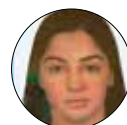


Early extraction of the first permanent molars: a five-year follow-up study



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Abstract

Aim Early extraction of first permanent molars (FPMs) is generally considered successful when the second permanent molar and premolar come into contact, regardless of whether the patient has a healthy occlusion. In this study, we aimed to investigate cases in which early extraction had a successful prognosis.

Methods Study design: Pre-extraction orthopantomograms of children whose one or more FPMs were extracted were examined retrospectively. Post-extraction parameters such as status of the extraction gap, any other diastema formation, and midline shift were evaluated clinically and radiographically. For the dental age estimations, development levels of the teeth were scored using the Demirjian method and the developmental status of a particular tooth was calculated in years based on tables given by Willems et al. [2001]. The ICON index was used to determine the orthodontic treatment needs of patients. Statistics: Descriptive analyses and the Kruskal-Wallis test were used for the statistical analysis of the data.

Results Twenty-six patients with 40 extracted FPM were followed-up for an average of 61.12 months. The mean chronological and dental ages of the patients at the time of extraction were 9.98 ± 1.35 and 10.65 ± 1.39 years, respectively. Closure of the extraction gap occurred in 83.3% and 78.5% of the cases in the maxilla and mandible, respectively. However, when the cases with the formation of a diastema between the other teeth and/or midline shift were assumed to have failed, success rates decreased to 50% in the maxilla and 17.8% in the mandible.

Conclusions Early extraction of FPM should be considered successful when there is no formation of any other diastema in the relevant quadrant, midline shift, or orthodontic treatment needs due to extraction.

KEYWORDS Early extraction; First permanent molar; Dental development; Dental age; Malocclusion.

Introduction

For young first permanent molars (FPMs) with excessive crown destruction, severe periapical infection, or hypomineralisation, whether endodontic treatment or extraction should be performed is always a challenging decision for dentists. According to some studies, early extraction of FPM involves on the one hand the loss of an important tooth, which has a major role in chewing function and dentofacial harmony in the early period of life, it is important not losing the chance of a spontaneously healthy occlusion by the extraction of a tooth with a bad prognosis at the appropriate time [Ong and Bleakley, 2010; Penchas et al., 1994].

In cases of molar incisor hypomineralisation (MIH), which is a common developmental dental disease in the paediatric population, owing to adhesion challenges in altered enamel structure and excessive material loss in the crown, restorative treatments may be repeated. Moreover, challenges in the cooperation of a child who had painful experiences owing to the difficulty in anesthesia of the teeth with MIH, may force clinicians to decide on early extraction of the FPM [Jälevik and Klingberg, 2002; Kotsanos et al., 2005; Williams et al., 2006].

In the studies and meta-analyses published on this subject, it was emphasised that the possibility of obtaining a healthy occlusion following early extraction of FPM is high, when factors such as the patient's age, the arch where the tooth is to be extracted, developmental stage of the second permanent molar (SPM), presence of the germ of third permanent molar (TPM), crowding, angulation of SPM, and second premolar tooth were present, and that ideal conditions were met [Hallett and Burke, 1961; Dahan, 1970; Jälevik and Moller, 2007; Teo et al., 2013; Patel et al., 2017; Alkhadra, 2017]. In almost all studies where long-term clinical and radiographic observation following early FPM extraction were reported, the cases where the second premolar and SPM came into contact were considered successful [Jälevik and Moller, 2007; Teo et al., 2013; Rahhal, 2014; Teo et al., 2015]. However, the question arises as to whether some factors such as the displacement of the diastema generated from the extraction of the FPM among the other teeth or shift of the midline of the jaw to the extraction side may have a positive effect on the closure of the extraction gap and cause the success rates of the treatment to be overreported.

In this clinical and radiographical study, we aimed to investigate early FPM extraction cases possibly resulting in a successful prognosis, the possibility of spontaneous closure of the extraction space, and the factors affecting this possibility. The initial hypothesis of the study is that in cases of early extraction of FPM, coming into contact with the SPM and second premolar would not be sufficient for correct positioning of the teeth in the dental arch, obtaining a proper occlusion, and considering it as a successful treatment.

