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Original Article

Clinical evaluation of the timing of mesiodens removal

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Abstract

Background: Mesiodens is a common clinical finding among children and has a higher prevalence in Asian populations. The timing of the removal of mesiodens remains controversial. Clinical studies comparing early versus late removal are lacking. The aim of this retrospective study was to evaluate the frequency of clinical complications regarding the timing of childhood mesiodens removal and to explore the factors associated with complications following mesiodens removal.

Methods: In total, 384 Taiwanese children diagnosed with unerupted mesiodens who had attended the Pediatric Dentistry Department, Taipei Veteran General Hospital, Taipei, Taiwan from 2005 to 2012 were identified as potential participants. Among these patients, 105 children had received surgical odontectomy of the mesiodens under general anesthesia and had complete longitudinal clinical and radiographic follow-up records, including computed tomography (CT) evaluations; these patients were enrolled. The influence of age, the developmental stage of the adjacent permanent teeth, and the location of the mesiodens were explored regarding complications that were noted at the time of surgery, injury to the adjacent permanent teeth during surgical intervention, and the need for orthodontic treatment after surgery.

Results: The 105 children enrolled had 145 mesiodens. Removal of the mesiodens before the child was 5 years of age or 1/3 root-completed was associated with fewer complications at the time of surgery and a reduced need for orthodontic treatment after surgery. However, no significant difference was noted between the different groups in terms of surgical injury to the adjacent permanent teeth.

Conclusion: The early removal of an unerupted mesiodens before the age of 5 years would seem to reduce complications and the need for orthodontic treatment. With the help of general anesthesia and evaluation by CT imaging, concerns regarding the child's cooperation and the possibility of damage to adjacent permanent teeth during early surgical intervention can be minimized.

Keywords: mesiodens; supernumerary tooth; surgical odontectomy; surgical removal

1. Introduction

A supernumerary tooth is defined as an excess in the number of teeth when compared to the normal dental set and can occur in almost any region of the dental arch, but with a particularly strong predilection of about 90% towards the premaxilla area.[1] The most common type of supernumerary tooth is a mesiodens, which is located in the maxillary central incisor region. The prevalence of mesiodens varies between different racial groups, and there is a higher frequency in the Asian population of about 3% or even higher compared to the Caucasian population.[2,3] In addition, it appears that males are more commonly affected than females, with a reported ratio of 5.5:1 among Japanese and from 3.1:1 to 6.5:1 among Hong Kong children.[2–5]

The etiology of the occurrence of supernumerary teeth remains unclear. A combination of genetic and environmental factors has been proposed. In addition, several systemic disturbances, such as Gardner syndrome, cleidocranial dysplasia,

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orofaciodigital syndrome, Rothmund-Thomson syndrome, and cleft lip/palate have been reported to be associated with the occurrence of supernumerary teeth.[6]

Most mesiodens are unerupted during early mixed dentition with the reported range being 79–91%.[1,7,8] Furthermore, their presence is often detected during a routine clinical or radiographic examination without there being an association with any pathology in 7–20% of the cases surveyed.[9] In such cases, close follow-up without intervention is considered reasonable, but parents of the child should be warned regarding complications.[10,11] The presence of a mesiodens in certain circumstances can interfere with normal eruption and the position of the adjacent permanent dentition; such effects include prevention or delaying of eruption, retardation of development, root resorption, dilaceration, displacement associated problems like malocclusion, midline diastema/rotation, supernumerary tooth-associated cystic formation, and eruption into the nasal cavity.

The timing of mesiodens removal has remained controversial. Some studies have supported delayed intervention until the root development of the adjacent teeth is almost completed, which usually means that the patient is 8–10 years of age.[6] An operation at this time is then considered in order to reduce the possibility of harm to adjacent permanent tooth germs. However, there are some potential disadvantages to this approach, including a loss of eruption potential regarding the central incisors, the loss of anterior arch space, a midline shift, the need for more extensive orthodontic treatment, and a requirement for surgical exposure of the impacted incisors.[6,12,13] Other studies have proposed that mesiodens should be removed as soon as possible after the condition has been diagnosed in order to prevent the possible drawbacks mentioned above. This usually means before the patient has reached the age of 6 years; however, such an approach involves the risk of damaging developing tooth germs that are nearby.[6] Although many theoretical approaches have been proposed, most studies published have been case-series, and there has been only one cohort study.[14] Up to the present, there has been no research exploring the interrelationship between the location of the mesiodens in relation to its nearby permanent central incisors and the harm that surgery may cause.

