A multi-centre evaluation of multiple supernumerary premolar prevalence

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Aim: The occurrence of multiple supernumerary teeth is rare and often found in association with syndromes such as cleidocranial dysplasia, Gardner's syndrome or cleft lip and palate. Few examples of non-syndromal multiple supernumerary teeth have been reported. The aim of this multi-centre study was to investigate the prevalence of supernumerary premolar teeth in non-syndromic patients and to investigate the association between the presence of supernumerary premolar teeth and malocclusion type in a Turkish population.

Materials and methods: The clinical records and panoramic radiographs of 10,700 patients (referred to three different university hospitals) were retrospectively examined for the presence of supernumerary premolars. Age, gender, orthodontic malocclusion type, the number of supernumerary premolars (two or more), the distribution, location, position (vertical, horizontal, inverted, mesio-angular), surgical approach, and related complications (pain, cystic changes, root resorption, or eruption disturbance of adjacent teeth) were recorded.

Results: Forty-two cases (13 Class I, 17 Class II, 12 Class III) of multiple mandibular supernumerary premolars in patients without an associated syndrome were detected. A total of 97 (27 Class I, 41 Class II, 29 Class III) supernumerary premolar teeth were found, with a prevalence of 0.39%. No statistical difference was found related to gender, malocclusion type and supernumerary premolars ($p > 0.05$). The majority of the extra premolars were located in the mandible, which was statistically significant ($p < 0.05$).

Conclusion: The present study revealed that the prevalence of multiple supernumerary teeth was 0.39%. The most frequently impacted premolars were found in the mandible and more often associated with Class II malocclusions in the examined Turkish population.

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Introduction

Supernumerary teeth are defined as a dental developmental anomaly in which an extra tooth or teeth develop in excess of the normal complement in the primary or permanent dentition.[1] The majority of supernumerary teeth occur in the maxilla and, in order of frequency, are midline supernumerary teeth (mesiodens), maxillary fourth molars, maxillary paramolars, mandibular premolars, maxillary lateral incisors, mandibular fourth molars and maxillary premolars.[1-6] Supernumerary premolars comprise approximately 10% of the total number of supernumerary cases and almost 75% are located in the mandible.[2,3] Isolated supernumerary teeth occur in 76–86% of cases, two supernumerary teeth occur in 12–23% of cases and multiple supernumerary teeth are seen in less than 1% of cases.[5,6]

Over 20 syndromes and developmental conditions are known to be associated with a single supernumerary tooth, while multiple supernumerary teeth are reported in association with a systemic condition, such as cleidocranial dysplasia, Gardner's syndrome or cleft lip and palate.[7,8] The occurrence of multiple supernumerary teeth without any associated systemic condition or syndrome is rare,[9,10] and occurs with an incidence as low as 0.06% in circumstances of five or more supernumerary teeth.[13,14] This mainly affects the permanent dentition and usually involves the identification of supernumerary teeth in the anterior and premolar regions, although reports suggest that all areas in both arches may be involved.[4,9,10]

The presence of supernumerary teeth may require orthodontic intervention and has been given high priority in the dental health component of the Index of Orthodontic Treatment Need.[13] The clinical complications frequently associated with supernumerary teeth include dental impactions, delayed dental development, dental crowding, malocclusion, root resorption, dilacerations, ectopic eruption (into the floor of the nasal cavity) and the possible formation of follicular cysts or odontomas.[1,14,15]

It has been postulated that the prevalence of supernumerary multiple premolars may vary in different populations[5,9-16] and even in different groups within a population. Although reports for the Turkish population have been previously published,[6,7,17,18] no multi-centre study was found in the literature. The benefits of multi-centre trials include an increased number of participants and the likely assessment of a wider population range.[19] Hence, the aim of this multi-centre study was to investigate the prevalence of non-syndromic supernumerary premolar teeth and also to relate the presence of supernumerary teeth to malocclusion type in a Turkish population.

Materials and methods

Panoramic radiographs of a total of 10,700 patients were examined. The radiographs had been processed in three different university hospitals and, as the present study was based on a retrospective evaluation, no ethical approval was required but the investigation was conducted according to the principles described in the Declaration of Helsinki. Only the investigators had access to the collected data. Patient informed consent was obtained to allow any radiograph, photo or data from intra- and extra-oral examinations to be used for scientific purposes and future publication. No gender preference was considered and images of low quality, distorted magnification, insufficient accuracy or with artefacts were excluded. Patients who had received previous orthodontic treatment or the extraction of supernumerary teeth were also excluded. In addition, patients identified with maxillofacial anomalies such as cleft lip and palate and diseases associated with systemic conditions and syndromes, for example cleidocranial dysplasia and Gardner's syndrome, were also omitted from the study.

