD = standard deviation.
Axial incline = angle between the longitudinal axis of the 3rd molar and the line vertical to the 2nd molar axis in the 1st cephalogram.
Change of Ar-Pog length = difference of Ar-Pog distances at T1 and T2.
Ar-Pog= mandibular length, i.e. distance from articulare to pogonion.
Xi–M2 length = distance of the distal surface of the 2nd molar (M2) to the point Xi at the centre of the ramus.
M1–M2 length = amount of mesial movement of the 1st molar after orthodontic treatment.

20% had successful eruption. There was a significant difference in the rate of successful eruption between the 3 groups ($\chi^2 = 16.48$; $P < 0.001$). A significantly higher number of 3rd molars did erupt successfully in the extraction group.

There were 41 patients in the control group (35 cases bilaterally and 6 cases unilaterally) and 29 patients in the non-extraction group (27 cases bilaterally and 2 cases unilaterally) who needed surgical removal of the lower 3rd molar with chief complaints of pericoronitis, late mandibular crowding or caries. However, in the extraction group, only 19 patients (18 cases bilaterally and 1 case unilaterally) needed this surgical procedure. The number of cases of 3rd molar fracture during removal was 19 in the control group, 12 in the non-extraction group and 5 in the extraction group.

Discussion

The findings of this study suggested that extraction of the 1st left and right premolars in the lower jaw increased the chance of eruption of the lower 3rd molar. They also showed that non-extraction orthodontic treatment decreased the chance of eruption of the lower 3rd molar relative to the control group with only partial orthodontic treatment.

A significant proportion of patients who did not receive orthodontic treatment, either extraction or non-extraction, had unsuccessful eruption. This finding was in agreement with previous reports that lower 3rd molar impaction was a common problem in different populations [*21*]. The combined clinical and radiographic studies indicated that the

prevalence of impacted lower 3rd molars in a normal dentate young adult population was relatively high (72%) [*22*].

Similar to the control group, non-extraction orthodontic treatment resulted in a lower proportion of successful eruption of lower 3rd molars (12%). This might be due to the specific mechanics of treatment that were used for molar distalization or space regained during orthodontic treatment [*23,24*] such as class III mechanics, use of open coils or tip-back bends. This finding is supported by previous studies [*8,9,12*], although it was not in agreement with a number of others, including that of Williams, which reported an almost equal ratio (52% versus 48%) of proper eruption and impaction in the non-extraction group [*25*]. Moreover, Richardson reported no statistically significant difference between successful and unsuccessful eruption (44% versus 56%) in the non-extraction group [*26*]. The difference between the findings of our study and those of Williams and of Richardson might be due to the method of case selection. In their studies the patients were selected randomly without considering different factors affecting 3rd molar eruption [*25,26*], whereas in our study patients were selected based on the same skeletal relationship and growth pattern, 3rd molar angulation, Xi–M2 distance, pretreatment crowding and changes of Ar–Pog length during treatment.

Orthodontic treatment with extraction increased the chance of successful eruption, as indicated by no difference in the rate of successful (40%) and unsuccessful (60%) eruptions, which was noticed in control and non-extraction groups. Moreover, it increased the proportion of successful eruption to a level that was significantly higher than in the non-extraction group. This finding was in agreement with most of the previous studies [*16,22*], but against other reports [*26*]. Such a difference might be due to the differences in the method of case selection. The favourable effect of extraction on successful eruption of the 3rd molar might be due to the mesial movement of the mandibular 1st molars. It seems that mesial movement increases eruption space for the 3rd molars, thereby decreasing the discrepancy between tooth size and arch size and also improves proper axial inclination of the 3rd molar, which leads to proper eruption.

By increasing the chance of 3rd molar eruption in such a way, the risk of complications related to 3rd molar impaction are decreased in the extraction group; these include caries, root resorption, localized periodontal problem, pericoronitis, infection, cysts and neoplastic lesions. An analysis of post-orthodontic follow-up for all patients, as indicated by less 3rd molar impaction, showed that patients in the extraction group required fewer surgical procedures.

The findings of the present study should be interpreted in the light of the fact that only patients accessible 8–9 years after treatment were used in data analysis. Whether or not a greater sample size would lead to a different conclusion is uncertain.

Conclusion

The findings of this study indicate that the extraction of the 1st premolar is associated with a lower incidence of 3rd molar impaction and that this type of orthodontic treatment would lead to a lower incidence of health complications with resulting economic benefits.

