ORIGINAL ARTICLE

Postoperative prognosis of unerupted teeth after removal of supernumerary teeth or odontomas

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Introduction: Impacted teeth do not always erupt spontaneously after removal of supernumerary teeth or odontomas. The purpose of this study was to examine the effect of several variables on eruption of impacted teeth in children with supernumeraries or odontomas. **Methods:** The sample consisted of 53 patients with 69 impacted teeth; the supernumeraries or odontomas were removed without other interventions. The patients were identified retrospectively and followed until the impacted teeth erupted to their correct positions or until orthodontic traction was started. **Results:** Loss of space, a second surgical procedure, a third surgical procedure, and orthodontic treatment were recorded in 77.6%, 53.8%, 9.4%, and 85% of the patients, respectively. Spontaneous eruption occurred in 83%, 75%, 46%, 19%, and 32% of the impacted teeth with normal and small size superlative, conical, tuberculated, and odontoma forms, respectively. In the univariate analysis, spontaneous eruption correlated with apex distance of the impacted tooth relative to its estimated position ($P < .001$), extent of vertical impaction ($P < .001$), obstacle form ($P < .019$), stage of root development of supernumerary tooth ($P = .006$), angle of impaction relative to the midline ($P = .015$), and time of surgery ($P = .05$). In the multivariate logistic regression analysis, higher distraction of the apex of the impacted tooth relative to its estimated correct position and the obstacle form (tuberculated and odontomas) were independently associated with impediment of spontaneous eruption ($P = .03$ and $P = .04$, respectively). **Conclusions:** Spontaneous eruption of impacted teeth correlated mostly with lower distraction of the impacted tooth apex and obstacle form (conical and superlative). Immediate orthodontic traction is recommended concomitantly with the first surgery to remove supernumerary teeth. (Am J Orthod Dentofacial Orthop 2007;131:614-9)

Twenty-eight percent to 60% of the supernumerary teeth are associated with disruptive eruption of permanent teeth.[1-8] Treatment usually involves surgical removal of the obstruction. However, opinions differ concerning the optimal time for surgical intervention.[9] Some recommend removal soon after diagnosis to prevent loss of eruption potential, loss of space and midline shift, and more extensive surgical and orthodontic treatment for correction. Others favor postponing surgery until complete root development of the neighboring incisors cause damage, devitalization or malformation of adjacent teeth, and might be unnecessary if complications will not develop in the future.[10,11]

A second dilemma associated with surgical removal of supernumerary teeth is that, unfortunately, 42% (sum of published data, 175 of 413; range, 21%-50%)[2-4,7-9] of impacted teeth do not erupt after this treatment, and additional surgical intervention is required, such as exposure or orthodontic traction. Of the impacted teeth, 55% (sum of published data, 104 of 188)[3,4,9] need orthodontic treatment because of space loss or ectopic eruption. Moreover, the time for all affected incisors to completely erupt without orthodontic treatment is 7 months to 3 years, with an average of 20 months.[4] To prevent the need for additional surgery, some practitioners combine the first surgery with orthodontic traction in advance. Because young children, who might require generalized anesthesia for treatment, are usually involved, choosing an approach can be difficult.

Several factors, such as degree of apical displacement, maintenance of sufficient arch space, chronological age, degree of root maturity,[8] inclination of the impacted tooth, root curvature of the impacted tooth,[12]

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and conical as opposed to trabeculated form of the supernumerary (63% vs 36%, respectively)[9] can influence the rate of spontaneous eruption after removal of supernumerary teeth. However, due to the lack of clinical material, few studies have validated the influence of these factors.[3]

The purpose of this study was to correlate different variables to spontaneous eruption of an impacted tooth after removal of supernumerary teeth and to assess the incidence of reoperated and orthodontically treated patients.

