

Influence of mesiodens on adjacent teeth and the timing of its safe removal

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ABSTRACT

Purpose: To focus on the effects of the presence of mesiodens on adjacent teeth and to investigate the timing of its safe removal.

Materials and Methods: Cone-beam computed tomography examinations, obtained at Okayama University Hospital over a three-year period, were inspected. Data were recorded including the number of mesiodens; associated abnormalities; and the relationship with neighboring structures. Depending on multiple factors, the risk of developing complications due to early extraction of a mesiodens was divided into three categories: high, medium, and low risk.

Results: A total of 5,958 cone-beam computed tomography exams were obtained, 460 patients aged 3-85 years were diagnosed with a total of 568 mesiodens, 382 (67.3%) of which were discovered in young patients (age < 10 years), and 333 (87.2%) of these were associated with abnormalities. Regarding the risk categories, 11 (1.9%) were considered to be in the high-risk, five (0.9%) in the medium-risk and 552 (97.2%) in the low-risk categories. Moreover, eight out of 11 high-risk mesiodens were extracted and no post-operative complications have been seen.

Conclusion: As the results showed that no postoperative complications were seen in all the extracted cases of high-risk mesiodens, this indicates the possibility of safe extraction at an early age which could reduce related future complications. (*Imaging Sci Dent* 2022; 52: 67-74)

KEY WORDS: Tooth, Supernumerary; Cone-Beam Computed Tomography; Tooth Extraction

Introduction

Supernumerary tooth is a dental anomaly defined as an additional tooth beyond the normal number. It can occur in both the maxilla and mandible.¹ The most common type of supernumerary teeth is mesiodens which is an extra tooth located in the premaxilla with a reported prevalence of 0.15%-1.9%.²

Many theories have been developed regarding the etio-

logy of mesiodens. These include atavism, dichotomy, and hyperactivity of the dental lamina, with the last being the most logical and acceptable theory.^{3,4} Additionally, mesiodens might be associated with multiple genetically inherited syndromes such as cleidocranial dysplasia, cleft lip and palate, Gardner's syndrome, and oral-facial-digital syndrome. It has also been reported that environmental and genetic factors play an important role in the development of mesiodens.^{5,6}

Mesiodens can give rise to numerous complications related to both the adjacent teeth and other vital structures. The effects on adjacent teeth may range from displacement, rotation, and interference with normal tooth eruption to even more severe complications such as root resorption

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or abnormal root formation.⁷ Mesiodens may also affect adjacent vital structures, causing perforation of the nasopalatine canal or nasal floor, or the formation of cysts.^{8,9}

Detection of mesiodens usually occurs either during routine radiographic examination or when the patient presents with a chief complaint of failure of normal tooth eruption.¹⁰ Mesiodens can be detected on any plain dental radiograph that includes the premaxillary region. However, mesiodens may be superimposed on adjacent structures, which results in misinterpretation, thus hindering the diagnostic process.¹¹ Therefore, to reach a precise diagnosis and treatment plan, it is essential to identify the three-dimensional (3D) location of the mesiodens by using different radiographical approaches. The same lingual opposite buccal (SLOB) technique has been reported to be useful in the diagnostic process.^{2,4} However, plain two-dimensional (2D) radiographs will always have the same limitations of superimposition, loss of clarity, and magnification problems. The use of 3D radiography, such as computed tomography (CT) and cone-beam computed tomography (CBCT), can help practitioners overcome these limitations. CT has proven to be useful in providing a 3D image and enabling an exact diagnosis to be made. However, the problem with CT lies in its high cost and high radiation dose. The introduction of CBCT technology to dental practice has helped overcome these disadvantages and has provided many benefits for maxillofacial imaging, including rapid scan time, image accuracy, and reduced patient radiation dose.^{12,13}

The exact criteria for treatment planning for mesiodens still remain unclear. The decision is made by each practitioner on the basis of the patient's age and the properties of the mesiodens.¹⁴ Different management approaches have been discussed in the past literature. Some researchers recommended that mesiodens should be left in place with regular follow-up appointments if it does not appear to cause any problems.^{15,16} Other reports suggested the removal of mesiodens; however, the timing of the extraction remains controversial (early versus late). The early approach has been defined as extraction at the time of discovery or, according to some reports, before the eruption of the adjacent permanent teeth.¹⁷ Late intervention has been defined as delaying the extraction until the adjacent permanent teeth have erupted or until their roots have completely formed, to prevent potential damage to the developing permanent teeth.^{4,18}

The aim of our study is to end the controversy regarding the diagnosis and treatment planning of mesiodens. By using CBCT to precisely identify the 3D position of

the mesiodens and study its various effects on adjacent teeth, we can investigate the preferable timing for its safe removal.

