

Frequency and Distribution of Fusion and Gemination in Permanent Dentition: Clinical and Radiological Study

Daimi Dentisyonda Füzyon ve Geminasyonun Dağılımı ve Sıklığı: Klinik ve Radyolojik Çalışma

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ABSTRACT Objective: Fusion and gemination are developmental dental anomalies. The aim of this study was to determine the prevalence, localization, distribution according to age and gender of double teeth (fusion and gemination) in permanent dentition. **Material and Methods:** The presence of a fusion and/or gemination in patients admitted to the Department of Oral and Maxillofacial Radiology for dental examination was investigated. Diagnoses of fusion and gemination were done by clinic and radiographic examination. The incidence, age, gender and upper and lower jaw localization were examined. Results: A total of 32 double teeth were detected in 30 patients after clinical and radiological examination, and the prevalence was found as 0.47%. Fusion was found in 22 patients, gemination was in 8 patients. Fusion was seen in two patients bilaterally. Fourteen (43.8%) cases were in the upper jaws and 18 (56.2%) cases were in the lower jaws. Mandibular and maxillary molars were the most commonly affected teeth (n:21, 65.6%). **Conclusion:** Fusion and gemination are uncommon dental anomalies. A careful clinical and radiological examination is important in the diagnosis of double teeth. Early diagnosis of these teeth is important to prevent possible complications. It will also facilitate treatment procedures such as endodontic, orthodontic or surgery to be performed by the dentist.

Keywords: Fused teeth; permanent dentition; diagnosis; dental radiography

ÖZET Amaç: Füzyon ve geminasyon gelişimsel dental anomalilerdir. Bu çalışmanın amacı, daimi dentisyonda ikiz diş (füzyon ve geminasyon) prevalansını, lokalizasyonunu, yaş ve cinsiyete göre dağılımını değerlendirmektir. **Gereç ve Yöntemler:** Dental muayene için Ağız, Diş ve Çene Radyolojisi kliniğine başvuran hastalarda füzyon ve/veya geminasyon varlığı araştırıldı. Füzyon ve geminasyon tanısı klinik ve radyografik muayene ile konuldu. Yaş, cinsiyet, üst ve alt çenelerdeki lokalizasyonları, görülme sıklıkları değerlendirilmiştir. **Bulgular:** Klinik ve radyolojik muayeneden sonra 30 hastada toplam 32 ikiz diş tespit edildi ve prevalansı %0,47 olarak bulundu. 22 hastada füzyon ve 8 hastada geminasyon belirlendi. İki hastada bilateral olarak füzyon izlendi. Üst çenede 14 (%43,8) vakada, alt çenede 18 (%56,2) vakada belirlendi. Mandibular ve maksiller molarlar en çok etkilenen dişlerdi (n: 21, %65,6). **Sonuç:** Füzyon ve geminasyon oldukça nadir görülen dental anomalilerdir. Çift dişlerin tanısında dikkatli bir klinik ve radyolojik muayene önemlidir. Bu dişlerin erken tanısı olası komplikasyonlarının önlenmesi açısından önemlidir. Hekimin uygulayacağı endodontik, ortodontik ya da cerrahi gibi tedavi prosedürlerini de kolaylaştıracaktır.

Anahtar Kelimeler: Kaynaşık dişler; daima dentisyon; tanı; dental radyografi

Dental anomalies are defects caused by many genetic and environmental factors during tooth morphogenesis.¹ The shape anomalies in the teeth are usually determined by coincidence during routine dental examination. Dental fusion and gemination are not frequent dental anomalies. The terms fusion and gemination are used to describe two different morphological tooth anomalies character-

ized by a clinically wide tooth formation.² They are usually termed “double teeth”, “joined teeth”, and “twinning” in the literature.³⁻⁶ Dental fusion is identified as partial or complete union between one or more adjacent dental germs during dental development, and teeth have divided or connected pulp canals and chamber depending on the time of union.^{2,7} Gemination is formed by the complete or partial di-

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vision of a single tooth germ.⁴ This condition is seen as a large single tooth with bifid crown and usually common root and root canal.⁴ Mader defined the difference between fusion and gemination with “two teeth” rule.⁸

