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ORIGINAL RESEARCH

Prevalence of Dental Anomalies in Saudi Orthodontic Patients

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ABSTRACT

Aim: This study aimed to investigate the prevalence of dental anomalies and study the association of these anomalies with different types of malocclusion in a random sample of Saudi orthodontic patients.

Materials and methods: Six hundred and two randomly selected pretreatment records including orthopantomographs (OPG), and study models were evaluated. The molar relationship was determined using pretreatment study models, and OPG were examined to investigate the prevalence of dental anomalies among the sample.

Results: The most common types of the investigated anomalies were: impaction followed by hypodontia, microdontia, macrodontia, ectopic eruption and supernumerary. No statistical significant correlations were observed between sex and dental anomalies. Dental anomalies were more commonly found in class I followed by asymmetric molar relation, then class II and finally class III molar relation. No malocclusion group had a statistically significant relation with any individual dental anomaly.

Conclusion: The prevalence of dental anomalies among Saudi orthodontic patients was higher than the general population.

Clinical significance: Although, orthodontic patients have been reported to have high rates of dental anomalies, orthodontists often fail to consider this. If not detected, dental anomalies can complicate dental and orthodontic treatment; therefore, their presence should be carefully investigated during orthodontic diagnosis and considered during treatment planning.

Keywords: Dental anomalies, Orthodontic, Saudi.

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INTRODUCTION

Developmental anomalies of the dentition are frequently observed in orthodontic patients. Anomalies in tooth number, shape and position may lead to disturbances in maxillary and mandibular arch length and occlusion which may complicate orthodontic treatment planning or might be a possible cause of treatment relapse.[1] Dental anomalies can result from many factors, both genetic and environmental. Although defects in certain genes are the most influential, etiological events in the prenatal and postnatal periods have also been blamed for anomalies in tooth dimension, morphology, position, number and structure.[2-5]

Several studies have investigated the prevalence of dental anomalies in Saudi Arabia. In Gizan, the most common dental anomaly reported was hypodontia (2.2%), followed by supernumerary (0.50%), peg-shaped lateral incisors (0.37%) and gemination (0.08%) among 2,393 children 4 to 12 years old.[6] Al-Emran studied the prevalence of hypodontia and congenital malformations in permanent teeth of 500 male Saudi children in Riyadh, and the findings indicated that hypodontia was present in about 4% of the children. Tooth malformations, mainly peg-shaped upper lateral incisors, were also observed in about 4% of the sample.[7] In Jeddah, the prevalence rates of 10 selected dental anomalies were determined among 1,010 dental patients. Results showed that hypodontia was the most prevalent (9.41%), followed by taurodontism (8.61%) and microdontia (5.35%). Other anomalies were found at lower frequencies ranging from 0.20% for transposition to 1.19% for dilacerations.[8] In Tabuk, the prevalence of missing teeth, supernumerary teeth including mesiodens, fused teeth and talon cusps was studied in 1,878 children attending the North-West Armed Forces Hospital. It was found that the most frequently missing tooth was the mandibular second premolar (48%).[9]

Although, orthodontic patients have been reported to have high rates of dental anomalies, orthodontists often fail to consider this.[10,11] Lind showed that 3.6% of 1,717 Swedish orthodontic patients had supernumerary teeth.[12] Horowitz investigated the prevalence of hypodontia and supernumerary teeth in 1,000 orthodontic patient and he found that 6.5% of the patients had hypodontia, 1.6% had

supernumerary teeth, and 0.8% had peg-shaped lateral incisors.[11] Rubenstein et al. evaluated the prevalence of supernumerary teeth in orthodontic patients to be 0.64%.[13] Rose found that 4.3% of the sample had at least one congenitally missing tooth.[14] A pilot twin study by Kotsomitis et al. on 202 orthodontic patients reported a prevalence of 29.7% for ectopic eruption and 8.4% for hypodontia.[4]Thongudomporn and Freer investigated the prevalence of dental anomalies in 111 orthodontic patients and found that 74.8% had at least one dental anomaly.[10] Basdraet et al. reported that dental anomalies were most commonly found in class II division 2 malocclusion subjects, followed by class III then class II division 1 subjects.[1] Endo et al reported that hypodontia in 3358 Japanese orthodontic patients has a prevalence rate of 8.5%.[15]Altug-Atac and Erdemn found that 5.46% of the total group of Turkish orthodontic patients had at least one developmental dental anomaly.[16] However, Uslu et al. found that 40.3% of the orthodontic patients had at least one dental anomaly.[17] In Brazil, Gomes et al reported that the prevalence of hypodontia among 1,049 orthodontic patients was 6.3%.[18]