MATERIAL AND METHODS

The participants in the study were children who underwent surgical removal of supernumerary teeth, including odontomas, to facilitate eruption of impacted teeth, without initial orthodontic intervention. They were followed until eruption of the impacted tooth or start of orthodontic treatment. Children with syndromes or more than 4 supernumerary teeth, or without outcome of follow-up, were excluded. The final sample included 53 children (31 boys, 22 girls) from 4 to 16 years of age, with 69 impacted teeth. Mean age at the first operation was 9.21 ± 2.41 years (median, 9 years). Table I shows the distribution of ages. Thirty-three children had 45 impacted teeth because of 49 supernumeraries, and 20 children had 24 impacted teeth because of 26 odontomas.

Data were obtained from consecutive clinical and surgical records of patients examined and followed by the Departments of Pediatric Dentistry at Tel Aviv University and Sheba Medical Center from 1993 to 2000. Three children were treated at the Department of Orthodontics, Hadassah School of Dental Medicine. Additional patients were obtained from biopsy reports, Department of Pathology, Tel Aviv University, from 1993 to 2000. Patients who were treated at Tel Aviv University and Tel Hashomer Hospital were followed by analyzing their files. Follow-up data for the other patients were obtained from referring dentists or orthodontists, or directly from the patients. The Ethics Committee of Tel Aviv University approved the study.

A total of 138 radiographs were available: 43 panoramic, 68 periapical, 23 occlusal, and 4 lateral. There were 24 surgery reports and 2 clinical slides. Most patients had a minimum of 2 radiographs taken. All available radiographs were analyzed as well as clinical slides and surgical records. Although the radiographs were not standardized and comparative data were not completely accurate, the assumption was that significant variables would still be expressed. The following information was recorded.

1. Patient characterization: date of birth, sex, age at operation for supernumerary removal; dates, types, and number of radiographs taken for diagnosis; date of operation in relation to the expected eruption date according to dental age.
2. Characterization of the obstacle: type of supernumerary tooth (conical, supplemented, tuberculated, or odontoma), number of supernumerary teeth per patient; shape and stage of root development of the supernumerary teeth. This evaluation was coded as follows: range of crown, 0; 0%-25% of root formation, 1; 25%-50% of root formation, 2; 50%-75% of root formation, 3; 75% to complete root formation, 4. The position of the supernumerary as related to the correlated impacted tooth was recorded as mesial, distal, or overlapping.
3. Characterization of the impacted teeth: number and type, stage of root development on the day of operation for obstacle removal (coded as described above), angulation of the tooth relative to the maxillary midline suture, tooth rotation around its axis, distance in millimeters of the tooth apex relative to its expected position, and degree of impaction of the unerupted tooth relative to its erupted antimere in the arch. This was coded as described above.
4. Subsequent results and treatments: spontaneous eruption after the first surgery, position of the erupted teeth in the arch, space loss with or without correlation to eruption position of the adjacent teeth, subsequent surgical procedures, or orthodontic treatment required to facilitate eruption of the impacted teeth. Also recorded were the times from diagnosis to eruption and second surgery, or until orthodontic treatment was started.

Statistical analysis

The Student *t* test and the chi-square test were used to calculate the significance of differences between continuous and nominal variables, respectively. For the chi-square tests of dichotomous variables, the continuity correction was applied. Analyses were made with a standard statistical package (version 10.0, SPSS, Chicago, Ill).

RESULTS

Seventy-five supernumeraries, including odontomas, were diagnosed, and 73 were evaluated for type. Fifty were located in the maxillary incisor area. A histologic diagnosis was found in 20 of the 26 odontomas: 12 complex odontomas (8 in the maxilla, 4 in the mandible) and 8 compound (3 in the maxilla, 5 in the mandible).