Materials and Methods

The study was approved by the ethics committee of Okayama University Graduate School of Medicine, Dentistry and Pharmaceutical Sciences and Okayama University Hospital (1904-008).

This is a three-year retrospective study in which we examined CBCT images taken at the Dental School of Okayama University Hospital from January 2016 to December 2018. The images were taken using Veraviewepocs (Morita, Kyoto, Japan) with a field of view (FOV) of 80 mm × 80 mm, 80 kV, 5 mA, and 9.4 s and 3D Accuitomo F17 (Morita, Kyoto, Japan) with a FOV of 80 mm × 80 mm, 90 kV, 5 mA, and 9.0 s. Over the three years, 5,958 CBCT examinations were obtained. All CBCT images were processed using SYNAPSE VINCENT (Fujifilm Medical Co., Tokyo, Japan) and were thoroughly examined to detect mesiodens and to assess their relationship with adjacent teeth and other vital structures. Additionally, we studied the chronology of the movement of the mesiodens and the development of any mesiodens-related complications.

Images that were excluded from our study were those for patients with congenital diseases associated with supernumerary teeth such as cleft lip and palate, and CBCT images with insufficient FOV. Finally, 460 patients with a total of 568 diagnosed mesiodens were included in the study.

Data were collected for all patients including the patient's age, sex, and dentition phase. A thorough analysis of the 3D location of all mesiodens was performed, and other mesiodens-related data were recorded including eruption status (impacted, semi-erupted, erupted); effects on adjacent teeth (diastema, displacement, rotation, delayed eruption, abnormal root formation, root resorption); and associated abnormalities in the surrounding vital structures (in relation with nasopalatine canal, nasal floor, labiocortical bone, and maxillary sinus, as well as the formation of cysts).

Our study focused on two important points that were thought to be essential for diagnosis and treatment planning: the contact point and the maturity status of the adjacent teeth. The relation between the mesiodens and adjacent teeth has been carefully examined in order to locate direct contact with the vital point which in the present study describes the open apex of the immature tooth. The

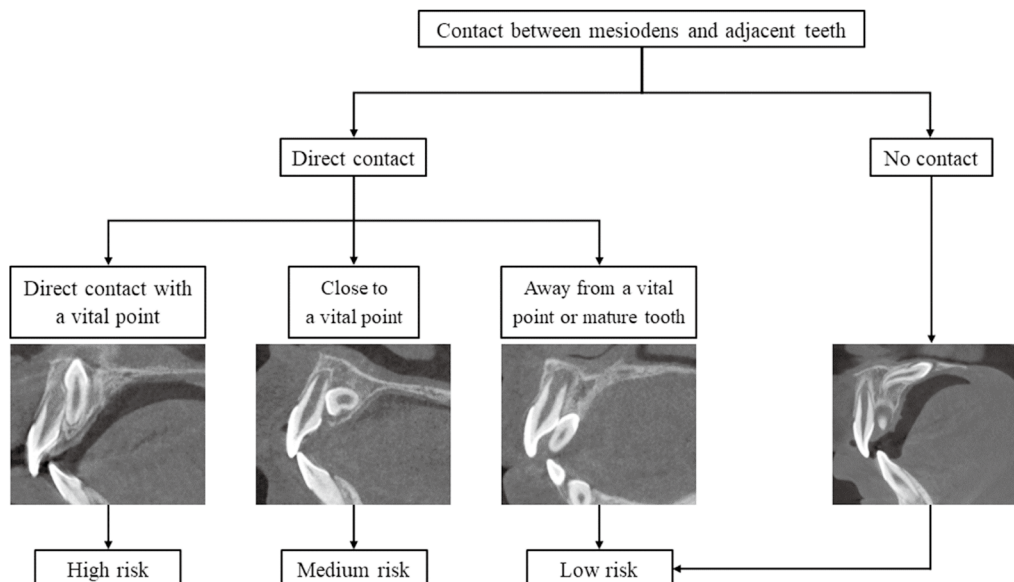


Fig. 1. A scheme shows the classification of risk of developing complications due to extraction of mesiodens depending on the contact between mesiodens and adjacent teeth.

maturity status of the adjacent teeth was assessed by studying both their eruption status (unerupted, semi-erupted, erupted) and the development stage of their roots (incomplete, complete). Taking these two factors into account, the risk of developing complications due to extraction of a mesiodens was divided into three categories: high risk (the mesiodens is in direct contact with a vital point), medium risk (the mesiodens is so close that the adjacent tooth might be injured during extraction) and low risk (the mesiodens is far enough away from any vital point of the tooth or the tooth is mature and unlikely to be affected by external force) (Fig. 1). All other cases in which there is no contact with the adjacent teeth were considered to be low risk cases.