Therefore, the main purpose of this retrospective study was to evaluate if the timing of mesiodens removal from children was associated with the frequency of clinical complications. The influence of the patient's chronological age, the dental maturity stage of permanent central incisors adjacent to the mesiodens, and the vertical location of the mesiodens were explored with respect to their effect on the frequency of clinical complications at the time of surgery, the effect of the surgical intervention on the adjacent permanent teeth, and the need for subsequent orthodontic treatment or further surgery for exposing the impacted incisor.

2. Methods

Initially, 384 Taiwanese children with unerupted mesiodens were identified after they had attended the Pediatric Dentistry Department, Taipei Veteran General Hospital, Taipei, Taiwan from 2005 to 2012. The diagnosis of mesiodens was based on a radiographic examination and/or an additional computed tomography (CT)/cone-beam CT examination. The patients accepted for the study from the above group met the following inclusion criteria: (1) receiving surgical odontectomy of their mesiodens under general anesthesia; and (2) having complete records longitudinally covering both clinical and radiographic follow-up. Individuals with pathology-confirmed odontomas, any medical condition or syndrome associated with the presence of supernumerary teeth, a history of pathological apical lesion, or dental trauma affecting the maxillary incisors were excluded from this study.

Based on the clinical and radiographic examinations, the following information was collected: age; gender; present dentition; the number, morphology, and orientation of the mesiodens; dental maturity stage of the permanent central incisors (Table 1)[15]; the location of the mesiodens relative to the adjacent permanent central incisors; any complications associated with the presence of the mesiodens, including the presence of midline diastema > 2 mm, delayed tooth eruption, tooth rotation, loss of tooth vitality, root resorption of any nearby permanent tooth; signs of surgical injury to the adjacent permanent teeth, including dilaceration, arrest of root development, root resorption, loss of vitality of a tooth, or loss of the lamina dura, the need for further orthodontic treatment and the need for further surgery due to exposure of an unerupted permanent incisor after initial surgery.

The association between the age when surgical removal of the mesiodens took place (≤ 4 years old, 5 years old, 6 years old, 7 years old, 8 years old, and ≥ 9 years old), the stage of dental maturity of the permanent central incisors (Stage ≤ 6, Stage 7, Stage 8, and Stage ≥ 9), the location of the mesiodens relative to the permanent central incisors (crown, cervical, root, or root apex) were analyzed in relation to, firstly, the rate of clinical complications associated with the presence of mesiodens noted at the time of surgery, secondly, the frequency of injuries to the adjacent permanent teeth during surgical intervention and, thirdly, the frequency of subsequent orthodontic treatment or a second surgical intervention for exposing the impacted incisor.

Table 1
Dental maturity was evaluated according the stages proposed by Nolla.[15]

Stage	Developmental condition
Stage 0	Absence of crypt
Stage 1	Presence of crypt
Stage 2	Initial calcification
Stage 3	One-third of crown completed
Stage 4	Two-third of crown completed
Stage 5	Crown almost completed
Stage 6	Crown completed
Stage 7	One-third of root completed
Stage 8	Two-third of root completed
Stage 9	Root almost completed–open apex
Stage 10	Apical end of root completed

Statistical analysis was carried out using SPSS version 19.0 (SPSS Inc., Chicago, IL, USA). In addition to the stages of dental maturity, for which inter- and intraexaminer reliability were determined, all radiographic diagnoses were made by two examiners who were postgraduate dentists, and a consensus was reached if there were differences in opinion. Interexaminer reliability was tested using Cohen's Kappa; specifically, 25 mesiodens were randomly chosen by computer, and the stages of dental development were separately determined by the two examiners. The Kappa value was 0.76, indicating a substantial interexaminer consistency. Fisher's exact test was carried out to test the association between the variables during the various comparisons and $p < 0.05$ was considered to be statistically significant.

3. Results

In total, 105 patients were enrolled in our analysis [82 (78.1%) males and 23 (21.9%) females]. These individuals had a mean age at the time of surgical removal of the mesiodens of 6.35 ± 1.85 years, with a range of 3–12 years (Table 2). Overall, 38 (36.2%) of the patients had a mesiodens in their primary dentition, 62 (59.0%) had one present in the early mixed dentition, four (3.8%) had one present in the late mixed dentition, and one (1.0%) had one present in the permanent dentition. There were 65 patients (61.9%) with a single mesiodens and 40 patients (38.1%) with two mesiodens bilaterally. When these 145 mesiodens were examined, there were 130 (89.7%) of conical shape, 11 (7.6%) of tuberculate shape, and four (2.8%) of a supplemental type. In addition, 125 mesiodens (86.2%) were inverted, 17 (11.7%) were normal, one (0.7%) was transverse (M-D) and two (1.4%) sagittal (A-P).

