



Complications associated with specific characteristics of supernumerary teeth

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Objectives. The purpose of this study was to identify the characteristics of supernumerary teeth, analyze the associated complications, and to present new clinical knowledge on surgical interventions for supernumerary teeth.

Study Design. This retrospective cohort study was based on the medical records and radiographic records of patients who underwent surgical extraction of supernumerary teeth. The relationships among the patient's age, gender, anatomic features of supernumerary teeth, and presence and type of complications (i.e., spacing, rotation, delayed eruption of the adjacent tooth, cyst formation.) were investigated. The groups were compared by using the Mann-Whitney U test, the Kolmogorov-Smirnov test, and multiple logistic regression analysis ($P < .05$).

Results. The study population consisted of 705 participants who underwent extraction for 1036 supernumerary teeth. The mean age of the participants was 11.5 years, and 73.5% of the participants were males. The complication rate was 55.6%. Variables associated with an increased risk of complications were the patient's age, dentition, tuberculate shape, and horizontal direction of eruption ($P < .05$).

Conclusions. An increase in the patient's age or abnormalities in the shape and direction of eruption of supernumerary teeth was associated with complications. These parameters should be considered while formulating the treatment plan. (Oral Surg Oral Med Oral Pathol Oral Radiol 2020;130:150–155)

Patient age at the first dental visit has decreased owing to the increasing interest in children's oral health. Moreover, the frequency of detection of supernumerary teeth has also increased. Supernumerary teeth are teeth that develop in addition to the normal dentition and can be found in almost any region in both dental arches.¹ The etiology of supernumerary teeth is not well understood, but several hypotheses have been formulated to explain their occurrence. One such hypothesis attributes their formation to the dichotomy of the tooth bud, whereas others attribute it to hyperactivity of the dental lamina, or a combination of genetic and environmental factors.^{2–5} The presence of supernumerary teeth is also associated with several syndromes, including cleft lip and palate, cleidocranial dysostosis, and Gardner syndrome.² The frequency of development of supernumerary teeth in the permanent dentition is 0.15% to 3.9% in Caucasians and greater than 3% in individuals of Mongoloid race.⁶ The frequency of occurrence in the primary dentition is 0.2% to 0.8%, 2.8%, and 7.8% in the Caucasian, Hong Kong, and Taiwanese populations, respectively.⁷

Furthermore, gender-based differences were reported in the frequency of supernumerary teeth. Several studies reported a male/female ratio of 2:1 in Caucasians^{8,9}; Satio et al.¹⁰ reported a male/female ratio of 5.5:1 in the Japanese population, Davis et al.⁶ reported a male/female ratio of 6.5:1 among children in Hong Kong, and Anthonappa et al. reported a male/female ratio of 3.1:1 in Southern Chinese children.⁷ Most supernumerary teeth are asymptomatic, but some supernumerary teeth may cause complications, such as spaces, cyst formation, rotation, delayed eruption, and root resorption of the adjacent tooth.⁷ Supernumerary teeth can be kept under observation. The planning and timing of treatment depends on the location, eruption status, and presence of complications.¹¹ However, there is no consensus on the timing of surgical intervention. Although immediate extraction of supernumerary teeth may harm adjacent teeth, delayed intervention may lead to loss of eruptive force for adjacent nonerupted teeth, midline shift, and loss of the anterior arch curvature.^{1,12,13} This study aimed to identify the characteristics of supernumerary teeth and analyze their associations with complications. The investigators

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Statement of Clinical Relevance

In this retrospective study of patients who underwent surgical removal of supernumerary teeth, parameters, such as age, shape of supernumerary teeth, and direction of eruption, were associated with complications. These parameters should be considered when designing the treatment plan.

hypothesized that the characteristics of supernumerary teeth, including their number, shape, and location, could be associated with complications. The principal aims of this study were to estimate the frequency of complications while extracting supernumerary teeth and to identify the factors associated with an increased risk of complications.

MATERIALS AND METHODS

Study population

This retrospective cohort study included data of patients who had undergone surgical intervention under general anesthesia from January 2011 to December 2018 at the Department of Oral & Maxillofacial surgery at the Pusan National University Dental Hospital. Patients with multiple congenital dental anomalies, such as cleft lip or palate, cleidocranial dysostosis, or Gardner syndrome, in addition to supernumerary teeth, were excluded. The participants' panoramic radiographs and cone beam computed tomography (CBCT) images were analyzed by an oral and maxillofacial surgeon. This study was reviewed and approved by the Institutional Review Board of Pusan National University Dental Hospital (PNUDH-2019-012).