Results

Out of the 5,958 primary CBCT examinations obtained, 460 patients aged 3-85 years (average age 14.5 years) were diagnosed with a total of 568 mesiodens (Table 1). Of these 460 patients, 323 (70.2%) were males and 137 (29.8%) were females (male : female ratio = 2.4 : 1). Among the 568 mesiodens, 531 (93.5%) were discovered during the mixed and permanent dentition phases. Additionally, per their eruption status, 502 mesiodens (88.4%) were impacted.

Of the 568 mesiodens, 382 (67.3%) were found in young patients (age < 10 years), and 333 (87.2%) of these exhibited mesiodens-related abnormalities.

Table 1. Characteristics of mesiodens

		No. of mesiodens (%)
Age	< 10 years old	382 (67.3%)
	≥ 10 years old	186 (32.7%)
Dentition	Primary	37 (6.5%)
	Mixed	400 (70.4%)
	Permanent	131 (23.1%)
Eruption status	Impacted	502 (88.4%)
	Semi-erupted	30 (5.3%)
	Erupted	36 (6.3%)
Total		568 (100%)

Out of 568 mesiodens, 289 (50.9%) exhibited one or more complications related to the adjacent teeth. The most common complication, found in 164 mesiodens (28.9%), was displacement of the adjacent teeth (Table 2, Fig. 2). One rare case (0.2%) was found with calcification of the root canal of the adjacent tooth (Fig. 3). About half (49.1%; 279 mesiodens) showed no dental effects on adjacent teeth. Our records also included one case showing the development of mesiodens-related complications over time (Fig. 4).

Moreover, 351 mesiodens (61.8%) exhibited one or more effects related to surrounding vital structures. The most common effect, found in 233 mesiodens (41.0%), was the association with the nasopalatine canal. In addi-

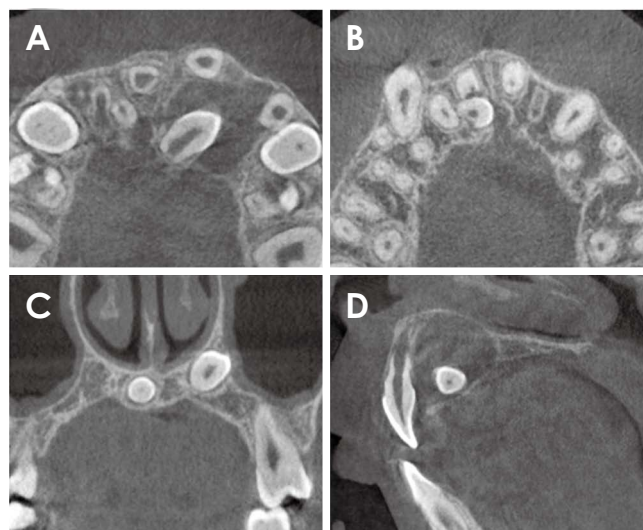


Fig. 2. Cone-beam computed tomographic images of mesiodens-related complications. A. Cyst surrounding left mesiodens cause the displacement of anterior teeth. B. Root resorption of permanent maxillary right central incisor. Note the direct contact between the mesiodens with both the affected tooth and nasopalatine canal. C. Perforation of left maxillary sinus is caused by migrated left mesiodens. D. Abnormal root formation of permanent maxillary central incisor is seen.

Table 2. Mesiodens-related effects on adjacent teeth and other vital structures

Effects		No. of mesiodens (%)
Adjacent teeth	Displacement	164 (28.9%)
	Diastema	98 (17.3%)
	Direct contact	82 (14.4%)
	Delayed eruption	36 (6.3%)
	Rotation	34 (6.0%)
	Abnormal root formation	25 (4.4%)
	Root resorption	17 (3.0%)
	Calcification	1 (0.2%)
Other vital structures	In relation with nasopalatine canal	233 (41.0%)
	In relation with nasal floor	81 (14.3%)
	In relation with labiocortical bone	28 (4.9%)
	Cystic formation	24 (4.2%)
	In relation with maxillary sinus	4 (0.7%)
Total		568 (100%)

tion, 24 mesiodens (4.2%) showed cystic formation. Only 217 mesiodens (38.2%) showed no effects on the surrounding vital structures.