The etiology of fusion and gemination is not exactly known.⁴ The cause of fusion may be attributed to factors such as trauma, physical force or pressure during the development.^{2,9} There is also some evidence that dental gemination has a familial tendency.¹⁰ Environmental factors and genetic may play a role in the development of these dental anomalies.^{4,9} Some authors suggest that one of the etiologic factors may be autosomal dominant inheritance.¹¹

Fusion and gemination can be seen in primary and permanent dentition. However, the literature reported that double teeth were more seen in primary dentition than in permanent dentition.¹² The prevalence of double teeth in primary dentition was reported as ranging from 0.1% to 4.1%.¹³ In the literature, the prevalence of double teeth in the permanent dentition is found to be as 0.05% and 1.4% (Table 1).^{3,4,12,14-17} Fused teeth are encountered more often in primary dentition than in permanent dentition and most occur by fusion of mandibular lateral incisor and canine teeth.⁹ However, in the permanent dentition, it is more often seen in the maxillary central incisor teeth.⁴ The most common site of gemination is the incisor region and canine teeth, it is rare in the posterior region.¹²

The determination of fusion and gemination is important for dentists and careful clinical follow-up should be performed due to demanding dental treatments.^{9,14} The aim of this study was to determine the prevalence, localization, relationship between age

and gender of fusion and gemination (double teeth) in permanent dentition.

MATERIAL AND METHODS

This study protocol was approved by the Ethical Review Board of the Gazi University (No: 2018-054) and followed the Declaration of Helsinki. The present study was based on clinical examination and dental radiographic evaluation of the patients (15 years old or older) who attended to Gazi University, Dental Faculty, Department of Oral and Dentomaxillofacial Radiology between November 2018 and April-2019. The patients who were admitted to the clinic for various dental reasons were included in the study. After intra-oral examination of the patients, radiographic imaging suitable for dental indication was requested. Panoramic radiographs or periapical radiographs were evaluated. Radiographic images were not taken unless there was an indication for radiography. Informed consent was obtained from the patients. The digital panoramic images were obtained with a machine (Sirona Dental Systems, Bensheim, Germany), operating at 66 kVp, 8 mA, with a 0.5 mm focal spot and an exposure time of 14 seconds with standard positioning according to the manufacturer’s recommendation. Lead apron is used as a routine procedure while imaging. Exclusion criteria included being under 15 years of age, any significant medical history, poor radiographic images, patients without radiography. A careful clinical examination was carried out to identify double teeth. The images of the patients were examined by the consensus of three experienced oral radiologists (G.A, N.G.I, D.H).

The double teeth were assessed and classified as fusion and gemination. The distinction between the

TABLE 1: Previous studies about double teeth in permanent dentition.

Studies	Studies group/design	Country	Sample size	Fusion N (%)	Gemination N (%)	Total
Hamasha (2004)	Double teeth	Jordan	3024	18 (0.19)	21 (0.22)	0.42%
Knezevic et al. (2002)	Orthodontic patients-double teeth	Croatia	3517	4 (0.08)	3 (0.11)	0.2%
Finkelstein et al. (2014)	Orthodontic patients-double teeth	Israel	574	-	-	1.4%
Hagiwara et al. (2016)	All dental anomalies	Japan	9584	1 (0.01)	4 (0.04)	0.05%
Altuğ-Ataç et al. (2007)	Orthodontic patients-all dental anomalies	Turkey	3043	7 (0.23)	2 (0.07)	0.3%
Kazancı et al. (2011)	Orthodontic patients-all dental anomalies	Turkey	3165	1 (0.03)	1 (0.03)	0.06%
Bilge et al. (2018)	All dental anomalies	Turkey	1200	-	-	0.08%



FIGURE 1: Images of gemination in upper central incisive tooth of 21-year-old female patient (intraoral photography (a), periapical radiography (b)).



FIGURE 2: Images of fusion with supernumerary tooth in the lateral incisor of 59-year-old male patient [intraoral photography (a), periapical radiography (b)].

fusion and gemination was performed according to the number of teeth on the arc changed; if the tooth crown was enlarged with a normal root and the number of teeth was normal, it was diagnosed as gemination. If the root and crown were enlarged and the number of teeth was less than one, it was diagnosed as fused tooth (Figure 1, Figure 2).

The results are described by descriptive statistics. The presence of double teeth, age, gender and localization in the dental arch were recorded.