Study variables

The study variables were categorized into patient age, gender, and anatomic features of supernumerary teeth. Complications, which were the outcome variables, were categorized into spacing, rotation, delayed eruption of the adjacent tooth, cyst formation, and so on. We primarily analyzed whether each study variable was related to the presence or absence of complications (complication or no complication). Among them, the study variables related to the presence of complications were examined for the relationship between specific variables and the type of complications. The details of these variables are shown in [Table I](#) and [Figures 1 and 2](#).

Statistical analysis

Data were analyzed by using the SPSS statistical software version 22.0 (SPSS Inc., Chicago, IL). The frequencies among the groups were compared by using the χ^2 test. The results were analyzed with the Mann-Whitney U test and the Kruskal-Wallis test. The Kolmogorov-Smirnov test was used for analyzing patient age. Multiple logistic regression analysis was used for factor analysis of the complications. *P* values less than .05 were considered statistically significant.

RESULTS

Of the 705 patients included, 518 were men and 187 were women, with a male/female ratio of 2.8:1. The mean age of the study patients was 11.5 years (standard deviation [SD] 11.4; range 4–78 years). The early and

late mixed dentition periods were the most (54.6%) and least (5.5%) common periods for surgical extraction of supernumerary teeth, respectively. The most common shapes were the conical and tuberculate shapes, occurring in 68.2% and 16.0% of supernumerary teeth, respectively. Most supernumerary teeth were located in the anterior maxilla (90.4%), followed by the posterior mandible (6.7%). Most supernumerary teeth erupted in the inverted direction (64.0%), followed by the normal direction (16.5%), and eruptions in the horizontal and sagittal directions occurred with a similar frequency (8.8% and 9.1%, respectively) ([Table II](#)).

There was no statistically significant association between the presence of complications and gender or the number of supernumerary teeth ($P = .071$ and $.368$, respectively). With multiple logistic regression analysis, we attempted a multifactor analysis of the number of supernumerary teeth, dentition, shape, position, direction of eruption, and complications. Thus, it could be explained by the model coefficient test result model ($P < .001$).

Spacing was statistically significant in the case of supplemental and tuberculated supernumerary teeth, which was about 0.1 times higher than that of conical shapes ($P = .005$ and $.030$, respectively). Rotation of the adjacent tooth increased about 10-fold in the primary and early mixed dentitions ($P < .001$) and doubled when supernumerary teeth were tuberculate in shape ($P = .008$). The risk of delayed eruption increased by 6 to 8 times in the primary and early mixed dentitions ($P = .008$ and $.004$, respectively) and tripled when the direction of eruption was horizontal ($P = .025$). Finally, a statistically significant relationship was observed between patient age and cyst formation ([Table III](#)). The incidence of cyst formation increased by greater than 5 times with a 10-year increase in patient ages ($P = .025$) ([Table IV](#)).

DISCUSSION

The number of complications associated with supernumerary teeth has increased proportionally with the increase in the frequency of their diagnosis. Clinicians are primarily concerned about the possibility of surgically extracting supernumerary teeth without complications and the ideal timing for extraction. Moreover, specific associations between the characteristics of supernumerary teeth and their complications, as well as identification of the specific complications that are particularly triggered, remain elusive because of lack of criteria or consensus.

Therefore, this study aimed to identify the characteristics of supernumerary teeth and analyze their associations with complications. Patient age and shape and direction of supernumerary teeth eruption were characteristically associated with complications.

Table I. Classification of supernumerary tooth

Categories		Classification	Definition	
Influencing variable	Gender	Female		
		Male		
	Age (years)	4 to ~78		
		Number	1	
			2	
	≥ 3			
	Dentition ¹⁴	Primary dentition	No permanent teeth, but only deciduous teeth	
		Early mixed dentition	The eruption of the first molar or permanent incisors (or both)	
		Late mixed dentition	Eruption of at least one premolar or canine assumed	
		Permanent dentition	No deciduous teeth, but only permanent teeth	
	Shape ²	Conical	Small/peg shaped tooth with normal root	
		Supplemental	Duplication of tooth in the normal series	
		Tuberculate	Barrel-shaped tooth, which has more than a cusp or tubercle	
		Atypical	No regular shape	
Position	Anterior maxilla	Between the canines on both sides of the maxilla		
	Posterior maxilla	Maxillary area except anterior maxilla		
	Anterior mandible	Between the canines on both sides of the mandible		
	Posterior mandible	Mandibular area except anterior mandible		
Direction	Normal		The axis of tooth is between 0 and 45 degrees from the longitudinal axis of body in both coronal and sagittal cuts	
		Inverted	Upside down	
	Horizontal		The axis of tooth is between 45 and 90 degrees from the dental midline in coronal cut	
		Sagittal	The axis of tooth is between 45 and 90 degrees from the longitudinal axis of body in sagittal cut	
	Others		When the direction cannot be identified because of irregular tooth shape or resorption	
Outcome variable	Complication	None		
		Spacing	There is space between teeth that is more than half of the adjacent crown size.	
		Rotation of adjacent tooth	There is an angle difference of greater than 30 degrees in the normal tooth direction.	
		Delayed eruption of adjacent tooth	The eruption height difference is more than half the crown length of adjacent teeth.	
		Cyst formation	The follicle size is greater than 5 mm.	
Others		example Resorption of adjacent tooth.		