Because of the high rates of dental anomalies in orthodontic patients and due to the lack of studies that document the prevalence of these anomalies in Saudi Arabia, we investigated the prevalence of dental anomalies in a sample of Saudi orthodontic patients, and we studied the association of the dental anomalies (supernumerary, hypodontia, macrodontia, microdontia, ectopic eruption and impaction) with different types of malocclusions in this study.

MATERIALS AND METHODS

Pretreatment dental casts and panoramic radiographs were obtained after searching through the archive of the Orthodontic Clinic at the College of Dentistry, King Saud University. Six hundred and two patients who fulfilled the inclusion criteria formed the sample of the present study. The selection criteria were based on the followings: All subjects should be in the permanent dentition stage, available pretreatment panoramic radiographs, and available pretreatment study models (neatly trimmed and with no broken teeth). Patients with syndromes, developmental anomalies such as ectodermal dysplasia, cleft lip or palate, Down's syndrome, extractions of any permanent teeth, history of a previous orthodontic treatment, prosthodontic treatment or trauma to any tooth before the commencement of orthodontic treatment were excluded.

Panoramic Radiographs Evaluation

The following dental anomalies were investigated using the OPG and the dental models (third molars were excluded):

a. Number abnormality:
   - *Supernumerary teeth*: Those which develop in addition to the normal complement.[19]
   - *Hypodontia:* The congenital absence of one or few teeth.[20]

b. Shape abnormality:
   - *Macrodontia:* A tooth that is substantially larger than average normal size or to the contra-lateral homolog or a tooth of the same group from the opposing arch.[21]
   - *Microdontia:* A tooth that is much smaller than the average normal size, or its contralateral homolog or a tooth of the same group from opposing arch (e.g. peg-shaped lateral incisors).[21]
   - *Fusion:* Two tooth germs unite to form a single large crown with two root canals.[22]
   - *Gemination:* Arises when a single tooth germ splits into partially or fully separated crowns but with a common root or root canal.[22]

c. Eruption abnormality:
   - *Impaction:* A tooth that was unerupted after complete root development.[23]
   - *Ectopic eruption:* Eruption of a tooth not in its normal position.

Study Cast Evaluation

One trained examiner assessed the molar relationship (anteroposterior dental arch relationship) on the basis of Angle's definition. Molar class I was defined as occurring where the mesiobuccal cusp of the upper first molar occluded with the mesiobuccal groove of the lower first molar or within the range of 2 mm anteriorly or posteriorly. Molar class II was defined as occurring where the mesiobuccal cusp of the upper first molar occluded anterior to the class I position (> 2 mm). Molar class III was defined as occurring where the mesiobuccal cusp of the upper first molar occluded posterior to the class I position (> 2 mm).

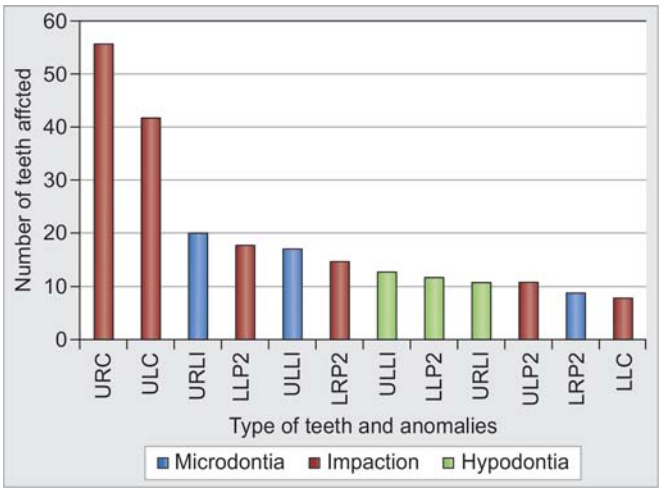
Data were evaluated using statistical package software system, version 13 (SPSS 13.0®) (SPSS Inc, Chicago, Illinois, United States), and descriptive statistical analysis (mean, standard deviation) were calculated to assess the prevalence of dental anomalies. The association of the dental anomalies with different types of malocclusions was studied using Chi-square test.

