European Journal of Orthodontics 34 (2012) 208–212
doi:10.1093/ejo/cjq189
Advance Access Publication 12 January 2011

An evaluation of factors associated with persistent primary teeth

Ali Murat Aktan*, İsa Kara**, İsmail Şener***, Cihan Bereket***, Salih Çelik****, Mustafa Kırtay*****, Mehmet Ertuğrul Çiftçi* and Nursel Arıcı******

*Departments of Oral Diagnosis and Radiology and, **Oral and Maxillofacial Surgery, Faculty of Dentistry, Gaziantep University, Gaziantep, Turkey, ***Department of Oral and Maxillofacial Surgery, Faculty of Dentistry, Ondokuz Mayis University, Samsun, Turkey, ****Department of Oral and Maxillofacial Surgery, Faculty of Dentistry, Mustafa Kemal University, Hatay, Turkey, *****Department of Oral and Maxillofacial Surgery, Faculty of Dentistry, Cumhuriyet University, Sivas, Turkey and ******Department of Orthodontics, Faculty of Dentistry, Ondokuz Mayis University, Samsun, Turkey

Correspondence to: Dr Ali Murat Aktan, Department of Oral Diagnosis and Radiology, Faculty of Dentistry, Gaziantep University, Gaziantep, Turkey. E-mail: alimuratktan@yahoo.com

SUMMARY The aim of the present study was to investigate the reasons for the persistence of primary teeth and also use panoramic radiography to determine the characteristics of persistence teeth.

Four-hundred and twenty-six panoramic radiographies, which diagnosed one or more retained primary teeth, were selected from 100,577 panoramic radiographic image files from nine clinics and six different cities in Turkey. The selected radiographies were evaluated to determine the reasons for the persistence of primary teeth; furthermore, this study analyzed the characteristics of the retained primary teeth including tooth type, number, location, and root resorption, and whether, or not, the primary teeth showed evidence of pathological conditions, such as periodontal problems, caries, ankylosis, infra-occlusions, or tipping of the adjacent permanent teeth.

Six hundred and seventy-seven retained primary teeth were determined in 426 patients (148 males and 278 females). Retained primary teeth were found most frequently in the mandible rather than the maxilla and the left side was more frequently affected than the right side. Level 1 was found as a most frequently encountered root resorption level.

Within the limitation of the present study, the most common type of persistent primary teeth seen on the dental arch were mandibular primary second molars, followed by maxillary primary canines. The most frequent reason for the persistence was the congenital absence of successors to the primary teeth, followed by impaction of the successor teeth.

Introduction

A primary tooth is retained beyond the time of normal exfoliation in some cases. This results in an extended life for that tooth and the condition is known as 'persistence'. A retained deciduous tooth, with good crown, roots, and supporting alveolar bone, can offer an adult patient many years of service. Thus, most of the deciduous teeth studied can continue to function (Sletten *et al.*, 2003). However, persistence teeth can lead to some clinical problems including periodontitis, profound caries, and ankylosis.

Only a limited number of publications on the persistence of deciduous teeth were found in the literature (Bjerklin and Bennett, 2000; Ith-Hansen and Kjaer, 2000; Haselden *et al.*, 2001; Sletten *et al.*, 2003; Bjerklin *et al.*, 2008; Kjaer *et al.*, 2008; Robinson and Chan, 2009). In cross-sectional studies, the most commonly persisting type of tooth was the mandibular second primary molar, followed by the maxillary deciduous canine. The longest lifespan was found for mandibular primary canines, followed by maxillary canines. Previous studies also determined that the degree of the root resorption of the primary teeth was unaltered in 20 (77 per cent) of the study participants, 15 years later. However, these radiographic-based studies, and other literature (Brook, 1974), provide little or no information about the reasons for the persistence of primary teeth. The common knowledge regarding the persistence of primary teeth is that primary teeth may be retained for variety of reasons, the most common being developmental absence of the permanent successor (Robinson and Chan, 2009). Other information about that subject suggests that impaction or intra-bony migration of the successor tooth also plays a role (Joshi, 2001; Shapira and Kuftinec, 2003; Aktan *et al.*, 2008). However, these studies do not clearly explain the conditions by which the primary teeth become persistent. Therefore, the aim of this panoramic radiographic-based study was to investigate the reasons for the persistence of primary teeth and also to determine the characteristics of those persistence teeth.