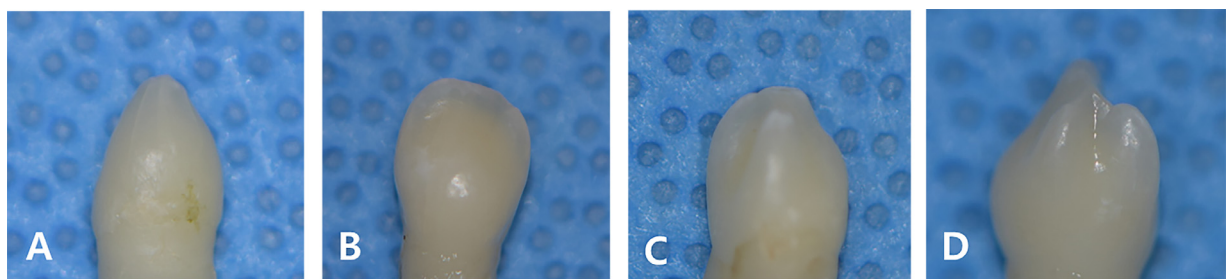


Fig. 1. Classification of supernumerary tooth shape. **A**, Conical. **B**, Supplemental. **C**, Tuberculate. **D**, Atypical.

Similar to previous studies, the conical shape was the most commonly observed shape in this study as well (68.2% of supernumerary teeth). The incidence of the tuberculate shape, which was seen in 16.0% of supernumerary teeth, was low, but the incidence of complications associated with it was as high as 69.0%. Compared with a conical supernumerary tooth, a tuberculated supernumerary tooth is 0.1 to 2 times more likely to cause rotation and spacing of adjacent teeth,

respectively. Foster suggested that tuberculate supernumerary teeth do not erupt properly, thereby affecting the eruption of adjacent teeth, and that conical supernumerary teeth erupt frequently, and thus, they do not interrupt the eruption of the adjacent teeth.⁸ Moreover, spacing between adjacent teeth was statistically significant for supplemental teeth because it seems that supplemental supernumerary teeth are regarded as normal teeth that try to erupt.

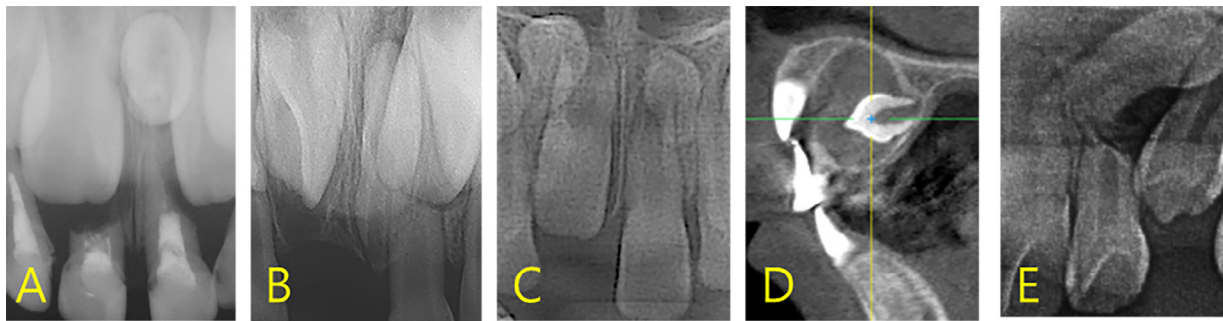


Fig. 2. Classification of complications. **A**, Spacing. **B**, Rotation of adjacent tooth. **C**, Delayed eruption of adjacent tooth. **D**, Cyst formation. **E**, Others. example Root resorption of adjacent tooth.