Among the 145 mesiodens examined in the study, 54 mesiodens (37.2%) were identified as the cause of an associated complication (midline diastema, 52.2%; delayed eruption, 25.4%; rotation of an adjacent tooth, 16.4%; single tooth crossbite, 3.0%; root resorption of an adjacent tooth, 1.5%; loss of vitality of an adjacent tooth, 1.5%; and cyst formation, 1.5%). On statistical analysis, a significant difference was found regarding the complications noted at the time of mesiodens removal between patients who were aged younger than 5 years old and those who were aged 5 years or older ($p =< 0.001$; Table 3). Similarly, a statistically significant difference was noted for complications when patients who had a dental development stage that was lower than Stage 7 were compared to patients who were Stage 7 or above ($p < 0.0001$; Table 4).

Five cases had signs of injuries to one or more adjacent permanent teeth as a result of the surgical intervention based on the follow-up radiography (retarded root development, 3; root resorption with loss of tooth vitality of a permanent incisor, 1; and loss of the lamina dura, 1). Most complications were noted when the patients were aged 9 years or more (15.8%; Fig. 1), when the stage of dental development was about 9 (8.33%; Fig. 2), when the location of the supernumerary was cervical (6.25%), and when the location of the supernumerary was in the root area (7.89%) of an associated incisor (Fig. 3). However, no significant difference was noted

Table 2
Distribution of age and dental maturity stage of the permanent central incisor of 105 patients enrolled.

		No. of patients (%)
Total		105 (100)
Age (y)	Mean (range)	6.35 ± 1.85 (3–12)
	≤ 4	17 (16.2)
	5	17 (16.2)
	6	24 (22.9)
	7	24 (22.9)
	8	9 (8.6)
	≥ 9	14 (13.2)
Dental stage[a]	Mean (range)	7.70 ± 1.26 (5–10)
	≤ 6	19 (17.7)
	7	21 (19.6)
	8	37 (34.6)
	≥ 9	30 (28.1)

[a] Nolla's[15] method.

Table 3
The association between total cases with clinical complications noted at the time of mesiodens removal and the various ages of the patients.

Age (y)	≤ 4	5	6	7	8	≥ 9
≤ 4	—	0.490	<0.001*	<0.001*	<0.001*	<0.001*
5		—	<0.001*	<0.001*	<0.001*	<0.001*
6			—	0.450	0.719	>0.99
7				—	0.294	0.398
8					—	0.702
≥ 9						—

*$p < 0.05$, Fisher's exact test.

Table 4
The association between total cases with clinical complications noted at the time of mesiodens removal and the development stage of the associated permanent tooth using Nolla's[15] method.

Stage	≤ 6	7	8	≥ 9
≤ 6	—	0.242	<0.001*	<0.001*
7		—	<0.001*	<0.001*
8			—	0.826
≥ 9				—

*$p < 0.05$, Fisher's exact test.

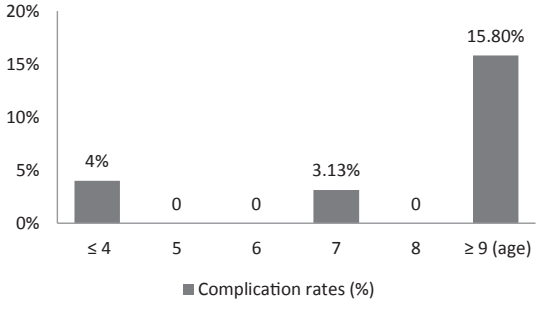

Fig. 1. Complication rates of cases with injury to an adjacent permanent tooth as a result of surgical intervention relative to the age of the patients.

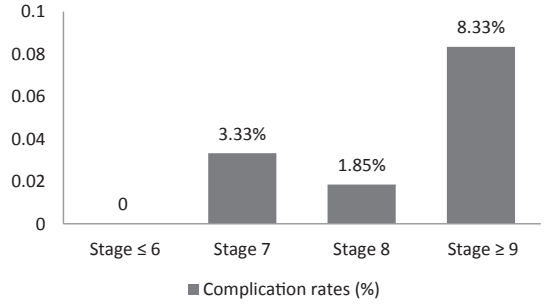

Fig. 2. Complication rates of cases with injury to an adjacent permanent tooth as a result of surgical intervention relative to the development stage of the associated permanent tooth using Nolla's[15] method.