Materials and methods

The comprised panoramic radiographic-based materials used in this study present the case of 426 patients, 148 males and 278 females, collected from 100,577 panoramic radiographic image files obtained from nine clinics in six

different cities in Turkey. Each panoramic image had at least one retained primary tooth. The retained primary teeth ratio in males was 1–12, while the retained primary teeth ratio in females was 1–5. At the time the radiographs were taken, the age range of participants was 14–56 years for the males and 14–55 years for the females. A primary tooth was considered persistent if the last eruption time of the permanent successor tooth had been expired for more than 1 year and if the primary teeth did not exfoliated yet.

In radiographic examination, the reasons for the persistence of primary teeth were analyzed as were the characteristics of the retained primary teeth including tooth type, number, location, and root resorption level. The study also determined if the teeth showed evidence of having pathological conditions, such as periodontal problems, caries, ankylosis, infra-occlusion, and tipping of the adjacent permanent teeth.

The overall radiographic examinations, related to the assessment of retained primary teeth for the subjects, were performed by one oral radiologist with over five years of experience. Each subtopic was converted into an ordinal scale for statistical purposes. The following values were employed:

The reasons for persistence

1. Congenitally absence of successor teeth in individuals with persistent primary teeth
2. Impaction of successor teeth
3. Translation or transmigration of successor teeth
4. Existence of pathology, such as cysts, tumours, and odontoma under the primary tooth that results in the impaction of successor teeth
5. Microdontia of permanent dentition, partially or totally

Scoring of root resorption

1. Intact tooth–no root resorption
2. One-quarter of the root resorbed
3. Half of root resorbed
4. Three-quarters of the root resorbed
5. Root fully resorbed, but the tooth is still persistent

Ankylosis

1. Not ankylosed
2. Ankylosed

Tipping of the adjacent teeth

1. No tipping
2. Tipping

Caries

1. No caries
2. Caries

Periodontal problems

1. No periodontal problems
2. Periodontitis

Treatment options

1. Extraction
2. Filling
3. Root treatment
4. Periodontal treatment
5. Prosthetic restoration

Infra-occlusion

1. No infra-occlusion interval
2. Infra-occluded

Descriptive statistics were determined, including the patient's age and gender, the location, type, and resorption level of the retained primary tooth. Frequencies and percentages were given as descriptive statistics, using the SPSS program (Ver.9.1). The level of significance was set at 5 per cent.

Results

In this study, 677 retained primary teeth were determined in 426 patients (148 males and 278 females). Retained primary teeth were found most frequently in the mandible (415 teeth) than in the maxilla (262 teeth) and females (437 teeth) were more frequently affected than males (240 teeth). The most common persistent primary teeth on the dental arch were mandibular primary second molars (60.8 per cent) followed by maxillary primary canines (17.8 per cent; Table 1). As shown in Table 2, the left side (346) was more frequently affected than the right side (332). In the present panoramic radiographic-based study, congenital absence of successor teeth was the most frequently encountered reason as to why primary teeth were persistent. The second most

Table 1 Distribution of retained primary teeth by gender, location, and tooth.