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References

1. Elsey MJ, Rock WP. Influence of orthodontic treatment on development of third molars. ***British journal of oral and maxillofacial surgery***, 2000, 38(4):350–3.
2. Krausz AA, Machtei EE, Peled M. Effects of lower third molar extraction on attachment level and alveolar bone height of the adjacent second molar. ***International journal of oral maxillofacial surgery***, 2005, 34(7):756–60.
3. Baykul T et al. Incidence of cystic changes in radiographically normal impacted lower third molar follicles. ***Oral surgery, oral medicine, oral pathology, oral radiology, and endodontics***, 2005, 99(5):542–5.
4. Al-Balkhi KM. The effect of different lower third molar conditions on the recrowding of the lower anterior teeth in the absence of tight interproximal contacts one year post orthodontic treatment: a pilot study. ***Journal of contemporary dental practice***, 2004, 5(3):66–73.
5. Libersa P et al. Immediate and late mandibular fractures after third molar removal. ***Journal of oral and maxillofacial surgery***, 2002, 60(2):163–5.
6. Chossegros C et al. Is lingual nerve protection necessary for lower third molar germectomy? A prospective study of 300 procedures. ***International journal of oral and maxillofacial surgery***, 2002, 31(6):620–4.
7. Queral-Godoy E et al. Incidence and evolution of inferior alveolar nerve lesions following lower third molar extraction. ***Oral surgery, oral medicine, oral pathology, oral radiology, and endodontics***, 2005, 99(3):259–64.
8. Richardson ME, Dent ME. Some aspects of lower third molar eruption. ***Angle orthodontist***, 1974, 44(2):141–5.
9. Kim TW et al. Prevalence of third molar impaction in orthodontic patients treated nonextraction and with extraction of 4 premolars. ***American journal of orthodontics and dentofacial orthopedics***, 2003, 123(2):138–45.
10. Saysel MY et al. The effects of first premolar extractions on third molar angulation. ***Angle orthodontist***, 2005, 75(5):719–22.
11. Sable DL, Woods MG. Growth and treatment changes distal to the mandibular first molar: a lateral cephalometric study. ***Angle orthodontist***, 2004, 74(3):367–74.
12. Dierkes DD. An investigation of the mandibular third molars in orthodontic cases. ***Angle orthodontist***, 1975, 45(3):207–12.
13. Forsberg CM. Tooth size, spacing and crowding in relation to eruption of third molar. ***American journal of orthodontics and dentofacial orthopedics***, 1988, 94(1):57–62.
14. Richardson ME. Lower third molar space. ***Angle orthodontist***, 1987, 57(2):155–61.
15. Svendsen H, Bjork A. Third molar impaction: a consequence of late M3 mineralization and early physical maturity. ***European journal of orthodontics***, 1988, 10(1):1–12.
16. Stephens RG, Kogon SL, Reid JA. The unerupted or impacted third molar: a critical appraisal of its pathologic potential. ***Journal of the Canadian Dental Association***, 1989, 55(3):201–7.
17. Ramezanian M. An assessment on the effects of mandibular impacted third molar

surgery on the periodontium of the adjacent molar. ***Journal of dentistry, Tehran University of Medical Sciences***, 2003, 16(2):76–81.

18. Forsberg CM, Vingren B, Wesslen U. Mandibular third molar eruption in relation to available space as assessed on lateral cephalograms. ***Swedish dental journal***, 1989, 13(1–2):23–31.

19. Richardson ME. The etiology and prediction of mandibular third molar impaction. ***Angle orthodontist***, 1977, 47(3):165–72.

20. Haavikko K, Altonen M, Mattila K. Predicting angulation development and eruption of the lower third molar. ***Angle orthodontist***, 1978, 48(1):39–48.

21. Kruger E, Thomson WM, Konthasinghe P. Third molar outcomes from age 18 to 26: findings from a population-based New Zealand longitudinal study. ***Oral surgery, oral medicine, oral pathology, oral radiology, and endodontics***, 2001, 92(2):150–5.

22. Bataineh AB, Albashaireh ZS, Hazza'a AM. The surgical removal of mandibular third molars: a study in decision making. ***Quintessence international***, 2002, 33(8):613–7.

23. Woods MG. Mandibular arch dimensional and positional changes in late mixed-dentition class I and II treatment. ***American journal of orthodontics and dentofacial orthopedics***, 2002, 122(2):180–8.

24. Brennan MM, Gianelly AA. The use of lingual arch in the mixed dentition to resolve incisor crowding. ***American journal of orthodontics and dentofacial orthopedics***, 2000, 117(1):81–5.

25. Silling G. Development and eruption of the mandibular third molar and its response to orthodontic therapy. ***Angle orthodontist***, 1973, 43(3):271–8.

26. Richardson ME. The development of third molar impaction. ***British journal of orthodontics***, 1975, 2(4):231–4.