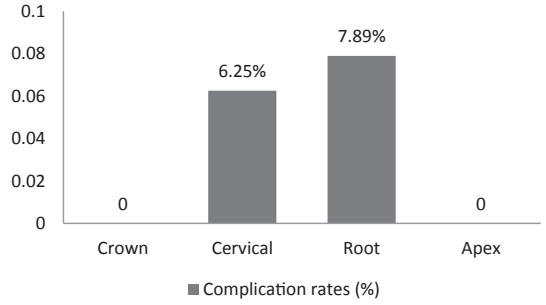

Fig. 3. Complication rates of cases with injury to their adjacent permanent tooth as a result of surgical intervention relative to its position in relation to the permanent central incisors.

with respect to age, dental maturity stage or the location of the mesiodens ($p > 0.05$).

Of the 105 patients who underwent odontectomy, 30 received orthodontic treatment or a second surgery. Of these interventions, 17 (9%) were due to persisting rotation of the affected permanent incisor, six (4.1%) were due to a midline shift > 2 mm, three (2.1%) were due to the presence of a large diastema > 2 mm, three (2.1%) were due to there being an anterior crossbite, and one (0.7%) was because there had been a second surgery due to surgical exposure. A statistically significant difference was noted when the proportion of total patients with subsequent treatment were compared between those aged younger than 5 years and those aged ≥ 5 years (Table 5). Furthermore, a similar result was obtained when the patients with stages of dental development lower than Stage 6 were compared to patients whose stage of development was Stage 7 or more. Finally, a similar result was also obtained when patients at Stage 9 were compared to patients at a lower stage (Table 6).

4. Discussion

More male patients than female patients were enrolled in this study, with the ratio being 3.6:1. This ratio is in agreement with other studies of Asian populations[2,4,5] and is higher than results reported for Caucasian populations, which are approximately 2:1.[6] A gender bias in the predilection to the occurrence of mesiodens strongly favors males in Asian populations.

In agreement with other published reports, conical mesiodens were found to be the most common type in our study; this was followed by tuberculate mesiodens and supplemental-type mesiodens. In addition, the proportion of patients with only one mesiodens present in the mouth was 61.9%, which is similar to the findings in Liu's[24] study (64.3%) and in Anthonappa et al's[4] study (61.5%). None of our patients had more than two mesiodens, but unlike some other studies, odontoma was not counted as a supernumerary tooth. When the orientation of mesiodens was investigated, the majority were of the inverted type, which accounted for 86.2%; this is higher than the frequency presented in the study of Roychoudhary et al,[16] who reported that 62.7% of impacted mesiodens were inverted. This difference might due to the fact that in our study, the normally aligned mesiodens might have already erupted or have been extracted at a local dental clinic before the more difficult ones were referred to our department for further management.

In the present study, 62.8% of the 145 cases (mean age, 6.35 ± 1.85 years) were clinically normal after treatment and did not have any complications that could be associated with the removal of a mesiodens. This percentage is greater than the 53.1%[17] of mesiodens reported to be clinically normal for patients with a mean age of 11 years and much greater than another reported (19.1% of 204 mesiodens) when patients had ages between 6 years and 9.5 years.[5] These differences might be associated with the fact that we enrolled younger patients than did these two studies, with the result that many central incisors remained unerupted. Therefore, it is not surprising that the results of the study show significantly fewer complications when patients were aged < 6 years old and were before Stage 8 of Nolla's[15] classification of dental development. In the present study, the complications resulting from mesiodens

Table 5
The association between total cases with orthodontic treatment or second surgery and the various ages of the patients.

Age (y)	≤ 4	5	6	7	8	≥ 9
≤ 4	—	0.490	0.030*	0.015*	0.006*	<0.001*
5		—	0.276	0.167	0.051	<0.001*
6			—	>0.99	0.248	0.006*
7				—	0.430	0.015*
8					—	0.450
≥ 9						—

*$p < 0.05$, Fisher's exact test.

Table 6
The association between total cases with orthodontic treatment or second surgery and the development stage of the associated permanent tooth using Nolla's[15] method.

Stage	≤ 6	7	8	≥ 9
≤ 6	—	0.117	0.014*	<0.001*
7		—	0.557	0.015*
8			—	0.035*
≥ 9				—

*$p < 0.05$, Fisher's exact test.

removal were consistent with those seen in previous studies.[5,17,18] Midline diastema was the most commonly noted complication, constituting 50% of all cases with complications; this was followed by delayed eruption and rotation of an adjacent tooth. Root resorption, loss of vitality of an adjacent tooth, and cyst formation occurred less often. Thus, malocclusion was the major complication associated with the presence of a mesiodens in the premaxillary regions. Clinically, if patients have a complaint regarding malocclusion of the upper anterior region, the presence of a mesiodens needs to be ruled out early.