	Molar I, *n* = 5 (0.73%)		Molar II, *n*= 468 (69.13%)		Canine, *n*= 165 (24.37%)		Lateral, *n* = 27 (3.99%)		Central, *n* = 12 (1.77%)		Total (%)
	M (%)	F (%)	M (%)	F (%)	M (%)	F (%)	M (%)	F (%)	M (%)	F (%)	
Maxilla	3 (0.44)	1 (0.15)	22 (3.25)	51 (7.53)	55 (8.12)	103 (15.21)	15(2.22)	12 (1.77)	0	0	262 (38.70)
Mandible	0	1 (0.15)	136 (20.09)	259 (38.26)	1 (0.15)	6 (0.89)	0	0	8 (1.18)	4 (0.59)	415 (61.30)
Total	3 (0.44)	2 (0.30)	158 (23.34)	310 (45.79)	56 (8.27)	109 (16.10)	15 (2.22)	12 (1.77)	8 (1.18)	4 (0.59)	677 (100)

Table 2 Distribution of the reasons for being persistence of primary teeth.

The reasons for persistence of primary teeth	Female (%)	Male (%)	Right (%)	Left (%)	Total (%)
Missing teeth	349 (51.55)	206 (30.43)	279 (41.21)	276 (40.77)	555 (81.98)
Crowding	1 (0.15)	0	0	1 (0.15)	1 (0.15)
Delay of eruption	3 (0.44)	0	1 (0.15)	2 (0.29)	3 (0.44)
Impacted	82 (12.11)	32 (4.73)	50 (7.39)	64 (9.45)	114 (16.84)
Supernumerary	0	0	0	0	0
Abnormal position	1 (0.15)	1 (0.15)	1 (0.15)	1 (0.15)	2 (0.30)
Cyst	1 (0.15)	1 (0.15)	1 (0.15)	1 (0.15)	2 (0.30)
Total	437 (64.55)	240 (35.45)	332 (49.04)	345 (51.11)	677 (100)

Table 3 Situation of the retained primary teeth (anklyosing, infra-occlusion, periodontal problem, caries, etc.).

	Ankylosis (%)	Tilting (%)	Restoration (%)	Periodontal problem (%)	Infra-occlusion (%)	Morphologic diversity (%)	Caries (%)
Yes	68 (10.04)	169 (24.96)	41 (6.06)	169 (24.96)	557 (82.27)	13 (1.92)	257 (37.96)
No	609 (89.96)	508 (75.04)	636 (93.94)	508 (75.04)	120 (17.73)	664 (98.08)	420 (62.04)
Total	677	677	677	677	677	677	677

frequently encountered reason was the impaction of successor teeth.

The most commonly seen pathological problems related to retained primary teeth were caries (37.96 per cent), followed by periodontal problems (24.96 per cent; Table 3). The most frequently proposed treatment option was extraction (70.46 per cent; Table 4).

Table 5 shows the levels of root resorption in the 677 teeth. The resorption level 1 was found in 25.4 per cent of patients, the resorption level 3 was found in 19.2 per cent of patients, the resorption level 4 was found in 20.09 per cent of patients, the resorption level 2 was found in 14.62 per cent of patients, and the resorption level 0 was found in 10.64 per cent of patients. The relationship between the resorption levels of retained primary teeth and the reasons for the persistence of primary teeth is shown in Table 6. There were no statistically significant differences between gender or age and root resorption levels and tooth type, with regard to the persistence of retained primary teeth ($P > 0.05$).

Table 4 Treatment choices.

Treatment choices	*n*(%)
Crown	3 (0.44)
Extraction	477 (70.46)
Restoration	54 (7.98)
No treatment	143 (21.12)
Total	677

Discussion

The present investigation, which is the first radiographic retrospective study of a large group of subjects with retained primary teeth, focused on understanding why primary teeth have persisted and their various characteristics. To our knowledge, limited data are available regarding the reasons for the persistence of primary teeth and the exact reasons for the persistence of primary teeth are yet unknown. Therefore, this study was aimed to collect comprehensive data regarding the subject.