RESULTS

In the present study, the error of the method was determined by repeating the evaluations of dental anomalies and molar relation from 20 panoramic radiographs, and pairs of study casts within a 2-week interval. All investigations were made by the same operator. Kappa statistics were calculated to

determine the reliability of determining each dental anomaly and molar relation. Kappa score of 1, indicating a perfect agreement between the first and the second evaluations, was observed.

There were a total of 220 (36.54%) out of 602 patients with developmental dental anomalies; (49.5%) were males and (50.5%) were females. The most common type of anomaly was impaction (51.4% of the teeth), especially impaction of the upper right canine (56 teeth), followed by the upper left canine (42 teeth). The second most common type was hypodontia (20%), followed by microdontia (12.5%), macrodontia (8.4%), ectopic eruption (4.7%) and supernumerary (3.5%). No gemination or fusion cases were found in the sample. Graph 1 shows the ranking of the distribution of the teeth most affected by dental anomalies.



Graph 1: Distribution of the teeth most commonly affected by dental anomalies (U: upper, L: lower, R: right, L: left, C: canine, LI: lateral incisor, P2: second premolar)

Table 1: Distribution of dental anomalies across gender (by patient)

Anomalies	*Male (n)*	*Female (n)*	*Total (%)*
Hypodontia	19	23	42 (19.1%)
Supernumerary	5	6	11 (5%)
Impaction	55	61	116 (52.7%)
Ectopic eruption	9	2	11 (5%)
Macrodontia	9	4	13 (5.9%)
Microdontia	12	15	27 (12.3%)
Total	109	111	220 (100%)

Pearson Chi-square showed a p-value of 0.19 indicating a non-significant difference

Table 1 shows the distribution of anomalies across gender. Results showed that the distribution of dental anomalies was almost equal between males (109 subjects) and females (111 subjects). Hypodontia, supernumerary, impaction and microdontia were more common in females. Ectopic eruption and macrodontia were more common in males. Chi-square showed that there was no statistically significant association ($p < 0.05$) between dental anomalies and gender.

Table 2 shows the distribution of dental anomalies by region. The most commonly affected area, the upper anterior region, exhibited 200 dental anomalies (58.1%), followed by the mandibular premolars region, 76 anomalies (22.1%), the maxillary premolars region, 32 anomalies (9.3%) and the mandibular anterior region, 24 anomalies (7%). Table 3 shows the distribution of both hypodontia and microdontia of upper lateral incisors across gender.

Distribution of dental anomalies in subjects with different molar relations was shown in Table 4. Dental anomalies were commonly found in class I molar relationship (50%) followed by asymmetric molar relation (28.6%), class II (17.3%), then in class III molar relation (4.1%).

Distribution of the total number of anomalies in relation to gender and across molar classes was presented in Table 5. About 68.5% of the males had no anomalies, 14.9% had one anomaly and 16.6% had more than one anomaly. Females' results were almost equal to males with 69.6% of them having no anomalies, 14.4% having one anomaly and 16% having more than one anomaly. Chi-square test was used to determine if there was an association between dental anomalies and molar classes in males and females. The results showed that there was no statistically significant association between dental anomalies and molar classes in males and females ($p < 0.05$). Graph 2 illustrates the total number of subjects in each molar class and the number of subjects with at least one dental anomaly in both females and males.

Table 2: Distribution of dental anomalies in anterior and posterior regions (by tooth)

Anomalies	*Maxillary anterior teeth*	*Mandibular anterior teeth*	*Maxillary premolars*	*Mandibular premolars*	*Maxillary molars*	*Mandibular molars*	*Total (%)*
Hypodontia	27	9	11	22	-	-	69 (20%)
Supernumerary	6	-	1	4	1	-	12 (3.5%)
Impaction	100	10	19	37	6	5	177 (51.4%)
Ectopic eruption	6	2	1	5	-	-	14 (4.7%)
Macrodontia	19	2	-	8	-	-	29 (8.4%)
Microdontia	42	1	-	-	-	-	43 (12.5%)
Total (%)	200 (58.1%)	24 (7%)	32 (9.3%)	76 (22.1)	7 (2.03%)	5 (1.45%)	344 (100%)