Among the patients enrolled in the present study, 30 cases received orthodontic intervention after the surgical removal of a mesiodens. The most common reason for orthodontic treatment of these patients was rotation of the affected permanent incisors, which accounted for 17 cases in the study; by way of contrast, only three cases were related to persistent diastema. This is in contrast to the findings of several previous reports that investigated the recovery and proper alignment of the rotated permanent incisors; those studies suggested that the early removal of mesiodens before the age of 9 years resulted in a proper alignment.[14,19] In our study, there was no evidence to suggest that there was an improvement in permanent incisors rotation after odontectomy. However, it would seem that most problems associated with midline diastema are able to self-correct following the eruption of the lateral incisors and canines. In the present study, only 0.7% (1 case) who was aged 9 years old had a second surgery to correct for the surgical exposure of unerupted central incisors after odontectomy; this incidence is much lower than the findings presented by Foley,[26] in which 27% of cases with a mean age about 9.9 years had a need for such surgery. This is puzzling because the chronological ages of the cases in the present study and the cases in Foley's study are similar. However, the study of Leyland et al[20] pointed out that space availability was an important factor when there was spontaneous eruption of an unerupted tooth after extraction of a mesiodens. The results of this study indicate that the need for the subsequent orthodontic therapy and/or further surgical intervention is significantly reduced when patients undergo odontectomy of a mesiodens at an age that is younger than 6 years and when it is before Nolla's[15] Stage 7. These findings suggest that the early surgical removal of mesiodens before the patient is 6 years old or before the associated central incisor has 1/3 root formation is likely to result in better options for patients.

In the present study, the mean age of the patients at the time of the surgical removal of the mesiodens was 6.35 ± 1.85 years, and only two cases were found to have retarded root development after surgery; one was 4 years old, while the other was 7 years old. These two patients accounted for only 1.59% (2/126) of patients aged < 9 years and 1.83% (2/109) of patients who were before Stage 9 of the Nolla's[15] classification of dental development. By contrast, a greater proportion of complications affecting associated teeth was noted among patients who were older and had a later stage of dental development. These accounted for 15.8% (3/19) of patients and 8.3% (3/36) of patients, respectively. The findings of the current study seem to be in contrast to earlier studies that mention early surgical removal of mesiodens and indicate an increased risk of harm to the tooth germs of adjacent permanent teeth or result in a retardation of tooth development. They suggest that there should be a delay in treatment until there has been almost complete root development of the adjacent permanent incisors, which usually occurs at the age of 8−10 years.[6,21] The present results seem to support recent research by Omer et al,[14] who found early removal of unerupted mesiodens seemed to be advantageous and that more complications are to be expected after a cutoff point of 6 years old or 7 years old, which is when the permanent teeth are about to complete crown formation. In our study, the numbers of cases with injuries to the adjacent permanent teeth postoperatively were too few to reach statistical significance when a comparison between the groups with different ages and different stages of dental development was carried out. With the help of CT or cone-beam CT, which are able to provide accurate three dimensional information about the orientation of the mesiodens, sagittal positioning, local problems, and neighboring anatomic structures, the operator is able to lower the risk of harming adjacent teeth during the operation. All of these factors are of great significance when carrying out a pretreatment evaluation and creating a treatment plan.[22−24] However, if the mesiodens is closed to the adjacent permanent incisors, a delay in the surgical removal is recommended because early surgical intervention may injure Hertwig's epithelial root sheath and cause disruption or cessation of future development of the affected roots.[25]

Finally, there are a number of limitations that affect this study and need to be considered. First, since there was no absolute definition of an early or a delayed intervention, the groupings used for comparison are difficult to choose. Second, the presence of complications related to the associated tooth were in some cases diagnosed only from the occlusal film of a radiograph, which is a two dimensional rather than a three dimensional image; this may have caused an underestimation of the incidence of such cases. Third, excluding cases that were lost during postsurgical follow-up might have led to bias and affected the results.

Based on the findings of the present study, it seems likely that the early removal of unerupted mesiodens before the age of 5 years may significantly reduce future complications and limit the need for orthodontic treatment. With the help of general anesthesia and a CT image evaluation, concerns regarding child cooperation and possible damage to adjacent permanent teeth during such early surgical interventions can be overcome successfully.

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