In the present study, the congenital absence of the permanent successor teeth was found to be the most common reason for the persistence of primary teeth, followed by impaction, abnormal position, and late eruption of successor teeth. In addition, the results showed that the primary mandibular second molars were the most frequently retained deciduous teeth, followed by the right and left primary maxillary canines and second molars on both sides. Persistence of other primary teeth was relatively rare. These results were compatible with previous studies that showed the prevalence of tooth agenesis and the relationship between agenesis of permanent teeth and the persistence of primary teeth (Becker *et al.*, 1999; Polder *et al.*, 2004; Attug-atac and Erdem, 2007; Bjerklin *et al.*, 2008; Aktan *et al.*, 2010). Therefore, primary mandibular second molars persist most often due to most common developmental absence of permanent mandibular second premolars which are their successors. Similarly, the most frequent impaction of maxillary permanent canines leads to second most common persistence rate of primary maxillary canines. In

Table 5 Distribution of resorption degree according to tooth.

	Molar I (%)		Molar II (%)		Canine (%)		Lateral (%)		Central (%)		
Resorption degree	Maxilla	Mandible	Maxilla	Mandible	Maxilla	Mandible	Maxilla	Mandible	Maxilla	Mandible	Total (%)
Level 0	0	0	5 (0.74)	47 (6.94)	15 (2.22)	0	4 (0.59)	0	0	1 (0.15)	72 (10.64)
Level 1	0	0	8 (1.18)	96 (14.18)	51 (7.53)	3 (0.44)	11 (1.62)	0	0	3 (0.44)	172 (25.41)
Level 2	1 (0.15)	0	7 (1.03)	61 (9.01)	24 (3.55)	2 (0.30)	3 (0.44)	0	0	1 (0.15)	99 (14.62)
Level 3	0	0	11 (1.62)	79 (11.67)	33 (4.87)	1 (0.15)	4 (0.59)	0	0	2 (0.30)	130 (19.20)
Level 4	1 (0.15)	1 (0.15)	25 (3.69)	82 (12.11)	21 (3.10)	1 (0.15)	3 (0.44)	0	0	2 (0.30)	136 (20.09)
Level 5	2 (0.30)	0	21 (3.10)	26 (3.84)	14 (2.07)	0	1 (0.15)	1 (0.15)	0	3 (0.44)	68 (10.04)
Total	4 (0.59)	1 (0.15)	77 (11.37)	391 (57.75)	158 (23.34)	7 (1.03)	26 (3.84)	1 (0.15)	0	12 (1.77)	677

Table 6 Distribution of resorption degree according to the reasons for persistence of primary teeth.

Resorption degree	Missing teeth (%)	Impacted (%)	Supernumerary (%)	Crowding (%)	Cyst (%)	Abnormal position (%)	Delay in the eruption (%)	Total (%)
Level 0	66 (9.75)	6 (0.89)	0	0	0	0	0	72 (10.64)
Level 1	150 (22.16)	19 (2.81)	0	0	1 (0.15)	0	0	172 (25.41
Level 2	81 (11.96)	20 (2.95)	0	0	0	0	0	99 (14.62)
Level 3	101 (14.92)	28 (4.14)	1 (0.15)	0	0	0	0	130 (19.20)
Level 4	108 (15.95)	24 (3.55)	2 (0.30)	1 (0.15)	0	0	1 (0.15)	136 (20.09)
Level 5	45 (6.65)	14 (2.07)	4 (0.59)	0	1 (0.15)	2 (0.30)	2 (0.30)	68 (10.04)
Total	551 (81.39)	111 (16.40)	7 (1.03)	1 (0.15)	2 (0.30)	2 (0.30)	3 (0.44)	677

the light of these findings, the results of the present study indicate that persistence of primary teeth may be related to developmental anomalies of their permanent successors.

