

Dental asymmetry using the example of the mesiodens and the change in therapeutic approach due to socio-cultural influences

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Abstract

Introduction: Sagittal, vertical, or horizontal dental symmetry, although usually hidden behind the lips, is one of the key elements of the aesthetic quality of a face and a significant factor of the facial expression of a person. A supernumerary tooth challenges anatomy and humanities at different levels. Mesiodens as a dental embryological variant is investigated in this interdisciplinary analysis with the aim of profiting from a synergetic approach.

Material and method: Critical review of sufficiently detailed clinical reports (n: 9) on mesiodens between 2004 and 2020 was undertaken. A review of representation of mesiodens in ancient and medieval artistic objects is performed in the anatomical and cultural context of the subject. Best evidenced therapeutical recommendations were summarized.

Results: Altogether 4485 reported cases among 193 595 patients were included in nine high quality articles, representing a prevalence between 0,76% and 2,7%. The overall range in the wider literature is significantly wider with 0.15-3.9%. The diagnostic and therapeutical protocols are quite homogenous in terms of recommendations. The jury is still out on the question of the optimal time for extraction. The artistic representation of mesiodens has a strong symbolism. Early culture representations were followed by Christian theology infused manifestations, where sins were coded by mesiodens. Bussagli's research on the "Teeth of Michelangelo" is contextualized by contemporary clinical research. The code lost its relevance in the present age of the secularism in the Western World.

Discussion: Teeth have a strong cultural reference value in the present and the past. While dealing with the decision-making challenges and technical details of the actual procedure in the individual patient with mesiodens, the wider cultural context of the phenomenon might serve triple aims. First, management of the patient's self-reflection, sickness awareness, patient information might get a more humanistic approach. Second, providing dental trainees and junior doctors with cultural cross references such as the mesiodens phenomenon offers antidote against professional tunnel vision or too early fixation on just one treatment solution. Third, interdisciplinary research enriches non-medical science, like art history and theology educating their professionals in factual background of their field. Supernumerary teeth and the mesiodens in particular, can also be seen under a reflection of different social, cultural, and religious perspectives. Looking beyond the horizon of the modern welfare states and their health-care services, dental medicine included the question of cross-cultural relevance of congenital abnormalities like mesiodens seems to be a neglected topic.

Conclusion: Clinical, historical, artistic, and philosophical interdisciplinary investigation of a rare genetic front tooth abnormality offers a chance for an open-minded and holistic approach for better patient care and professional education with a wider aspect as well.

Keywords: mesiodens, artistic representation, medical humanities, interdisciplinary study, theology

Introduction

Sagittal, vertical, and horizontal dental symmetry is one of the key elements of the aesthetic appearance of the facial expression especially where open mouth and lifted lips are presented in an artistic object and daily life as well. Achieving this desired metacommunicative and functional impression is one of the basic principles of reconstructive dentistry and aesthetic facial surgery of today. Symmetry of definite optical components is the key to esthetics, and any deviation – occasionally or intentionally – has a metacommunicative signaling function, either intentional or subliminal, open, or encoded.

The representation of teeth showing open mouth in the presentation of faces or facial expressions was a rare phenomenon. This can be applied for the period from the prehistoric ages through the Greek and Roman statuary till the late Renaissance paintings, or murals of centuries prior to the 17th centuries in Europe. Symbolism of different body parts, teeth included, is a relatively well researched topic.¹ As far as the meaning and context of teeth are concerned in the Holy Bible and the Quran, it is usually reflecting not a bony or anatomical structure but as a code of strength, health, moral and occasionally aggressivity. There are 37 references to the teeth in the Old Testament, while only 9 references in the New Testament respectively.² And there is just one

mentioning of teeth in the Quran. Maybe the most well-known site is Exodus 21:24, repeated in Matthew 5:38, where the proverbial „eye for eye and teeth for teeth” rule is texted. Human code is paralleled by the fact, that the aggressivity of animals on prehistoric and ancient artistic objects are usually signed with mouth open as a part of body language. The boars, dogs of the representation of mythical scenes are ready to bite and the dragons are rarely closed mouthed. Martyrology brought a new interpretation as the body parts are concerned. Teeth as relics of Christian saints became the objects of adoration. On the other hand, lack of teeth is referenced to a lack of power and a signal of loss of desire, power, unwitting ageing, and not infrequently mental handicap.