The records of the 10,700 patients were identified and retrieved from the orthodontic archives because of a presenting history related to missing teeth, pre-orthodontic examinations, impacted teeth, third molar problems, caries detection or routine check-ups. Of the total, 5,371 were female (50.2%) and 5,329 were male (49.8%). The patient age range was 10 to 73 years. An agreement between age-related variations and normal distribution was tested using the Shapiro-Wilk test and descriptive statistics were expressed as medians as well as means ± standard deviations (IQR – interquartile range). The average age of female patients was 38.0 (IQR = 29.0), while male patients had an average age of 39.0 (IQR = 28.0). There was no statistical difference between male and female patients' average age (Z = 1.420; p = 0.225). Statistically, it was advised that male and female participants should be selected from similarly-aged people in order not to age bias the study.

The clinical records of the patients, together with panoramic radiographs, were examined independently by three experienced dento-maxillofacial radiologists (K.G., H.A., K.O.). The examiners were calibrated to recognise and agree on the presence of multiple supernumerary teeth, as well as to identify the teeth, their numbers and also the surrounding structures. For this purpose, a series of 300 panoramic radiographs, with and without supernumerary teeth, was obtained from each centre (100 panoramic radiographies each) and examined.

Age, gender, malocclusion, number of supernumerary premolars, distribution, location, position (vertical, horizontal, inverted, mesio-angular), surgical approach, and related complications (pain, cystic changes, root resorption, or eruption disturbance of adjacent teeth) were recorded. If there was a suspicion that root resorption was present in the conventional radiographic images, a cone beam computed

tomography (CBCT) examination was obtained to provide further information and allow evaluation. Two or more supernumerary teeth found in a single patient was termed 'multiple supernumerary teeth'. All assessors examined the radiographs to determine the number and location of extra teeth and the presence of any associated pathology.

Patients who were diagnosed with multiple supernumerary premolars were further grouped by occlusion type by analysing lateral cephalometric radiographs and recording the ANB angle as either Class I, Class II or Class III. In addition, conventional cephalometric radiographs and the molar relationship noted on dental casts were used in order to confirm the malocclusion type. A consultant orthodontist, who was blinded to the patient data, evaluated the cephalometric images, and a cephalometric analysis was conducted for the patients identified with impacted teeth. If there was a conflict between cephalometric variables and the cast molar relationship, the cephalometric analysis was repeated. The orthodontic consultant performed all cephalometric analyses twice with an interval of at least two weeks between each assessment.

Statistical analysis

The Chi-square test was used to assess the difference between malocclusion type, gender, location (mandible/maxilla; right/left). Statistical analysis was performed using the SPSS for Windows, Ver. 15.0 (SPSS Inc., IL, USA). The value $p \leq 0.05$ was considered as 'statistically significant'. No inter- or intra-examiner study was performed as the diagnosis of 'supernumeray' was an objective assessment. However, the data of patients who had multiple radiographic supernumerary teeth were reviewed by all investigators. Final agreement was obtained by consensus.

The intra-observer reliability related to the cephalometric analysis was assessed by calculating intra-class correlation coefficients (ICC).

Results
Method error

Overall, the intra-observer reproducibility (ICCs) for the orthodontic consultant ranged from 0.89 to 0.99 for hand tracings. All skeletal (ANB) measurements were found to be highly reproducible.

Of the 10,700 patients, 42 cases of multiple (two or more) mandibular supernumerary premolars were identified. Of the 42 patients, 17 were female and the male to female ratio was 1.4:1. In all, a total of 97 supernumerary premolar teeth were found. The prevalence of non-syndromic mandibular supernumerary premolars was therefore 0.39% in a patient population whose mean age was 21.2 years (Table I). Two of the supernumerary premolars were partially impacted, whereas the remainder were fully impacted and unerupted. Ninety-two of the supernumerary premolar teeth were in a supplemental form and the remaining five were rudimentary. Ninety-four of the supernumerary premolars were positioned vertically, while three were positioned mesio-angularly (Figure 1).

Eight of the patients reported pain in the mental foramen region (Figure 2) and resorption was detected in the root of an adjacent tooth in four patients (Figure 3). The majority of the supernumerary teeth were asymptomatic and without complications. Treatment in 33 cases consisted of surgical removal of the supernumerary teeth followed by clinical and radiographic review to detect the possible delayed appearance of associated pathology.