After analyzing the 3D position of the mesiodens using all planes of CBCT (axial, coronal, and sagittal), we were

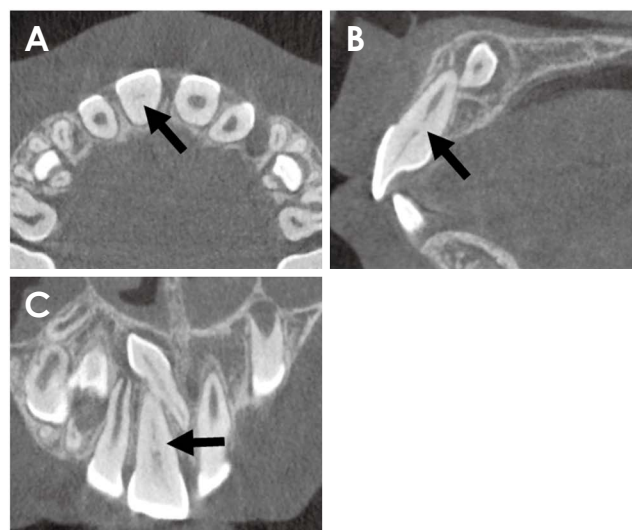


Fig. 3. Mesiodens-related calcification of the root canal of permanent maxillary right central incisor. Note that the mesiodens is in direct contact with the apex of the root. A. Axial cone-beam computed tomographic (CBCT) image. B. Sagittal CBCT image. C. Coronal CBCT image.

Table 3. Characteristics of teeth in direct contact with mesiodens

Characteristics		No. of teeth (%)
Teeth in contact	Primary teeth	8 (9.1%)
	Permanent teeth	80 (90.9%)
Root formation	Incomplete root	63 (71.6%)
	Complete root	25 (28.4%)
Eruption status	Unerupted	17 (19.3%)
	Semi-erupted	16 (18.2%)
	Erupted	55 (62.5%)
Total		88 (100%)

able to locate the exact contact point between the mesiodens and the adjacent teeth and concluded that 82 mesiodens (14.4%) had direct contact with one or more adjacent teeth with the remaining 486 located away with no contact. The total number of teeth in contact with a mesiodens was 88, of which 80 (90.9%) were permanent teeth (Table 3). With regard to root formation, 63 of these adjacent teeth (71.6%) had incomplete root formation, and 25 (28.4%) had completely formed roots. Additionally, 71 adjacent teeth (80.7%) were in a semi-erupted or erupted status. Regarding the risk categories, 11 (1.9%) were considered to be in the high-risk, five (0.9%) in the medium-risk and 552 (97.2%) in the low-risk categories. Out of the 11 mesiodens in the high-risk category, eight were extrac-