When gingival and occlusal levels of retained primary teeth are apically located, inter-occlusal space is increased and 'infra-occlusion' has occurred (Robinson and Chan, 2009). Infra-occlusion has been detected in 55 per cent of the retained mandibular second molars (Bjerklin and Bennett, 2000). Of 1035 retained teeth, 819 were infra-occluded in the present study. Infra-occlusion is frequently caused by ankylosis of the retained primary teeth and by tipping of the adjacent permanent teeth. In the present study, 77 ankylosed primary teeth and 202 tipping of the adjacent permanent teeth were found. These findings showed no relationship between ankylosed primary teeth and tipping of the adjacent permanent teeth.

In normal dentition, the primary tooth roots undergo gradual resorption concurrently with the eruption of the successors. The normal interrelationship between the eruption of a permanent tooth and the resorption of the primary tooth is well described (Haavikko, 1973), but the resorption of the primary tooth root is also generally viewed as a process that can occur when the underlying permanent tooth is absent (Rune and Sarnas, 1984). There are several studies related to surveying the root resorption in subjects with agenesis of the successors. Ith-Hansen and Kjaer (2000) reported that root resorption of the primary molar had not progressed up to 16 years after the age of natural exfoliation. The rate of the root resorption varied widely among individuals and diminishes with age (Kurol and Thilander, 1984). In the present study, the resorption level 1 (27 per cent) was higher for mandibular primary molars and the level 5 was lowest in mandibular primary molars; for maxillary primary molars, the level 4 was the highest and the level 0 was the lowest. For maxillary primary canines, the level 1 was the highest and the level 5 was the lowest; however, for mandibular primary canines and mandibular primary lateral teeth, the level 1 and level 2 were the highest and the level 5 and level 0 were the lowest. Although there was diversity in the resorption levels of the primary teeth, the level 1 was higher and the level 5 was lowest in primary teeth totally (Table 6). Those results revealed that the resorption level 1 was more related to the congenitally missing successors of the primary teeth and the level 5 was less related to the congenitally missing successors. This result suggested that if the persistent teeth were related to the congenital absence of successor teeth, less resorption of the primary teeth roots were encountered. On the other hand, if the reason for the persistence of primary teeth was the impaction of the successor teeth, more resorption of the primary teeth root was encountered (Table 6).

If the root and coronal structure are good, the tooth is functionally and aesthetically acceptable, and there is no compelling orthodontic need for extraction the primary

tooth may be retained intact. Where root and crown structure are good, but infra-occlusion has occurred or aesthetic improvement is required, the primary tooth may be retained and reshaped with direct composite or indirect restorations, such as composite, porcelain, or gold onlays. Where crowding exists, and an extraction is necessary to align the arch orthodontically, it is usually common to extract the primary teeth. If the arch is well aligned, but the prognosis of the primary teeth is poor due to root resorption, caries, periodontal or periapical disease, or insufficient aesthetics, extraction and prosthetic replacement may be necessary, such as fixed replacement, conventional bridge, resin bonded bridge, dental implant supported crown, or bridgework(e.g. Robinson and Chan, 2009). In the present study, extraction of retained primary teeth was recommended for 665 (64 per cent) of the cases; filling was recommended for 12 per cent of the cases and retaining the teeth intact was recommended for 23 per cent of the cases. However, it should be noted that intra-oral examination and anamnesis was not a part of this study. Therefore, slight changes in these suggestions could have been expected if these parameters were applied. In order to achieve an accurate diagnosis with regard to treatment options for retaining primary teeth, radiographic investigation is as important as clinical investigation.

Although evaluation of retained primary teeth was made using panoramic radiography in the literature, there were some limitations arising from panoramic radiography. The quality of the panoramic radiography varies and is limited, which means that it was not possible to make a confident quantitative measurement of root length because radiographic material is always distorted and flawed as the object is three-dimensional and projected photographically down to two planes. The morphology of the dentition is not optimal because the radiographic tube revolves around the head and serially exposes the patient, who is able to move during the exposure, resulting in 'shaking' and a lack of clarity. This distorts the impression of the morphology of the dentition and may lead to uncertainty in the scoring of the degree of root resorption. Additionally, the patient's head posture, according to beam direction, is important. Most likely, the patients were positioned differently, and their head postures were varied, resulting in specific rendition and enlargement.