RESULTS

Intra-oral and radiographic examination of 6800 patients were carried out. The age distribution of the pa-

tients ranged from 17 to 59 years; mean 28.8 ± 16.2 years. A total of 32 double teeth were detected in 30 patients after clinical and radiological examinations, and the prevalence was found as 0.47%. Regarding gender, double teeth (n:32) were present in 16 males (50%) and 16 females (50%). Gender distribution of double teeth is shown in Table 2. Eighteen (56.2%) of double teeth were in mandible and fourteen (43.8%) teeth were in maxilla. Nineteen cases were observed on the right side, and 13 cases were on the left side. Bilateral occurrence of double teeth was recorded in two patients, and these cases were fusion. Fusion was observed in 22 (73.3%) patients and gemination was observed in 8 (26.7%) patients. While fusion was frequently observed in mandibular molar teeth, gemina-

TABLE 2: Distribution of fusion and gemination according to genders.

Gender	Fusion n (%)	Gemination n (%)	Total n (%)
Males	12 (37.5%)	4 (12.5%)	16 (50%)
Females	12 (37.5%)	4 (12.5%)	16 (50%)
Total	24 (75%)	8 (25%)	32 (100%)

tion was determined in maxillary incisors. The descriptive statistic and distribution of the double teeth are given in Table 3. Two double teeth were diagnosed with periapical pathology. As treatment planning; endodontic treatment was performed for two fusion cases, six cases were directed to orthodontic treatment. Periodontal problems were also observed in four of these cases. The tooth extraction was performed for three cases and follow-up was recommended for the other double teeth (n:19).

DISCUSSION

In the literature, there are various studies reporting the prevalence of dental anomalies, whereas studies on prevalence of fusion and gemination are limited.^{3,4} Many of them evaluated the prevalence of double teeth in primary dentition.¹⁸⁻²⁰ According to double teeth in permanent dentition, the great majority of publications have been usually presented as case reports. For this reason, this study investigated the prevalence of double teeth in the permanent dentition. In Jordanian adult individuals, Hamasha et al. found the prevalence of fusion and gemination as 0.19% and 0.22%, respectively, with a total preva-

lence of double teeth as 0.42%.³ Hagiwara et al. reported the prevalence of fused teeth as 0.05% in Japanese population.¹⁴ In the study of Bilge et al., 1200 panoramic radiographs were examined and the related anomalies with teeth were evaluated among 6-to 40-year-old patients.¹⁵ In their study, the prevalence of fusion and gemination was found to be 0.08%.¹⁵ In 2014, Kılınç et al.²¹ evaluated the presence of fusion and gemination in the permanent and primary dentition of children aged between 3-18 years. Other studies reported the prevalence of dental anomalies in the Turkish orthodontic patients.^{16,17} Kazancı et al. found the frequencies of fusion and gemination to be 0.03% in the permanent teeth.¹⁶ In our study, double teeth were detected in 30 patients and the prevalence was 0.47% in the permanent dentition. The prevalence of double teeth observed in this study was greater than reported by Hagiwara et al., Bilge et al., Kazancı et al. Altuğ-Ataç and Erdem. However, similar results have been obtained with the studies of Hamasha et al. The differences between studies may be related to sample sizes, patient groups (orthodontic patients or general dental patients) and diagnostic criteria.^{3,14-17}

Fusion and gemination are used to describe two distinct morphological dental anomalies.⁴ The distinction between fusion and gemination is clinically confirmed by counting the number of teeth in the mouth, however, fusion may occur between two normal teeth, or between a normal tooth and a supernumerary tooth, the second condition complicates to differentiate between fusion and gemination.^{4,19} It is

TABLE 3: Distribution of teeth fusion and gemination among different tooth types.

Tooth type and region		Fusion n (%)	Gemination n (%)	Total n (%)
Maxilla	Incisor teeth	-	5 (15.6%)	5 (15.6%)
	Canine	-	-	-
	Premolar teeth	-	-	-
	Molar teeth	9 (28.1%)	-	9 (28.1%)
Mandible	Incisor teeth	3 (9.4%)	2 (6.3%)	5 (15.6%)
	Canine	-	-	-
	Premolar teeth	1 (3.1%)	-	1 (3.1%)
	Molar teeth	11 (34.4%)	1 (3.1%)	12 (37.6%)
Total	24 (75%)	8 (25%)	32 (100%)	

also possible to distinguish fusion and gemination with radiological evaluations.^{17,18} Gemination usually offers two crowns, completely or partially separated, with a single root and a root canal. In contrast, in fusion, the crowns are combined with enamel and/or dentin, but there are two roots or two canals in one root. The final diagnosis of fusion or gemination can be obtained with both radiological and clinical findings.⁷ In our study, the distinction between fusion and gemination was carried out considering the radiological and clinical findings.