In addition, the investigation of the relationship between malocclusion type and multiple impacted supernumerary premolars revealed that the Class I malocclusion group (ANB = 0 to 4 degrees) comprised 13 patients (5 females and 8 males; 39.5% of 42 patients), the Class II malocclusion group (ANB > 4 degrees) comprised 17 patients (7 females and 10 males; 40.5% of 42 patients), and the Class III malocclusion group (ANB < 0 degrees) comprised 12 subjects (5 females and 7 males; 28.6% of 42 patients). There were no quantitative statistically significant differences between gender, malocclusion type and the prevalence of supernumerary premolars ($p > 0.05$) (Table II).

There was a statistically significant difference between location (maxilla/mandible) and the prevalence of supernumerary premolar teeth. The majority of premolars were located in the mandible ($p < 0.05$). However, no statistically significant difference was found related to right or left sides ($p > 0.05$).

Discussion

There are few published cases of multiple supernumerary teeth that are not associated with complex

Table I. Characteristics of nonsyndromic multiple supernumerary premolars.

Patient	Sex	Age (Y)	Number	Max.	Mand.	Location Right	Location Left	Position	ES	Uni/Bil	Associated pathology	Treatment
1	M	22	2	-	2	1	1	V	I	Bil	None	Observation
2	F	17	2	-	2	1	1	V	I	Bil	Pain	Extraction
3	M	45	2	-	2	1	1	V/MA	I	Bil	None	Observation
4	M	23	2	-	2	1	1	V	I	Bil	RS	Extraction
5	M	19	2	-	2	1	1	V	I	Bil	Pain	Extraction
6	M	35	3	1	2	3	-	V	I	Uni	None	Extraction
7	F	16	3	-	3	2	1	V	I	Bil	None	Observation
8	M	12	2	-	2	1	1	V	I	Bil	None	Observation
9	F	10	2	-	2	1	1	V	I	Bil	None	Observation
10	F	19	2	-	2	1	1	V	I	Bil	Pain	Extraction
11	M	25	2	2	-	1	1	V/MA	I	Bil	None	Extraction
12	M	22	2	-	2	1	1	V	I	Bil	None	Extraction
13	M	26	5	3	2	2	3	V	I(3) E(2)	Bil	RS (Left upper side)	Extraction
14	M	20	2	-	2	1	1	V	I	Bil	None	Extraction
15	F	19	2	-	2	1	1	V	I	Bil	None	Extraction
16	F	23	3	-	3	1	2	V	I	Bil	None	Extraction
17	F	25	2	-	2	1	1	V	I	Bil	None	Extraction
18	M	33	2	-	2	1	1	V	I	Bil	Pain	Extraction
19	M	19	3	-	3	1	2	V	I	Bil	None	Extraction
20	M	18	2	-	2	1	1	V	I	Bil	Pain	Extraction
21	M	16	2	-	2	1	1	V	I	Bil	None	Observation
22	F	15	2	-	2	-	2	V	I	Uni	None	Extraction
23	M	21	3	-	3	2	1	V	I	Bil	Pain	Extraction
24	F	20	2	-	2	1	1	V	I	Bil	None	Extraction
25	M	21	2	-	2	1	1	V	I	Bil	None	Extraction
26	M	21	3	-	3	2	1	V	I	Bil	None	Extraction
27	M	19	2	-	2	1	1	V	I	Bil	None	Extraction
28	M	18	2	-	2	1	1	V	I	Bil	None	Extraction
29	M	16	3	-	3	1	2	V	I	Bil	RS	Extraction
30	F	13	2	-	2	1	1	V	I	Bil	None	Observation
31	F	14	3	-	3	2	1	V	I	Bil	None	Observation
32	F	16	2	-	2	1	2	V/MA	I	Bil	None	Extraction
33	F	15	2	-	2	1	1	V	I	Bil	None	Extraction
34	M	18	2	-	2	1	1	V	I	Bil	Pain	Extraction
35	M	22	2	-	2	1	1	V	I	Bil	None	Extraction
36	F	25	2	-	2	1	1	V	I	Bil	Pain	Extraction
37	F	26	3	1	2	2	1	V	I	Bil	None	Extraction
38	F	27	3	-	3	1	2	V	I	Bil	None	Extraction
39	M	28	2	-	2	1	1	V	I	Bil	None	Extraction
40	M	24	2	-	2	1	1	V	I	Bil	None	Extraction
41	F	19	2	-	2	1	1	V	I	Bil	RS	Extraction
42	M	15	2	-	2	1	1	V	I	Bil	None	Observation

Abbreviations: Y, years; F, female; M, male; Max., Maxilla; Mand., Mandibula; V, vertical; MA, mesioangular; ES, eruption status; Uni/Bil, unilateral/bilateral; I, impacted; E, erupted; RS, root resorption.