Methods

The study was approved by the Faculty of Medicine Clinical Research Ethics Committee (date: 07.01.2020 number: 60116787-020/1717). The study included healthy paediatric patients whose dental examinations and treatments were performed at the Pamukkale University, Faculty of Dentistry, Department of Paediatric Dentistry, and whose one or more

permanent first molar teeth were extracted for various reasons between January 2016 and December 2017. Panoramic films that were recorded for early FPM extraction decisions of the patients were examined retrospectively, and the current status of the dental arches after the loss of the FPM was evaluated by clinical and radiographic examinations of the patients who agreed to come for control examination in the time interval of the study. The data of extracted FPM, the timing of tooth extraction, the chronological age of the patient at the time of extraction, the follow-up period, and tooth brushing habits were obtained from patient records. The variables examined in the pre-extraction panoramic films were: dental age of the patient, radiographical pathologies of the permanent first molar tooth, past treatments of first permanent molar, developmental stage of permanent second molar tooth according to the Demirjian method [Demirjian et al., 1973] and presence of permanent third molar tooth germ. The variables examined in the postextraction last control examination and panoramic films were: presence of diastema between permanent second molar and second premolar teeth, comparison of the developmental stage of permanent third molars on the extraction side with the contralateral side, comparison of the presence of approximal/occlusal caries in permanent premolar or molar teeth on the extraction side with the contralateral side, presence of diastema between the other teeth on the extraction side, midline shift and need for orthodontic treatment of the patient.

For the estimation of the patient's dental age, development levels of the teeth were scored using the method specified by Demirjian et al. [1973]. After noting the stages of all teeth from the central incisor to the second molar by the same examiner, the developmental status of a particular tooth was calculated in years based on tables given by Willems et al. [2001]. The ICON index (Index of Complexity, Outcome, and Need) was used to determine the orthodontic treatment needs of patients [Daniels and Richmond, 2000].

Statistical analyses

Statistical analyses were performed using IBM SPSS software (SPSS v 23.0; SPSS Inc., Chicago, IL, USA). Descriptive analyses were used in the statistical analysis of the data, and the Shapiro-Wilk omnibus normality test and Kruskal-Wallis test were used to analyse the differences at a significance level of $p < 0.05$.

Results

Records of 53 patients who underwent early extraction of FPM were examined, and 26 patients (15 girls, 57%, and 11 boys, 43%) who could attend the control examination were included in the study. The total number of extracted FPM was 40, and the mean follow-up period was 61.12 months (max. 73, min. 48 months). The dental age of the majority of the patients (80.8%) was higher than their chronological age, and the mean chronological and dental age of the patients at the time of extraction were 9.98 ± 1.35 and 10.65 ± 1.39 years, respectively.

The mean decayed, missing, filled teeth value of the patients was 6.92 ± 2.62 , and 7.7% of them never, and 34.6% rarely brushed their teeth. The distribution of extracted teeth 16, 26, 36, and 46 was 12.5%, 17.5%, 30%, and 40%, respectively. The extraction of FPM was primarily owing to excessive crown destruction (80%), and the others were due to severe periapical and/or furcal infections. It was observed that 36 (90%) of the extracted FPM did not receive any treatment, two (5%)

were filled, and two (5%) had root canal therapy before the extraction.

The SPM and second premolar tooth adjacent to the extraction space came into contact at a rate of 83.3% (10 teeth) in the maxilla and 78.5% (22 teeth) in the mandible, and 80% (32 teeth) of all cases. However, it was observed that in