Table II. Analysis by each study variables according to presence or absence of complication.

Study variables	No. of complications (n = 313)	Complications (n = 392)	(N=705)	
			X ² /z	P
N (%)				
Gender				
Male	219 (70.0)	299 (76.3)	3.55	.071
Female	94 (30.0)	93 (23.7)		
Age*				
> 10	184 (58.8)	317 (80.9)	5.01	< .001
10–19	94 (30.0)	31 (7.9)		
20–29	19 (6.1)	6 (1.5)		
30–39	8 (2.6)	7 (1.8)		
40–49	4 (1.3)	15 (3.8)		
50–59	4 (1.3)	9 (2.3)		
≤ 60	–	7 (1.8)		
M ± SD	11.55 ± 8.74	11.48 ± 13.11		
Number				
1	187 (59.7)	242 (61.7)	2.00	.368
2	112 (35.8)	140 (35.7)		
≥ 3	14 (4.5)	10 (2.6)		
Dentition			61.75	< .001
Primary dentition	48 (15.3)	56 (14.3)		
Early mixed dentition	124 (39.6)	261 (66.6)		
Late mixed dentition	27 (8.6)	12 (3.1)		
Permanent dentition	114 (36.4)	63 (16.1)		
Position				
Ant. Mx.	270 (86.3)	367 (93.6)	19.51	.001
Post. Mx.	6 (1.9)	4 (1.0)		
Ant. Mn.	1 (0.3)	6 (1.5)		
Post. Mn.	34 (10.9)	13 (3.3)		
Post. Mx. & Mn.	2 (0.6)	2 (0.5)		
Shape				
Conical	222 (70.9)	259 (66.1)	15.67	.003
Supplemental	37 (11.8)	25 (6.4)		
Tuberculated	35 (11.2)	78 (19.9)		
Atypical	19 (6.1)	30 (7.6)		
Direction				
Normal	55 (17.6)	61 (15.6)	12.74	.013
Inverted	215 (68.7)	236 (60.2)		
Horizontal	18 (5.8)	44 (11.2)		
Sagittal	22 (7.0)	42 (10.7)		
Others	3 (1.0)	9 (2.3)		

Ant, anterior; M ± SD, mean ± standard deviation; Mn, mandible; Mx, maxilla; Post, posterior.

*Mann-Whitney U test.

Similar to previous studies, we found that supernumerary teeth were more prevalent among men (2.8:1). The male/female ratio was much lower than that in other Asian countries and similar to that in a study of Caucasians (2:1 in Caucasians, 5.5:1 in the Japanese, and 6.5:1 in those living in Hong Kong).⁷ The differences among races may be attributed to sampling differences among the patients included in this study, who lived in several cities, and the patients included in other studies, who lived in a single city. However, there was no statistically significant association between gender and the presence of complications. Supernumerary teeth were most and least prevalent in the anterior regions of the maxilla (90.4%) and the mandible (1.0%), respectively, as observed by other studies. Supernumerary teeth were found in the mandibular posterior region in 47 of 705 patients (6.7%) (see Table II), and complications were found in 13 of 47 patients (27.7%). However, 270 of 637 teeth (42.4%) in the anterior region of the maxilla had complications. The alveolar bone in the mandible posterior region is wider than that in other regions of the jaw, and so supernumerary teeth might have sufficient space for eruption, limiting the impact on adjacent teeth. Thus, supernumerary teeth in the mandibular posterior region are associated with fewer complications.

As observed by Tay et al.,¹⁵ most supernumerary teeth in this study were in an inverted position (64.0%). Although the horizontal position was less common (8.8% of supernumerary teeth) (see Table II), the incidence of complications associated with it was as high as 71.0%. Horizontally directed supernumerary teeth rarely erupt, and this has a significant impact on adjacent teeth, subsequently delaying the eruption of adjacent teeth (see Table II).

In contrast to other studies,^{16,17} which suggested that in an adult population, the mesiodens did not have any effect on adjacent teeth, we found that there was a statistically significant correlation between patient age and cyst formation caused by supernumerary teeth. The incidence of cyst formation increased by greater than

Table III. Frequency of complications by age

Complication	None (N = 313)	Spacing (N = 106)	Rotation (N = 131)	Delayed eruption (N = 101)	Cyst formation (N = 51)	X ²	P
Age (M ± SD)							
< 10	184 (58.8)	105 (99.1)	117 (89.3)	87 (86.1)	7 (13.7)	109.88	< .001
10–19	94 (30.3)	–	13 (9.9)	13 (12.9)	3 (5.9)		
20–29	19 (6.1)	–	1 (0.8)	1 (1.0)	4 (7.8)		
30–39	8 (2.6)	–	–	–	7 (13.7)		
40–49	4 (1.3)	1 (0.9)	–	–	14 (27.5)		
50–59	4 (1.3)	–	–	–	9 (17.6)		
≤ 60	–	–	–	–	7 (13.7)		
M ± SD	11.55 ± 8.74	6.91 ± 4.15	7.17 ± 2.65	7.88 ± 2.68	39.21 ± 19.30		

M ± SD, mean ± standard deviation.