Table 3: Distribution of hypodontia and microdontia of upper lateral incisors across gender

	Hypo #12	*Hypo #22*	*Micro #12*	*Micro #22*	*Hypo #12 & Micro #22*	*Hypo #22 & Micro #12*	*Hypo#12 & 22*	*Micro#12 & 22*	*Total (%)*
Male	-	-	1	1	1	2	3	7	15 (41.7%)
Female	2	2	4	3	1	1	5	3	21 (58.3%)
Total (%)	2 (5.5%)	2 (5.5%)	5 (13.9%)	4 (11.1%)	2 (5.5%)	3 (8.3%)	8 (22.2%)	10 (27.8%)	36 (100%)

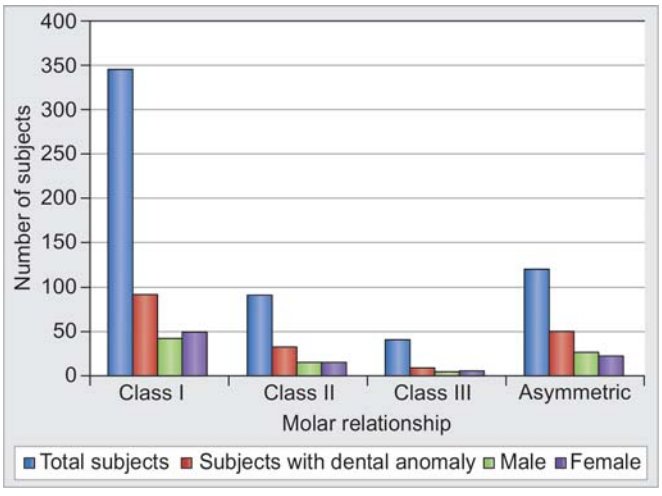
Table 4: Distribution of each type of dental anomalies across molar classes (n, %)

Anomaly	*Molar relationship*				*Total (%)*
	Class I	*Class II*	*Class III*	*Asymmetric*	
Hypodontia	20	10	1	11	42 (19.1)
Supernumerary	7	1	-	3	11 (5%)
Impaction	59	21	6	30	116 (52.7%)
Ectopic eruption	3	-	1	7	11 (5%)
Macrodontia	4	3	-	6	13 (5.9%)
Microdontia	17	3	1	6	27 (12.3%)
Total (%)	110 (50%)	38 (17.3%)	9 (4.1%)	63 (28.6%)	220 (100%)

Table 5: Distribution of the total number of anomalies in relation to gender and across molar classes (n, %).

Gender	*Molar classes*				*Total*
	Class I	*Class II*	*Class III*	*Asymmetric*	
Males with 0 anomalies	115 (72.3%)	30 (63.8%)	17 (81%)	36 (58.1%)	198 (68.5%)
Males with 1 anomaly	22 (13.8%)	4 (8.5%)	3 (14.3%)	14 (22.6%)	43 (14.9%)
Males with >1 anomaly	22 (13.9%)	13 (27.7%)	1 (4.7%)	12 (19.3%)	48 (16.6%)
Total	159	47	21	62	289
Females with 0 anomalies	138 (73.8%)	29 (63%)	15 (75%)	36 (60%)	218 (69.6%)
Females with 1 anomaly	24 (12.8%)	10 (21.7%)	3 (15%)	8 (13.3%)	45 (14.4%)
Females with >1 anomaly	25 (13.4%)	7 (15.3%)	2 (10%)	16 (26.7%)	50 (16%)
Total	18	46	20	60	313

Pearson Chi-square for males showed a p-value of 0.06, and for females a p-value of 0.16, indicating a nonsignificant difference.



Graph 2: Distribution of subjects with dental anomalies in each malocclusion

DISCUSSION

This study provides practitioners with a database for the percentages of occurrence of each type of dental anomaly and teeth that are mostly affected by each type in a sample of Saudi orthodontic patients. It also correlates the molar classification of malocclusion with the types of dental anomalies. The study was limited by its retrospective design that may sometimes overlook relevant historical information. In addition, the study did not evaluate structural and root anomalies due to lack of periapical radiographs.