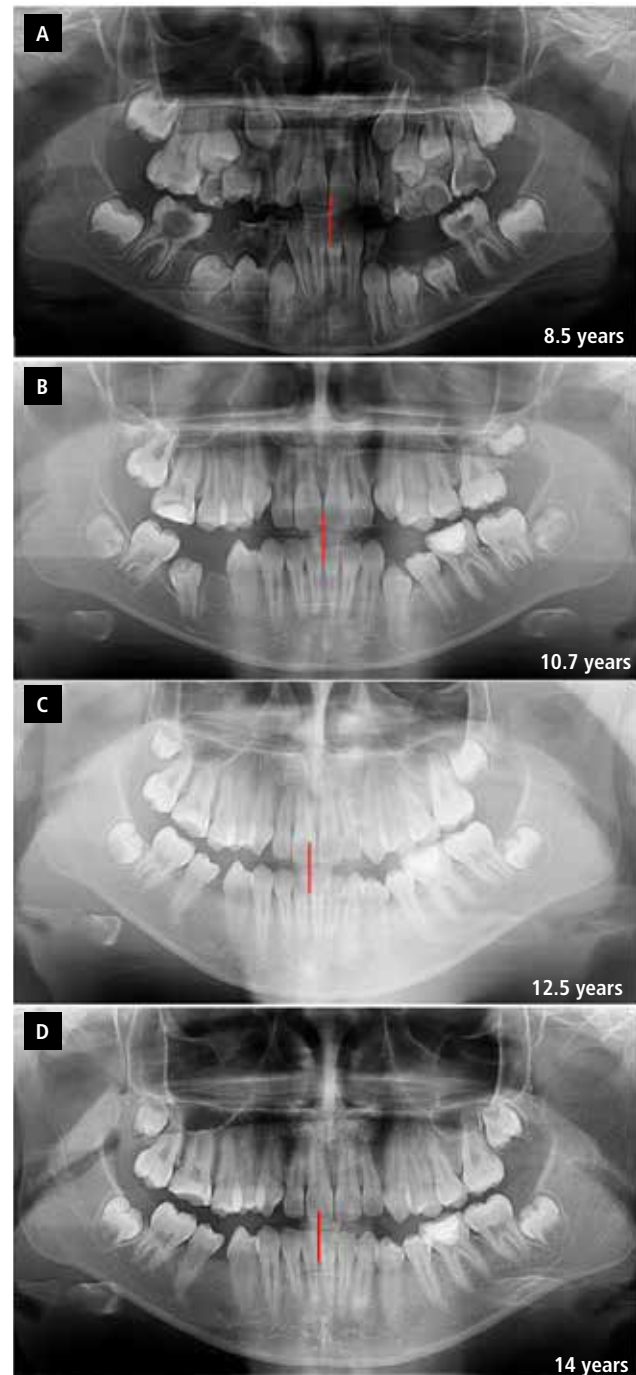


FIG. 1 Panoramic radiographs of patient 2. a) Preextraction panoramic radiograph: teeth 26 and 46 were planned to be extracted. b) Control panoramic radiograph 2 years after extractions: successful closure of the extraction gap in the left side of the maxilla. c) Control panoramic radiograph 4 years after extractions. d) At the end of 5.5 years, the lower right second permanent molar and the second premolar came into contact, but diastema formed between the other teeth in the relevant quadrant, and the midline shifted to the extraction side.