*Kolmogorov-Smirnov test.

Table IV. Analysis of variables causing complications

Variable	OR (95% CI)	P	Variable	OR (95% CI)	P
Spacing			Rotation		
Shape	Ref.: conical		Dentition	Ref.: Permanent dentition	
Supplemental	0.06 (0.01–0.43)	.005	Primary dentition	9.71 (4.06–23.18)	< .001
Tuberculated	0.09 (0.01–0.79)	.030	Early mixed dentition	9.62 (4.44–20.84)	< .001
			Shape	Ref.: conical	
			Tuberculated	2.24 (1.23–4.08)	.008
Delayed eruption			Cyst formation		
Dentition	Ref.: Permanent dentition		Age	Ref.: < 10 (years)	
Primary dentition	6.12 (1.60–23.46)	.008	> 10	5.72 (1.25–26.23)	.025
Early mixed dentition	8.17 (1.98–33.66)	.004			
Direction	Ref.: Normal				
Horizontal	3.37 (1.16–9.25)	.025			

CI, confidence interval; Ref., reference.

*Multiple logistic regression analysis.

5 times, as the age of patients increased by 10 years ($P = .025$). Dentigerous cysts were the most common cysts in this study. The incidence of cysts increases significantly with age, as these cysts develop slowly as a result of fluid accumulation between the reduced enamel epithelium and the unerupted tooth crown.

The rotation and delay in the eruption of adjacent teeth were significantly higher in the primary or early mixed dentition than in permanent teeth. It is likely that supernumerary teeth have a greater influence on adjacent teeth because deciduous or permanent teeth erupt during the primary or early mixed dentition period.

A limitation of the study is that long-term follow-up of the cases with supernumerary teeth was not performed. There is no risk of recurrence after extraction of supernumerary teeth; thus, additional follow-ups were not needed if the teeth were extracted before the occurrence of complications. Moreover, additional treatments and follow-ups are often performed in other departments, such as orthodontics and pediatrics. Investigating patients who had undergone follow-up without extraction of supernumerary teeth could have

helped correlate the characteristics of supernumerary teeth with complications.

The timing of surgical intervention is still being debated among clinicians. Some authors have suggested that extraction of supernumerary teeth in the early mixed dentition period facilitates spontaneous eruption and alignment of adjacent teeth.^{15,18-20} Others have suggested that surgical intervention should be delayed until age 8 to 10 years when root development of the maxillary central and lateral incisors is almost complete.²¹ Furthermore, if the mesiodens is close to the adjacent permanent incisors, delayed surgical extraction is recommended because early surgical interventions may injure the Hertwig epithelial root sheath and cause disruption or cessation of future development of the affected roots.²² Munns¹³ stated that the earlier the mesiodens is removed, the better is the prognosis. Garvey et al.¹ reported satisfactory eruption of succeeding teeth and absence of associated pathologic lesions and risks of damage to the vitality of succeeding teeth without extraction of supernumerary teeth. Moreover, observation is recommended for

supernumerary teeth with no associated symptoms or effect on the dentition. However, cyst formation was observed to increase significantly with age in this study, suggesting that retention of supernumerary teeth for a prolonged duration may be associated with complications. This supports the importance of early extraction of supernumerary teeth. Moreover, complications are more likely to occur if the supernumerary tooth is tuberculate in shape or if the direction of eruption is horizontal.

Therefore, early surgical extraction of supernumerary teeth with anomalous shapes and direction of eruption, irrespective of the presence or absence of symptoms, is crucial. Clinicians should consider the association between the clinical and radiographic characteristics of supernumerary teeth and the complications while formulating a treatment plan.²³

CONCLUSIONS

In this retrospective study of patients who underwent surgical removal of supernumerary teeth, parameters such as age, the shape of the supernumerary teeth, and the direction of eruption were associated with complications. In the future, further comparative studies based on long-term follow-up of operated and non-operated patients will be needed.

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