Our results revealed that 36.54% of the total study group had at least one dental anomaly. This was in agreement with the results reported by Uslu et al. but it was significantly lower than Thongudomporn and Freer study prevalence rate.[10,17] Our results revealed that impaction was the most common dental anomaly, however, Thongudomporn and Freer reported that the most common dental anomaly was invagination followed by impaction.[10]Altug-Atac and Erdem and Uslu et al. reported that hypodontia was the most common dental anomaly in Turkish orthodontic patients.[16,17] In the Thongudomporn and Freer study, the age range was 10.2 to 20.6 years, thus the sample included patients with mixed dentition. In such an early stage, it is difficult to determine if the tooth is impacted or not. In addition, their sample was relatively small and may not be representative of the related population. Altug-Atac and Erdem did not evaluate impaction in their study, while Uslu et al defined impaction as 'the tooth that is not expected to erupt

completely into its normal functional position based on clinical and radiographic assessment'. This definition was not accompanied by a methodology that determines how a tooth is described as impacted clinically or radiographically.

When we compared our results to studies that measured dental anomalies among nonorthodontic patients in Saudi Arabia, differences were seen in the reported prevalence. Salem found that 3.2% of the dental patients had dental anomalies. This result was significantly different from ours, a result that confirms that our orthodontic patients had a higher prevalence of dental anomalies when compared with the general population.[6] However, our results were comparable to those reported by Ghaznawi et al who found that 32.5% of their sample had at least one dental anomaly.[8] The discrepancy in the reported dental anomalies prevalence between Salem and Ghaznawi et al might be due to fact that the sample selected by Salem included patients in the primary dentition and did not separate the percentage of anomalies in the primary and the permanent teeth. In addition, differences in the sample size between the two studies may have also affected the results. Our results were not in agreement with results by Salem and Ghanzawi et al regarding the most common type of dental anomaly affecting Saudi patients. That could be due to that fact that impaction was not one of the anomalies measured in both studies.[6, 8]

Dental agenesis has been reported to be the most common anomaly in the development of the human dentition and the prevalence of hypodontia varies greatly from 0.03% to 10.1% in various populations.[24] This can be attributed to different sample sizes, testing methods, geographic locations, and subject ages and ethnicities. Our results showed that hypodontia is the second most common type of anomalies among Saudi orthodontic patients, and the most commonly affected teeth were the upper lateral incisors followed by the lower second premolars. This was in agreement with Salem and Ghaznawi et al.[6,8] However, Al-Emran et al and Osujiet al. found that the most commonly affected teeth were the lower second premolars.[9,25] A possible explanation for our sample being on the high end of the spectrum for the prevalence of congenitally missing teeth is the fact that the sample being derived from a teaching institution. Private orthodontic practitioners may tend to refer certain patients to teaching institutions, particularly, patients with multiple congenitally missing teeth who will require significant prosthetic replacement of the missing teeth and/or who would be more likely to require a longer than traditional treatment duration. In our study, agenesis was most prevalent in the maxillary anterior region followed by the mandibular premolars region. The reported prevalence rates for each tooth affected by hypodontia vary according to the population. In Caucasian studies, the mandibular second premolars and the maxillary lateral incisors were the most frequently absent.[26] The mandibular second premolar was the most commonly affected in all of the United Kingdom studies.[14,27] A study of some Asian populations suggested that the mandibular incisor was the most commonly absent.[28]

In the literature, the occurrence of supernumerary teeth was a lesser common finding than other developmental anomalies.[16] In our study, the prevalence of supernumerary teeth was greater than the reported results of the Saudi general population.[6,8,9] The results were also higher than those of the studies on other orthodontic patient populations. Lind, Horowitz, Rubenstein, Thongudomporn and Freer, Altug-Atac and Edrem, and Uslu et al reported the prevalence range of 0.3-3.6%.[10-13,16,17]This might be due to racial and ethnic differences. Previous studies stated that 90 to 98% of all supernumerary teeth were present in the maxilla and most commonly in the premaxilla region.[29,30] Our results revealed that the most commonly affected area was the maxillary anterior region and this was in agreement with Altug-Atac and Erdem and Uslu et al studies.[16,17] Many studies reported that the most common type of hyperdontia is mesiodens, however, in this study, only 2 cases were reported.[29,30] Early detection and extraction of mesiodens before presenting for orthodontic treatment may have contributed to such low prevalence.