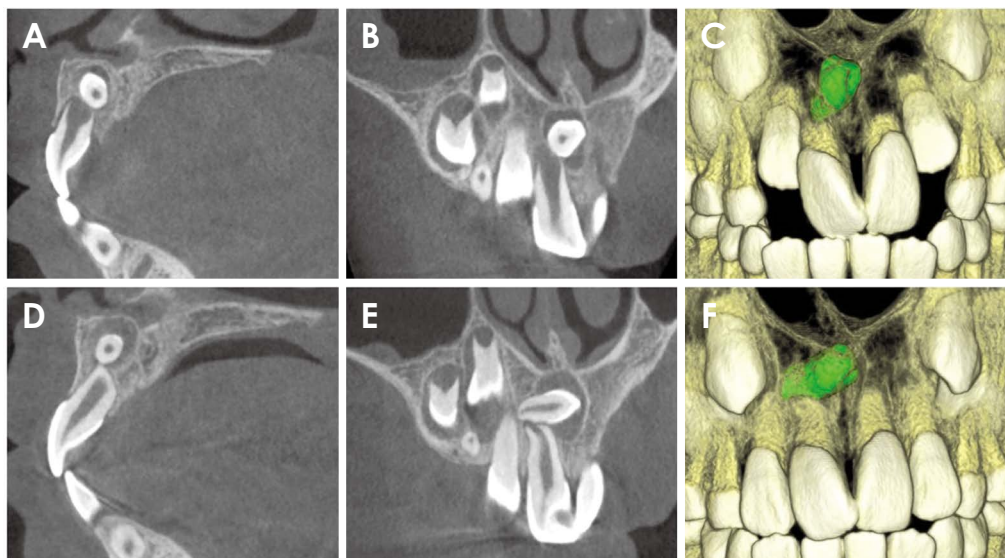


Fig. 4. A case shows the development of mesiodens-related complication over time. In a 7-years-old patient's sagittal (A), coronal (B), and 3-dimensional (C) cone-beam computed tomographic (CBCT) images taken from, a mesiodens is in a horizontal posteroanterior direction and in direct contact with the apex of immature permanent maxillary right central incisor. In the respective CBCT images (D-F) taken 1 year later, the mesiodens changes its direction toward the midline and the abnormal root formation of the right central incisor is seen.

ted and no postoperative complications have been reported. The remaining three mesiodens cases have not undergone any treatment up to the present time.

Discussion

In the present study, we examined CBCT images for the detection of mesiodens. CBCT can provide precise information about the shape and 3D position of mesiodens as well as its relationship with adjacent structures, which are all significant for making a diagnosis and determining the optimal treatment plan.^{1,2}

Mesiodens is the most frequently occurring type of supernumerary teeth. It is a dental anomaly commonly encountered in dental clinics during routine radiographic checkups or when investigating the failed eruption of anterior permanent teeth.¹⁹ Mesiodens is reported to occur more frequently in males than in females with a ratio of 2:1,² which is similar to the ratio of 2.4:1 found in the present study. The age of the patients in our study ranged from 3 to 85 years (average age 14.5 years). Most of the mesiodens in our study were impacted (88.4%), which is consistent with previous studies.^{3,6,20} Therefore, it is advisable to perform regular checkups at a young age for early detection before the development of complications.

The presence of mesiodens may lead to several esthetic or clinical complications if it is not detected and treated early.³ Various complications related to adjacent teeth and

anatomical structures have been reported. Previous studies reported that delayed eruption and diastema are the most common complications related to adjacent teeth.^{11,21,22} In the current study, the most common complication was displacement of adjacent teeth (28.9%), followed by diastema (17.3%) and delayed eruption (6.3%). A rare finding in one case was calcification of the root canal of the permanent tooth adjacent to the mesiodens. Regarding effects on the surrounding structures, it was found that 41% of mesiodens were in relation with the nasopalatine canal, 14.3% with the nasal floor, and 4.9% with the labiocortical bone. These percentages are similar to those reported by Mossaz et al.⁹ Additionally, 4.2% of mesiodens showed cystic formation, which is higher than some reported literature,^{1,12} possibly because our study included a wider range of patient ages (3-85 years). Asaumi et al.⁷ reported a higher rate of cyst formation than the current study and stated that the longer the impaction time, the higher the possibility of cyst development. In previous studies, it was reported that most mesiodens were discovered in patients aged < 10 years (28.1%-54%).^{7,9,12,22} In the present study, most mesiodens (67.3%) were discovered in patients aged < 10 years, from which 87.2% were found to manifest mesiodens-related complications. These findings underline the importance of early detection of mesiodens and proper treatment planning to prevent the development of any related complications.

The present study proposed a new classification system

which categorizes the risk of developing complications due to extraction of mesiodens. The proposed classification is based on the proximity of mesiodens to the vital point, which is the open apex of the adjacent permanent teeth. In immature tooth, the periapical region of the underdeveloped root consists of apical papilla cells and periodontal ligament cells which are essential to complete the development. Any trauma to this region might affect these cells which might result in hindering the complete root development.²³ The position of mesiodens in relation to the vital point of adjacent teeth is a factor of great significance when making a diagnosis and creating a treatment plan. Therefore, our new proposed classification system might be of great value in the clinical practice.

Recently the application of CBCT has been introduced as an effective diagnostic tool for the evaluation of mesiodens. CBCT can provide a detailed characterization of mesiodens and the surrounding structures, which can assist surgeons in choosing the most suitable surgical technique to minimize the surgical trauma on the adjacent teeth and other vital structures.^{2,12} A recent study by Maddalone et al.⁸ suggested that digital radiography, which requires low radiation exposure, should be used for screening primary school children, especially those with a family history of mesiodens even if they show no clinical symptoms. They stated that early diagnosis and intervention prevent future severe clinical complications such as root resorption or tooth displacement. Shih et al. stated that with the help of 3D radiography, such as CT or CBCT, an accurate 3D diagnosis can be made, which can help surgeons perform a low-risk surgery.⁶