Table I. Distribution of ages in sample

Age (y)	*Number of patients*
<6	3
6-7	7
8-11	35
12-15	7
>15	1

Table II. Eruption rate of impacted teeth in relation to associated supernumerary teeth

Type of supernumerary	*Number of spontaneous eruptions/ total impacted teeth (%)*
Small superlative	3/4 (75%)
Normal size superlative	5/6 (83.3%)
Conical	6/13 (46.2%)
Tuberculated	4/21 (19%)
Odontoma	7/22 (31.8%)
Unknown	0/3 (0%)
Total eruption rate	25/69 (36.2%)

Of 69 impacted teeth, 45 were due to the supernumerary teeth and 24 due to the odontomas. Supernumerary tooth types were evaluated in 66 impacted teeth (Table II). Most were located in the maxillary anterior region (80%) and the rest in the mandible. Impactions were equally split between sides, with 34 on the right and 35 on the left.

No significant differences were found in the probability of spontaneous eruption of maxillary anterior or posterior teeth, and maxillary or mandibular teeth. Spontaneous eruptions of the lateral incisors were similar to the central incisors ($P = .09$). However, when impacted teeth due to supernumerary teeth (not including odontomas) were evaluated separately, spontaneous eruption of the maxillary central incisors was limited to 30.3% of the patients, whereas all lateral incisors erupted ($P = .02$).

Table II summarizes the distribution of spontaneous eruption as correlated with types of supernumerary teeth. Spontaneous eruption of the impacted tooth was statistically correlated with the form of the obstacle ($P < .019$). The spontaneous eruption rate of impacted teeth associated with tuberculated and odontoma forms was 85% lower than for teeth associated with conical, small superlative, or superlative forms ($P < .007$). Three deciduous teeth (mandibular left second molar, maxillary right and left canines) were included. All were impacted due to odontoma and erupted spontaneously after the operation.

The first surgery was 18.9 ± 36.6 months after the estimated eruption age (median, 13 months; range, 11.4-16.8 months). Because time of surgery occurs after estimated time of eruption, the probability for spontaneous eruption decreases ($P = .05$) with 2% reductions with each month delay. However, age per se at first surgery was not correlated with eruption (Table III).

Table III. Spontaneous eruption in relation to timing of surgery relative to estimated eruption age

Timing of surgery relative to eruption (mo)	*Spontaneous eruption*		
	No (%)	*Yes (%)*	*Total (%)*
Earlier than eruption (<0)	9 (45)	11 (55)	20 (100)
0-6	3 (60)	2 (40)	5 (100)
6-12	7 (77.8)	2 (22.2)	9 (100)
>12	25 (71.4)	10 (28.6)	35 (100)
Total	44 (63.8)	25 (36.2)	69 (100)

The position of the supernumerary teeth—coronal, mesial, distal, or overlapping with the impacted tooth—did not correlate with spontaneous eruption.

The lower the stage of root formation of the supernumerary, the lower the probability for spontaneous eruption ($P = .006$).

When data of partial eruption were combined with full eruption, 3 or 4 supernumeraries were more often associated with noneruption ($P = .037$).

No correlation was found between stages of root formation of the impacted teeth and spontaneous eruption.

Five variables associated with degree of impaction were analyzed; they are summarized in Table IV.

Total follow-up time from first surgery to eruption of the impacted teeth or until start of orthodontic treatment was 4 to 60 months (23 ± 13 months; median, 21.5 months).

Space loss occurred in 38 of 49 patients (77.6%). No information could be obtained about this variable for 4 patients.

In 33 of 53 patients, the lateral incisors erupted at the time of the first surgery. No statistical correlation was found between space loss and eruption status of the lateral teeth at the first surgery ($P = .095$).

Of 53 patients, 28 (52.8%) were reoperated. Waiting times until the second operation ranged from 6 to 36 months (average, 15.5 ± 8.6 months; median, 12 months). Reoperation was significantly ($P = .015$) positively correlated to angle of impacted tooth relative to the midline with an 11.3% increase with each angle change.