Conclusion

Within the limitation of the present study, the most common type of persistent primary teeth seen on the dental arch were mandibular primary second molars, followed by maxillary primary canines. The most frequent reason for the persistence was the congenital absence of successors to the primary teeth, followed by impaction of the successor teeth. The resorption level 1 was found higher and the level 5 was lowest in primary teeth.

References

Aktan A M, Kara S, Akgunlu F, Isman E, Malkoc S 2008 Unusual cases of the transmigrated mandibular canines: report of 4 cases. European Journal of Dentistry 2: 122–126

Aktan A M, Kara S, Akgunlu F, Malkoc S 2010 The incidence of canine transmigration and tooth impaction in a Turkish subpopulation. European Journal of Orthodontics 32: 575–581

Altug-Atac A T, Erdem D 2007 Prevalence and distribution of dental anomalies in orthodontic patients. American Journal of Orthodontics and Dentofacial Orthopedics 131: 510–514

Becker A, Gillis I, Shpack N 1999 The etiology of palatal displacement of maxillary canines. Clinical Orthodontics and Research 2: 62–66

Bjerklin K, Al-Najjar M, Karestedt H, Andren A 2008 Agenesis of mandibular second premolars with retained primary molars: a longitudinal radiographic study of 99 subjects from 12 years of age to adulthood. European Journal of Orthodontics 30: 254–261

Bjerklin K, Bennett J 2000 The long-term survival of lower second primary molars in subjects with agenesis of the premolars. European Journal of Orthodontics 22: 245–255

Brook A H 1974 Dental anomalies of number, form and size: their prevalence in British schoolchildren. Journal of the International Association of Dentistry for Children 5: 37–53

Haavikko K 1973 Correlation between the root resorption of deciduous teeth and the formation of the corresponding permanent teeth. Proceedings of the Finnish Dental Society 69: 191–201

Haselden K, Hobkirk J A, Goodman J R, Jones S P, Hemmings K W 2001 Root resorption in retained deciduous canine and molar teeth without permanent successors in patients with severe hypodontia. International Journal of Paediatric Dentistry 11: 171–178

Ith-Hansen K, Kjaer I 2000 Persistence of deciduous molars in subjects with agenesis of the second premolars. European Journal of Orthodontics 22: 239–243

Joshi M R 2001 Transmigrant mandibular canines: a record of 28 cases and a retrospective review of the literature. Angle Orthodontist 71: 12–22

Kjaer I, Nielsen M H, Skovgaard L T 2008 Can persistence of primary molars be predicted in subjects with multiple tooth agenesis? European Journal of Orthodontics 30: 249–253

Kurol J, Thilander B 1984 Infraocclusion of primary molars and the effect on occlusal development, a longitudinal study. European Journal of Orthodontics 6: 277–293

Polder B J, Van't Hof M A, Van der Linden F P, Kuijpers-Jagtman A M 2004 A meta-analysis of the prevalence of dental agenesis of permanent teeth. Community Dentistry Oral Epidemiology 32: 217–226

Robinson S, Chan M F 2009 New teeth from old: treatment options for retained primary teeth. British Dental Journal 207: 315–320

Rune B, Sarnas K V 1984 Root resorption and submergence in retained deciduous second molars. A mixed-longitudinal study of 77 children with developmental absence of second premolars. European Journal of Orthodontics 6: 123–131

Shapira Y, Kuftinec M M 2003 Intrabony migration of impacted teeth. Angle Orthodontist 73: 738–743discussion 744

Sletten D W, Smith B M, Southard K A, Casko J S, Southard T E 2003 Retained deciduous mandibular molars in adults: a radiographic study of long-term changes. American Journal of Orthodontics and Dentofacial Orthopedics 124: 625–630