Patient number	Extracted FPM 16 26 36 46	Preextraction				Postextraction (At the last examination)			
		Chrono-logical age	Dental age	Develop-ment level of SPM* ⁹	TPM*	Diastema between SPM and premolar*	Diastema between the other teeth*	Midline shift	Need for orthodontic treatment
1	•	10.66	10.87	G	Yes	Yes	Yes	Yes ⁸	Yes
2	•	8.58 8.58	9.50 9.50	E D	No Yes	No No	No Yes	Yes ⁸	Yes
3	•	9.58 8.58	12.27 11.41	G F	Yes Yes	Yes No	No Yes	Yes ⁸	No
4	•	11.00	12.27	G	Yes	No	No	No	Yes
5	•	9.83	10.24	E	Yes	No	Yes	Yes ⁶	No
6	•	10.41	12.27	G	Yes	Yes	No	No	Yes
7	•	7.00 7.75 7.75 7.00	8.74 9.50 9.50 8.74	D E F D	Yes Yes Yes Yes	No No No No	No No Yes Yes	No	Yes
8	•	10.25 9.66	10.93 10.24	F F	Yes Yes	No No	No No	No	No
9	•	9.33	8.74	D	Yes	No	Yes	No	Yes
10	•	8.58	9.80	E	Yes	No	Yes	Yes ⁶	Yes
11	•	8.41	7.51	D	No	No	No	No	Yes
12	•	10.16 9.75	10.24 10.24	E E	Yes Yes	No No	No Yes	Yes ⁸	No
13	•	7.66	8.18	D	No	No	No	No	No
14	•	11.00 11.00 11.00	11.99 11.99 11.99	F G G	Yes Yes Yes	No No No	No No No	Yes ⁸	No
15	•	13.75 13.75	13.19 13.19	G H	Yes Yes	No Yes	No No	No	No
16	•	10.50	11.41	G	Yes	No	Yes	Yes ⁸	Yes
17	•	10.50 10.50	10.95 10.95	F F	Yes Yes	No Yes	Yes Yes	Yes ⁸	No
18	•	8.91	10.03	F	No	Yes	Yes	Yes ⁶	Yes
19	•	11.50	11.76	G	Yes	No	No	No	No
20	•	9.25 9.25 9.25	9.11 9.11 9.11	D E E	No No Yes	Yes No Yes	Yes Yes Yes	No	Yes
21	•	10.75	11.99	G	Yes	No	No	Yes ⁸	No
22	•	10.00	10.03	F	Yes	No	No	Yes ⁸	Yes
23	•	9.58 9.58	10.12 10.12	E E	Yes Yes	No No	No No	No	Yes
24	•	10.75	11.55	F	Yes	No	No	Yes ⁸	Yes
25	•	11.25	10.93	F	Yes	No	Yes	No	Yes
26	•	10.41	11.55	F	Yes	No	No	Yes ⁸	No

FPM:First permanent molar. SPM:Second permanent molar. TPM:Third permanent molar.

*At the extraction side. ⁸Midline shift to the extraction side. ⁶Midline shift to the side without FPM extraction.

⁹Development level of SPM was lettered according to Demirjian Method. 14

TABLE 1 Data of the patients included in the study.

42.5% of these cases (17 teeth), there was diastema between the other teeth in the relevant quadrant, and in 53.8% (78.6% to the extraction side and 21.4% to the other side) of the cases, there was a midline shift. When cases with a diastema between the other teeth and/or with midline shift were assumed to have failed, successful closure rates decreased to 50% in the maxilla and 17.8% in the mandible. In patient no. 2, the SPM and second premolar coming into contact and the formation of a diastema between the other teeth in the relevant quadrant and midline shift to the extraction side are shown in Figure 1. It was determined that 57.6% of the examined patients (15 patients) needed orthodontic treatment, and in 66.6% of them (10 patients) this was owing to reasons related to early FPM extraction, such as the formation of diastema and midline shift. The data of the patients in this study are summarised in Table 1.

The changes in the success rates of early extraction of

FPM according to the jaw in which the extracted FPM is, the development level of the SPM and the appearance of the germ of TPM on the radiography at the time of extraction, the presence of diastema between the other teeth in the relevant quadrant, and the presence of midline shift are presented in Table 2.

In three children examined in the study, it was observed that the development of the TPM on the extraction side was accelerated compared with the development of the TPM on the contralateral side, while in one child it was decelerated; however, these differences were not statistically significant ($p>0.05$). Additionally, when the development of new proximal and/or occlusal caries on the adjacent posterior teeth was compared between the extraction and non-extraction sides, new caries development was found in three children on the extraction side and in one child on the non-extraction side. However, these