Five patients had 3 operations: 3 with odontoma, 1 with a supernumerary tooth and impaction of a maxil-

Table IV. Variables examined for association with spontaneous eruption by univariate analysis

Variable	*Statistical significance (P value)*
Distance of apex of impacted tooth from estimated correct position	<.001
Depth of impaction (on vertical dimension) of impacted tooth relative to antimere	<.001
Lower root development of supernumerary teeth	.006
Tuberculated or odontoma forms	<.007
Wide angle of long axis of impacted tooth relative to midline of the jaw	.015
3 or 4 supernumeraries	.037
Time of surgery relative to eruption age of impacted tooth	.05
Rotation of impacted root around its axis	NS

NS, Not significant.

lary central incisor, and 1 with 2 supernumeraries and impaction of both maxillary central incisors. The third operation was performed after 1 to 48 months (average, 19.2 ± 17.78 months; median, 19 months) after the second operation. In 1 patient, who also suffered from minimal brain damage, it was decided 4 years after the second operation to extract the impacted tooth, which was erupted to an extreme ectopic position, and the child was unable to fully cooperate for orthodontic treatment.

A total of 44 teeth did not erupt (63.8%), 6 partially erupted and required further intervention (8.7%), 12 spontaneously erupted into ectopic position (17.4%), and only 7 spontaneously erupted to the correct position. Approximately 90% of the impacted teeth in 85% of the patients required orthodontic treatment to resolve the underlying problem.

DISCUSSION

A male predominance for supernumerary teeth from 62.2% to 87% has been reported.[7-10,13-15] In our study, 58.5% of the boys were affected. However, male predilections were 78.8% in the supernumerary patients and 40% in the odontoma patients. Thus, in this study, sex predilection differed for the supernumerary and the odontoma patients.

Opinions vary concerning the optimal time for surgical intervention.[10,11] In our study, surgery after the estimated time of eruption decreased the probability for spontaneous eruption. However, age per se at first surgery was not correlated with eruption. These results could clarify the findings of Witsenburg and Boering[14] in which there was no relationship between age at surgery and spontaneous eruption. Our results agree with others.[5,6,8,16-19] Mason et al[9] found that teeth with immature roots (28%) and mature incisors (63%) were among those that needed additional surgery. In a longitudinal study of 375 cases, Rotberg and Kopel[20] concluded that immediate removal (before 5 years of age) is superior to delayed removal (after 7 years of age), since the prevalence of future complications, such as displacement and retarded eruption, is reduced by 39%, and additional surgical or orthodontic treatment is reduced by 45%. Also, there is less bone loss when surgery is performed before the age of 5 years. Early removal of supernumerary teeth raises the question of potential damage to the developing adjacent teeth during surgery. Therefore, Di Biase[21] recommended early removal only when tuberculated and inverted conical forms of supernumerary teeth interfere with the eruption of adjacent teeth, because the supernumeraries do not erupt and often create complications. Otherwise, patients should be observed until the root of the permanent tooth has completely formed. Notwithstanding, Högström and Andersson[10] showed that early intervention (before 11 years) does not interfere with the development of adjacent immature teeth. Additional studies are needed to evaluate the effect of early intervention on the root development of adjacent teeth. One question remains unanswered. How early should the supernumerary tooth be removed if an early diagnosis is made and the decision is to extract the supernumerary tooth?

There are 4 main different types of supernumerary teeth[3,12-14]: peg-shaped, usually with complete root formation; incisiform or supplemental teeth in normal or smaller size; tuberculated form, in which the crown anatomy consists of multiple tubercles, and their width is equal to their length as a result of incomplete or total absence of root formation. Figure 1 demonstrates the radiographic appearance of the 3 types of supernumerary teeth (not including odontoma). In this study, odontoma and tuberculated-formed supernumerary teeth were significantly more often associated with eruption failure than the other types (P <.007); this agrees with the results of other studies.[2,5-7,9,12,13] However, most of the studies did not report their statistical evaluations and did not include odontomas. Because tuberculated teeth have incomplete or total absence of root formation, the correlation between supernumerary root formation and spontaneous eruption of the impacted tooth was also examined. A statistically significant negative correlation (P = .006) was found between root formation of the supernumerary teeth and spontaneous eruption of the impacted teeth. This agrees with the results of Di Biase,[13] who mentioned that



Fig. Radiographs showing 3 main types of supernumerary teeth: **A,** conical; **B,** normal size superlative; **C,** small size superlative; **D,** tuberculated.

supernumerary root formation is a striking factor correlating with disturbances of eruption.