Table II. The distribution of number of patients and number of supernumerary premolars according to gender and malocclusion type.

Malocclusion type	Gender		Impacted teeth number		Total impacted teeth number	Number of patients
	F	M	F	M		
Class I	5	8	11	16	27	13
Class II	7	10	18	23	41	17
Class III	5	7	10	19	29	12
Total	17	25	39	58	97	42

Figure 1. Panoramic radiograph of patient aged 16 years (case 7). This patient has three supernumerary premolars with early crown formations in the mandible (arrows).

Figure 2. Panoramic radiograph of patient aged 33 years (case 18). This patient complained of pain that was due to supernumerary premolars in the lower right premolar region (arrows).

Figure 3. Panoramic radiograph of patient aged 25 years (case 11). This patient has two supernumerary premolars in the mandible and three in the maxilla (arrows).

syndromes.[20-23] The prevalence of supernumerary premolars has been reported variously in previous studies due to differences in patient population samples, age groups, ethnicity, and applied radiographic techniques.[6,23] No multi-centre study was found in the literature. To the authors' knowledge, no epidemiological survey of this occurence in a large sample population has been previously conducted.

It has been reported that multiple supernumerary teeth are rarely seen and that the prevalence of extra teeth in the premolar regions is 0.14% in comparison with a prevalence of 1.3% in the anterior region.[17,22] The frequency of supernumerary premolars has been calculated at between 0.075% and 0.26% in the permanent dentition and as low as 0.06% in the instance of five or more supernumerary teeth.[13,14] Salcido-García et al.[24] reported the prevalence of supernumerary premolars to be 0.8% in a general dental population, whereas an American study, in which 1,100 orthodontic patients were included, reported the prevalence of supernumerary premolars as 0.64%.[25]

In a study of 2,599 Turkish children, Esenlik et al.[26] reported the prevalence of maxillary supernumerary premolars to be 0.2% and mandibular supernumerary premolars to be 0.5%. In the Turkish general population, Şimşek-Kaya et al.[18] reported the prevalence of maxillary and mandibular supernumerary premolars at 0.1–0.3% and 0.2–0.3%, respectively. Nevertheless, in the present study the prevalence of maxillary and mandibular supernumerary premolars in a general dental population was found to be 0.037% and 0.35%, respectively. This difference may be due to population factors as well as study design.

The current data were collected from multiple geographically remote centres and, as a consequence, environmental differences may be a possible reason for the discrepancy. Previous studies only focused on one regional population.[6,9,14-17,24,26,41]

Celikoglu et al.[15] found supernumerary teeth in 1.2% of the 3,491 patients studied, although 75% of those were identified with one supernumerary tooth and 25% with multiple supernumerary teeth. Patients with three or more supernumerary teeth were not recorded.

The frequency of supernumerary premolars has been calculated as between 0.075% and 0.26% in the permanent dentition and as low as 0.06% if five

or more supernumerary teeth are involved.[13,14] The occurrence of multiple supernumerary teeth without any associated systemic conditions or syndromes, however, is a rare phenomenon.[9,10] It was found that single supernumerary teeth occurred in 76–86% of cases, two supernumerary teeth in 12–23% cases and multiple supernumerary teeth occurred in fewer than 1% of cases.[11,12] In the present study, the prevalence rate of multiple supernumerary teeth was 0.39%, which matches previous studies. The current study also established baseline data for multiple supernumerary premolars – defined as two or more teeth in any given arch – not only for the examined population but also for the retrospective analysis of the larger samples.

The aetiology of supernumerary teeth remains unclear. Although theories to explain the development of this anomaly have been proposed, localised and independent hyperactivity of the dental lamina is the generally accepted cause.[5,20,27] Brook[28] stated that the position of the teeth usually depended upon a combination of genetic and environmental factors, each with a small effect, but occasionally a chromosomal anomaly, a major single gene or a major environmental insult may have a large effect. Mutations in MSX1, PAX9, AXIN2, EDA, EDAR and WNT10A have been identified in families with non-syndromic hypodontia.[28] Experiments using animal models have suggested that mutations affecting Fgf, Eda, Bmp, Runx2, Apc, Shh and b-catenin may be related to the occurrence of supernumerary teeth.[29] Therefore, when considering the aetiology in a particular individual, family or ethnic population, a number of factors may need to be explored together with the possibility of genetic studies identifying potential mutations.