Our results revealed that impaction was the most common dental anomaly. Thongudomporn and Freer study found that impaction was present among 9.9% of the subjects in their sample, while Uslu et al reported a smaller percentage (2.9%). Differences in the reported prevalence of impaction might be due to differences in the size of the sample, patient's age and the criteria that was used to diagnose impaction. Uslu et al defined impaction as a tooth that is not expected to erupt completely into its normal functional position based on clinical and radiographic assessments, while Thongudomporn and Freer did not mention their diagnostic criteria for canine impaction.[10,17] In our study the most commonly affected teeth with impaction were the upper canines and the most affected region was the upper anterior region, which was in agreement with previous studies.[10,17]

In the present study, the maxillary anterior region was the most commonly affected region by ectopic eruption, and the most commonly affected tooth was the upper left canine. This was in agreement with previous studies.[10,17,31]

Our results revealed that 5.9% of our subjects had macrodontia and the most commonly affected area was the maxillary anterior region. This prevalence value was high compared to previous studies.[8,16] Ghaznawi et al reported that the sizes of the teeth were morphometrically determined

by clinical, radiographical and study models. Only gross deviations in sizes easily discernible by clinical judgment were accepted. In this definition, there is a high possibility of individual variations because what can be easily detected by a clinician may not be detected by another, especially that in their study more than one examiner participated in the detection of anomalies and that might have affected their results.

The most common tooth abnormality is the variation in tooth size, particularly of the maxillary lateral incisors.[32] In our study, we found that 12.3% of the subjects had microdontia. Following the trend observed in previous anomalies, this prevalence was higher than the value (5.35%) found by Ghaznawi et al in their sample of Saudi general population.[8] In orthodontic patients, a variable prevalence estimation range of microdontia (0.7-9.9%) was reported.[10,16,17] The most commonly affected region was the upper anterior region, mainly the upper lateral incisors. This was in agreement with previous reports.[8,16] The distribution in our study was also in agreement with previous studies that reported that bilateral hypodontia was more common than unilateral hypodontia.[16,33] Results also showed that bilateral hypodontia and microdontia cases of the upper lateral incisor were more frequent than the unilateral cases, a finding that clinicians should be aware of particularly due to its effect on orthodontic diagnosis and treatment planning. In our study, no statistically significant correlations were observed between sex and dental anomalies. This was in agreement with Thongudomporn and Freer and Endo et al.[10,15] Uslu et al reported that there was a significant correlation between females and microdontia and ectopic eruption, which might be due to inclusion of more females (548) than males (352) in their study.[17]

Our results revealed that no malocclusion group had a statistically significant relationship with multiple dental anomalies. However, dental anomalies were more commonly found with class I followed by asymmetric molar relation, class II and then class III molar relation. This was in agreement with Horowitz who found that the majority of aplasia was found in Angle class I cases.[11]Uslu et al reported that class I group had the highest rate of dental anomalies, followed by the class III, class II division 2 and class II division 1. Similarly, Basdra et al reported that the occurrence rate of all congenital tooth anomalies was significantly higher in class III subjects when compared to class II division 1.[1,17] Class III molar relationship was the least common to be associated with dental anomalies in our study. There are three possible explanations: (1) In our study, we had a lower percentage of class III cases compared to both previous studies. (2) Both studies divided class II cases into division 1 and 2, while such division was not available in our study. (3) Our classification was based on molar relation, while in both studies they classified it based on both molar and skeletal relationship.

CONCLUSION

In the light of the present retrospective study, the following conclusions can be drawn:

- The prevalence of dental anomalies among Saudi orthodontic patients was higher than the general population.
- The most common types of the investigated anomalies were: impaction followed by hypodontia, microdontia, macrodontia, ectopic eruption and supernumerary.
- No statistically significant correlations were observed between sex and dental anomalies.
- Dental anomalies were more commonly found in class I followed by asymmetric molar relation, then class II and finally class III molar relation. No malocclusion group had a statistically significant relation with any individual dental anomaly.

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