Double teeth are very rare in molars.⁷ To the best of our knowledge, there are several studies investigating the prevalence of double teeth among different tooth types in permanent dentition.^{3,12,21} Hamasha et al. investigated the frequency of fusion and gemination among different tooth types, and found the frequency distribution of double teeth as 23.1% (n: 9) in molar teeth.³ Our results showed that fused teeth were found mostly in the mandibular and maxillary molars (n:20, 62.5%). We have also identified gemination in a mandibular molar tooth. This result is different from other studies in which maxillary central incisors were the commonly affected teeth in permanent dentition.^{3,12} Hamasha et al. and Knezevic et al. found the incidence more frequent in the maxilla than mandible.^{3,12} In our study, the distribution of double teeth in the jaws was frequent in the mandible than in the maxilla. Bilateral presentation was extremely rare (0.05%).⁷ In this study, the condition was only observed bilaterally in two patients. Incidence of fusion between supernumerary and normal teeth is 0.1% and this condition is seen in anterior region.^{2,18} In our samples, the anomalies were observed in equal frequency in both genders, which is in agreement with previous report.^{18,22}

Double teeth are usually asymptomatic. However, these teeth can cause some complications such as caries, periodontal problems, functional problems and malocclusions.^{2,23,24} In the anterior region, they can cause aesthetic problems due to irregular morphology.^{2,4} In the case of fused teeth, when the junction between the crowns is too deep, the bacterial plaque accumulation in this junction area is extremely high. Therefore, these teeth may be susceptible to

caries and periodontal diseases.^{2,4} The extraction of these teeth and endodontic treatments are also difficult.² Various treatment alternatives have been suggested depending on different morphological variations for fused and geminated teeth.^{2,4,25} When deciding the treatment choice of double teeth, it should be done according to the orthodontic, periodontal, aesthetic and functional requirements of the patient.^{2,25} Treatment options may include aesthetic purposes such as crown coverage with prosthetic treatment, orthodontic treatment of an abnormal tooth, or tooth extraction.⁴ Hemisection may also be recommended if the fused tooth contains 2 separate roots.²⁵ Therefore, treatment of these teeth requires a multidisciplinary approach to achieve the desired aesthetic and functional results.⁴ In the present study, the most common problem related to fusion and gemination was orthodontic problem. Most of the fusion and gemination cases in our study were asymptomatic. It was determined incidentally during radiological and clinical examination. Only eleven cases referred to our clinic with complaints related to these teeth. Three fusion cases with mandibular third molar teeth had pericoronitis and pain. Tooth extraction was decided in these patients. Deep groove in two cases may be the cause of pulp necrosis and periradicular lesion. These cases underwent endodontic treatment. In other cases, follow-up was recommended as the teeth didn't cause any problems such as functional problems, caries or malocclusion.

CONCLUSION

Although it is difficult to discriminate fusion and gemination, it is a fact that there is a high rate of double teeth in permanent dentition. Unless there is a pathological finding, it is likely to be overlooked during clinical examination. The awareness of dentists about clinic and radiographical findings of double teeth is important for early diagnosis and improvement in treatment procedures.

Ethical Consent

All procedures involving human participants were in accordance with the ethical standards of the institutional and national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Source of Finance

During this study, no financial or spiritual support was received neither from any pharmaceutical company that has a direct connection with the research subject, nor from a company that provides or produces medical instruments and materials which may negatively affect the evaluation process of this study.

Conflict of Interest

No conflicts of interest between the authors and / or family members of the scientific and medical committee members or members of the potential conflicts of interest, counseling, expertise, working conditions, share holding and similar situations in any firm.

Authorship Contributions

Idea/Concept: Gülsün Akay, Nebiha Gözde İspir, Dilara Haroğlu,

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