Past investigators have reported that supernumerary teeth are developmentally delayed compared with the normal dentition.[30-33] This provides an explanation as to why most supernumerary teeth are impacted. It is possible that supernumerary teeth are late to erupt because of slow root development and therefore might impact due to restricted space. For this reason, and because most supernumerary teeth develop palatal/lingual to the normal line of the arch, it is often difficult to determine exactly when a supernumerary tooth begins to form via a routine radiographic examination.[9,34] As a result, additional teeth may sometimes go unnoticed.[8,32] Cochrane et al.[34] reported a sample case in which two late developing supernumerary lower molars appeared, and a second case in which two lower premolars formed. According to Gardiner,[35] late developing (post-permanent) supernumerary teeth develop from the proliferation of the dental lamina after the permanent dentition is completed. Support for the proliferation of local dental lamina remnants is provided by the case of a 14-year-old subject in the present study who had bilateral supernumerary teeth in the mandibular premolar region, and another case of a 19-year-old patient who had bilateral supernumerary teeth in the lower premolar region. All of the extra teeth were newly developing.

Supernumerary premolars are usually asymptomatic.[6,16, 20-23] The anomaly is usually diagnosed by a routine radiographic evaluation, particularly before orthodontic treatment.[20] Bodin et al.[36] reported that only 2% of supernumerary premolars are likely to undergo pathological changes. Nevertheless, the most frequently reported pathology is delayed eruption or non-eruption and malformation of adjacent teeth.[20-23] In the present study, the most-encountered pathology was pain. Şimşek-Kaya et al.[18] suggested that the pressure delivered by the supernumerary premolars on neighbouring teeth and their proximity to the mental and inferior dental nerves may produce the discomfort. The second most frequently encountered pathology was root resorption of adjacent teeth.

Treatment alternatives for impacted supernumerary premolars may either be removal of the supernumerary teeth or their maintenance in situ, with appropriate review. Clinicians may see surgical removal of these teeth as the only effective method of management,[14,23,37] which should be based on the potential for pathological sequelae.[15] The most significant complications associated with supernumerary premolar teeth area are cyst formation and severe resorption of adjacent teeth.[16,23] When the extra teeth are associated with pathology, hinder the eruption of or cause displacement of permanent teeth, extraction is indicated.[6,16,18] In the present study, eight teeth caused resorption of adjacent teeth and were extracted, while 17 teeth without cystic or tumour involvement were extracted because of pain. In three cases, the pain was due to infection, whereas in an additional three cases the pain was believed to be the result of the close proximity of the impacted supernumerary tooth to the mandibular canal.

Many clinicians recommend leaving asymptomatic

supernumerary premolar teeth in situ until the development of the adjacent anatomic structures and root development of the adjacent teeth has been completed. Hopcraft[38] suggested that the incidence of pathological sequelae is relatively low for supernumerary premolar cases. Many authors prefer to monitor the impacted supernumerary teeth until the end of the permanent dentition rather than undertake early removal.[16,20,39,40] In the present study, 20 supernumerary premolar teeth were left in situ and were kept under periodic observation.

The limitation of the present study was that the 'non-syndromal' condition was solely defined by the anamnesis and the medical history of the patients. An additional limitation was that cephalometric analyses were not performed on all patients; the analyses were only performed for the patients who had supernumerary teeth. The data suggested that the supernumerary teeth were most frequent in Class II subjects. However, 26.8% of the patients with supernumerary teeth presented with a Class III malocclusion type. The prevalence of Class III malocclusion ranges between 4 and 6% in the entire population and is usually the least encountered malocclusion.[41-43] Therefore, considering the current results and the relationship between supernumerary teeth and Class III malocclusion, greater attention should be directed to this area.

In summary, although supernumerary teeth are most frequently associated with a Class II malocclusion, the presence of extra teeth associated with Class III malocclusions should also be noted. Further studies should be directed at the assessment of the cephalometric data of all patients, as well as an extensive examination of the facial characteristics of normal patients and patients presenting with multiple supernumerary teeth.

Conclusion

In the present study, the incidence of multiple supernumerary teeth was 0.39%. The most frequently impacted premolar teeth were found in the mandible and associated with Class II malocclusions for the sampled Turkish population. Further studies with larger groups should allow for comparisons of syndromic and non-syndromic patients using extensive genetic analysis.

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