Development level of SPM ^{••} (n) Success rate	Jaw in which extracted FPM is (n)	Success rate	Presence of TPM germ at extraction [•] (n)	Success rate	Diastema between other teeth [•] (n)	Success rate [•]	Midline shift (n)	Success rate [•]
D (7) 85.7%	Maxilla (3)	66.6%	Yes (1)	100%	Yes (0)	100%	Yes (0)	100%
			No (2)	50%	Yes (1)	50%	Yes (0)	50%
	Mandible (4)	100%	Yes (3)	100%	Yes (3)	0%	Yes (1)	
			No (1)	100%	Yes (0)	100%	Yes (0)	100%
E (10) 90%	Maxilla (4)	100%	Yes (2)	Yes (2)	Yes (0)	100%	Yes (1)	50%
			No (2)	Yes (0)	Yes (1)	50%	Yes (1)	
	Mandible (6)	83,3%	Yes (6)	83.3%	Yes (4)	33.3%	Yes (3)	33.3%
			No (0)	-	-	-	-	-
F (12) 83,3%	Maxilla (2)	100%	Yes (2)	100%	Yes (0)	100%	Yes (1)	50%
			No (2)	-	-	-	-	-
	Mandible (10)	80%	Yes (9)	88.8%	Yes (5)	44.4%	Yes (7)	11.1%
			No (0)	0%	Yes (1)	0%	Yes (1)	100%
G (10) 70%	Maxilla (2)	100%	Yes (2)	0				
			No (0)	-	-	-	-	-
	Mandible (8)	62,5%	Yes (8)	62,5%	Yes (2)	50%	Yes (6)	12,5%
			No (0)	-	-	-	-	-
H (1) 0%	Maxilla (1)	0%	Yes (1)	0%	Yes (0)	0%	Yes (0)	0%
			No (0)	-	-	-	-	-
	Mandible	-	Yes	-	-	-	-	-
			No	-	-	-	-	-

*Coming into contact of the SPM and second premolar tooth has been described as "success".

•At the extraction side.

•Development level of SPM was lettered according to Demirjian Method. 14

n: number of teeth.

• Shows the rate of success achieved when cases with diastema between other teeth in the related quadrant are considered unsuccessful.

• Shows the rate of success achieved when the cases with diastema between other teeth in the related quadrant and in addition the cases with midline shift are considered unsuccessful.

TABLE 2 The changes in success* rates of the early FPM extraction treatment due to various factors.

differences were not statistically significant ($p>0.05$).

In patient 13, the extracted FPM was in the mandibular arch, the development level of the adjacent SPM was at D according to the Demirjian method [Demirjian et al., 1973], and the germ of TPM was not observed in the pre-extraction orthopantomogram. However, the germ of the mandibular left TPM appeared late in the subsequent control orthopantomogram, and spontaneous closure of the extraction space was achieved without any other diastema or midline shift.

Discussion

Early extraction of FPM is a critical treatment decision that involves opinions of paedodontists, orthodontists, and even parents, as well as examination of the reasons, timing, and possible consequences. In making this decision, the severity of crown destruction and/or dentoalveolar infection, age of the child and the developing dentition, child's compliance with long-term dental procedures under local anesthesia, and parents' attitude must be evaluated.

The literature agrees with the positive prognosis of early FPM extraction in the maxilla [Dahan, 1970; Jalevik and Moller, 2007; Rahhal, 2014; Normando and Cavacami, 2010]. The development level of the adjacent SPM is at the early bifurcation (E) according to the Demirjian method [Demirjian et al., 1973] and the presence of the TPM germ in the related quadrant is also considered to be an important factor in the spontaneous closure of the extraction space [Teo et al., 2013, 2015; Eichenberger et al., 2015]. According to the findings of this clinical and radiographical study, if the FPM to be extracted is in the maxillary arch, the germ of TPM is present on radiography and the development of adjacent SPM is at the

level of E according to the Demirjian method [Demirjian et al., 1973], spontaneous closure of the extraction space occurs at a rate of 50% without any diastema between other teeth in the relevant quadrant and without a midline shift. If the FPM to be extracted is in the mandibular arch, the germ of TPM is present on radiography and the development of adjacent SPM is at the level of E according to the Demirjian method [Demirjian et al., 1973], this ratio decreases to 33.3%.

In our study, it was observed that false-positive success rates could be reported when complications such as diastema between the other teeth on the extraction side and midline shift were not considered as failures. We assume that possibly owing to this, the success rates of early FPM extraction in the literature vary from 33.3% to 94% in the maxilla and from 50% to 75% in the mandible [Jalevik and Moller, 2007; Teo et al., 2013; Răducanu et al., 2009; Saber et al., 2018].