In this study, there was no correlation between stage of root development of impacted teeth and the probability of spontaneous eruption; this agrees with Witsenburg and Boering.[14] Additional data are needed to elucidate the contribution of this factor to spontaneous eruption.

A correlation was found between the angle of the impacted tooth as related to the midpalatal suture and spontaneous eruption after surgery ($P = .015$). The correlation between the position of the impacted tooth to spontaneous eruption has been previously shown, but no statistical evaluation was carried out to verify this clinical impression.[12] Interestingly, this was the only variable to correlate with the second operation.

In this study, apical displacement was correlated with spontaneous eruption ($P < .001$). This factor could have a significant contribution to the failure of eruption after the first surgery.[3] However, Witsenburg and Boering[14] did not find a correlation between apical displacement and spontaneous eruption. Nevertheless, contrary opinions concerning the significance of this factor do exist.[12]

In this study, the 3 impacted teeth with curved roots did not erupt spontaneously after the first surgery. Since there is no substantial data in the literature, the question of whether unerupted curved teeth do not erupt because of deflected paths remains unanswered.

In this study, orthodontic treatment was required during treatment in 85% of the patients; this is higher than reported (57% and 75%) in other studies.[7,14] This can be attributed to the variation in esthetic demands of different populations and to the different samples examined (a higher percentage of odontomas). The mean follow-up period until eruption or initiation of orthodontic treatment was 23 ± 13 months; in other studies, it was 7 months to 3 years.[3,4,17,21] The long follow-up time could have negatively influenced the child's self-esteem at a critical time (teenage), necessitating several follow-up visits and increased exposure to x-rays. When all things are considered—eg, some children might need 2 surgical procedures, sometimes under general anesthesia—it would be justified to provide all impacted incisors with orthodontic traction during the first operation; this agrees with other studies.[7] However, it is in contrast to the study of Primosch,[12] who, based on 4 studies, concluded that 75% of impacted teeth will erupt naturally once the supernumerary tooth is removed. However, only 2 of these studies followed patients with impacted teeth due to supernumeraries until eruption. In 1 study of 56 patients, 25% needed reoperations, and the frequency of orthodontic treatment was 60%. As awareness of esthetic demands increase, so does orthodontic treatment. Therefore, patients who were untreated in the past would probably want treatment today.

In this study, 77.6% of the patients experienced space loss. This could be a reason for the secondary inhibition of spontaneous eruption of the impacted tooth. Thus, it is highly recommended that a space maintainer be considered for each child who is a candidate for surgery to remove a supernumerary tooth. When space is lost before surgery, it is advisable to extract the obstacle after the space is regained to increase the probability of spontaneous eruption postoperatively. The space maintainer will also improve the child's esthetic appearance during the follow-up period.

CONCLUSIONS

A unique sample of all types of supernumeraries including odontomas associated with impacted teeth and surgery to remove the obstacle without further intervention was presented. The results showed that spontaneous eruption of an impacted tooth after removal of a supernumerary tooth or odontoma depends on several factors, such as distance of the apex of the impacted tooth relative to its estimated position, depth of impaction, stage of root development of the supernumerary tooth, angle of impaction relative to the

midline, time of surgery relative to the expected eruption time of the impacted teeth, number of supernumerary teeth (more than 2), and loss of space. Because of the high prevalence of orthodontic treatment with long follow-up times, immediate orthodontic traction is recommended concomitant with the first surgery to remove the supernumerary teeth.

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