However, there is still no general agreement about the optimal age for extraction of mesiodens. Some researchers supported late intervention by either delaying the treatment until root development of the adjacent permanent teeth is complete to ensure patient cooperation and to avoid iatrogenic injury during extraction,²⁴ or leaving cases with no complications without performing any treatment while maintaining regular radiographical follow-up.^{20,25} Koch et al.²² suggested postponing surgical extraction until root development of the adjacent permanent teeth is complete to prevent potential injuries during the extraction procedure. They recommended avoiding any surgical procedure for patients aged <10 years to avoid the use of general anesthesia. Tyrologou et al.¹⁹ stated that early extraction is indicated only for those cases with eruption problems related to the adjacent teeth. They argued that there was a negligible risk of developing serious complications such as cyst formation or resorption of the roots of the adjacent

permanent teeth. However, the results of their study after follow-up of 43 symptomless mesiodens cases showed that 13 mesiodens manifested follicle widening and five migrated from their positions. These results should not be ignored as the possibility of developing more serious complications is high; the migrated mesiodens might come into direct contact with the adjacent permanent teeth which might be traumatized, or the proximity may hinder a future extraction process.

In contrast, other studies recommended that mesiodens be extracted at the time of discovery to prevent the development of complications or to reduce the need for subsequent orthodontic treatment or extra surgical intervention.⁶ According to Omer et al., early intervention for a mesiodens should occur before the eruption of the adjacent permanent teeth (up to approximately seven years of age), because there is a high likelihood of developing further complications after that age.⁵ They stated that delaying extraction until after the age of 10 years might cause more developmental damage to the permanent teeth. Shih et al. suggested that early intervention should occur before the age of five years.⁶ They stated that removal of mesiodens at this young age will minimize the need for later orthodontic therapy and/or additional surgical intervention. A previous study by Lee et al.²⁶ presented cases of early removal of mesiodens. They concluded that early extraction of mesiodens is considered to be a factor influencing the spontaneous correction of adjacent permanent teeth before the completion of root formation. Another case report by Sholapurmath et al.²⁷ described the outcome of late surgical intervention. They stated that by the time delayed treatment is performed, midline space may have already been lost as a result of teeth shifting, and the normal eruption forces of the incisors are decreased. This may result in a more frequent need for surgical exposure and orthodontic intervention.

The results of the present study showed that over two-third of the patients were in the young age category (<10 years old) and that most of them manifested mesiodens-related complications. This indicates that early discovery and treatment of mesiodens might be the most appropriate approach to prevent the development of complications and to ensure normal eruption of the adjacent permanent teeth without the need for additional complex surgical and/or orthodontic treatments. Nevertheless, in occasional cases it is better to either delay the extraction or leave the mesiodens in place. For example, for an uncooperative young patient whose medical status does not allow a general anesthetic intervention, it is recommended to delay interven-

tion. Additionally, an impacted mesiodens in an older patient with no apparent complications should be left in place without intervention.

As stated earlier, CBCT provides a 3D image of mesiodens in three planes (axial, coronal, and sagittal). In the present study, using CBCT as our main radiographic tool for diagnosis, we were able to precisely localize mesiodens and study its relationship with neighboring structures. The accurate information obtained from CBCT images allowed us to study the status of mesiodens and the adjacent teeth and the relationship between them which enabled us to create the new classification of the risk of developing complications as a result of extracting mesiodens located close to adjacent permanent teeth (high, medium, or low risk). With the use of CBCT accurate assessment, a safe extraction could be performed without the fear of damaging adjacent permanent teeth, taking into consideration the surgeon's point of view, the age of the patient, and the patient's medical condition and economical status.

It should be noted that few patients returned to the hospital for follow-up after extraction of the mesiodens, so it is a limitation of the present study that we were unable to follow up all the patients after having their mesiodens extracted. Future studies should focus on verifying the safety of early extraction by conducting follow-up research on cases that underwent early intervention. Moreover, future studies should include randomized control studies which focus on the comparison between early and late treatment of mesiodens.

Our findings showed that over two-third of mesiodens were discovered in patients younger than 10 years old and 87.2% of these manifested mesiodens-related complications. Additionally, based on the new classification system proposed by the current study, only 1.9% of all mesiodens were in the high-risk categories.

In conclusion, as the results showed that no postoperative complications were seen in all the extracted cases of high-risk mesiodens, this indicates the possibility of safe extraction at an early age which could reduce related future complications.

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Conflicts of Interest: None

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