In patient 13, although the FPM was in the mandibular arch, development of the adjacent SPM was not sufficient for the ideal timing and there was no crypt of TPM in the pre-extraction orthopantomogram, spontaneous closure of the extraction space was achieved. However, in this patient, it was noticed in subsequent control radiographs that the TPM germ started to develop with a little delay and may have a role in spontaneous closure of the extraction space. Thus, when deciding on early FPM extraction in children who are younger than the ideal age range or whose dental age is significantly lower than the chronological age, clinicians should conclude regarding the absence of TPM germ in the relevant quadrant only after postextraction radiographic examinations are repeated at regular intervals and the formation of TPM is followed.

Some researchers have reported that extraction of early FPM may accelerate the development of TPM in the relevant quadrant and provide eruption at a better position [Ay et

al., 2006; Yavuz et al., 2006]. In another study, researchers compared the incidence of caries at the extraction and non-extraction sides of the jaws and reported significantly fewer proximal caries but more occlusal caries in the adjacent premolar and molar teeth on the extraction side [Oliver et al., 1988]. However, in the present study, no significant difference was found between the extraction and non-extraction sides of the jaws in terms of the development level of the TPM and the formation of proximal and/or occlusal caries in the adjacent premolar and second molar teeth.

It is generally observed that clinicians are not attempting restorative or endodontic treatment methods before the extraction of FPM teeth, which are assumed to have a poor prognosis, possibly to avoid wasting time [Jalevik and Moller, 2007; Teo et al., 2013; Rahhal, 2014]. Similarly, in the present study, 90% of the cases did not receive any restorative or endodontic treatment before extraction.

Early extraction of the FPM is generally performed due to pathologies such as excessive crown destruction owing to progressive dental caries, persistent periapical infections, and molar-incisor hypomineralization. However, researchers have mentioned some conditions that require early extraction for FPM that do not have such pathologies. When a lower FPM is extracted for pathological reasons, researchers recommend compensating for the extraction of the FPM on the same side of the upper jaw, even if it is healthy. They also emphasised that in cases of crowding in the mandible, the contralateral lower FPM should also be extracted for balancing [Williams and Gowans, 2003].

All of the cases included in the present study were patients who had early FPM extraction due to a pathological reason; therefore, none of the extractions examined were compensating or balancing. In a study by Jalevik and Möller [2007], in which the uncompensated and unbalanced extractions were examined similarly to the present study, good spontaneous occlusal development was reported as a result of postextraction follow-up, and researchers have reported that compensating and/or balancing extractions are not always necessary in cases of early FPM extraction [Jalevik and Möller, 2007]. Although we agree with this result, it is thought that the cases with midline shifts in our study may have arisen due to the lack of balancing extractions.

In this study, it was determined that 66.6% of the children who needed orthodontic treatment were in need due to reasons related to early FPM extraction such as diastema and midline shift. Therefore, it is clear that early extraction of FPM has important orthodontic consequences, and the decision process for early extraction cannot be independent of orthodontic examination. Orthodontists stated that early extraction does not cause major problems in the maxilla, but for mandibular extractions, there should be factors together, such as crowding, no other missing teeth in the relevant quadrant, no sagittal deviation, and the patients should be in 8–10 years of age [Alkhadra, 2017]. In addition, they emphasised that in cases of distal occlusion, deep bite, and increased overjet, early FPM extraction in the mandible should be avoided [Alkhadra, 2017].

Conclusions

When making the critical decision of early extraction of the FPM, which is one of the most difficult to give up teeth in the jaw when considering their major role in the chewing function and dentofacial harmony, a detailed examination

by a paedodontist and an orthodontist must be provided and an evaluation of the child's compliance with the treatment, as well as the expectation of the parent should be taken into consideration. According to our results, early extraction of FPM should be considered as a successful treatment alternative not only when the second premolar and the second molar come into contact, but also if there is no diastema between the other teeth, no midline shift, and when the patient does not require any orthodontic treatment due to early extraction of FPM. However, further clinical research, particularly prospective studies, is needed to obtain sufficient evidence on this subject.

Conflict of interest

All authors declare that they have no conflict of interest.

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Author contribution

C. Ç. Ertuğrul and H. Özbey conceived the ideas; C. Ç. Ertuğrul, H. Özbey and A. İ. Gün collected the data; C. Ç. Ertuğrul analysed the data; and C. Ç. Ertuğrul led the writing.

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