The standard message of the closed lips covering teeth was the lack of aggressivity or at least, a controlled one. Vampires from the Middle Ages culminating in Mary Shelley’s story and the gothic novels, to Bram Stoker’s Dracula are just examples of a long line of visual and literary representation. The reason behind this code has been a social, cultural, or religious view that was associated with the meaning of teeth at that time. The rare exceptions must have a reason, revealed or otherwise. Supernumerary anatomical structures like extra bones, fingers were taken as signals of extra power as it is expressed in ancient shamanism.^{3,4}

Artistic objects, otherwise more or less mimicking and / or reflecting real life are challenging when deviating from standard, represented in some sort of extra numbers. Generally speaking, supernumerary surplus is a code of added value, a superpower like the sixth finger, or added extremities like the wings of an angel. Double headed eagles and falcons in the heraldry are the reduced and simpler relatives of multicranial dragons (up to seven). In the modern times, with an increased awareness of external body looks and not too infrequently overemphasis on cosmesis, adults with these special features are calling peculiar attention sometimes leading to psychological problems. As a sum up of the above detailed, interdisciplinary divergent observations, supernumerary frontal teeth as a symptomatic and a symbolic crossover deserves a closer analysis using an odontologic approach. The answer to the question might be, that whether the artistic expression of an extra frontal teeth is only the result of imagination, or does it have an anatomic explanation?

Odontologic state of art

The Mesiodens

In general, the term mesiodens denotes the occurrence of one or more supernumerary teeth in both deciduous and permanent teeth.⁵ The phenomenon can affect all types of teeth with front and canine teeth, premolars, and molars (Table 1).

Table 1 Prevalence of supernumerary teeth and distribution by gender

Author	Year	Country	Number of patients	Prevalence	Gender		Ratio
					Male	Female	
Brinkmann et al.	2020	Spain	518	1.84%			
Bereket et al.	2015	Turkey	111293	0.76%	478	373	1.28 : 1
Burhan et al.	2015	Syria	2753	1.40%	25	14	1.8 : 1
Anegundi et al.	2014	South India	63569	1.24%	481	309	1.55 : 1
Arikan et al.	2013	Turkey	7551	0.98%	48	26	1.84 : 1
Shorky et al.	2013	Saudi Arabia	1521	1.20%	12	6	
Celikoglu et al.	2010	Turkey	3491	1.20%	27	15	1.8 : 1
Eselink et al.	2009	Turkey	2599	2.70%	1239	1360	1.13 : 1
Salcido-García et al.	2004	Mexico			39	33	1.18 : 1

Etiopathogenesis

Oral embryology, derived from the Greek word “embryon” (ἔμβρυον) with the meaning of “unborn child” in its translation, refers to the development of the oral cavity and its structures during the formation and development of the embryo in the first 8 weeks of pregnancy. In a wider context the description includes the fertilization, prenatal development of germ cells and development of embryos and fetuses. There are many factors leading to development of extra frontal teeth, but no definite cause has been defined by now.

Epidemiology

There were occasional case reports on the occurrence of this strange

phenomenon in the pre-evidence-based medicine (EBM) period, but it was far from being unrecognized. An adult male skeletal dated to the Middle Iron Age (250 – 410 AD), found in South Uist, Western Isles of Scotland, can be given as an historical example. His double mesiodens, fully erupted in the anterior permanent maxillary dentition was detected with traces of mastication.⁶

This additional tooth formation occurs more frequently in men and has a prevalence between 0.15% and 2.7% in the population (Table 1). The mesiodens is the most common variant of supernumerary tooth formation (Table 2) and is possible in combination with or without a syndrome.⁷⁻⁹ This is also true in connection with and without other odontogenic anomalies.¹⁰

Table 2 Distribution of supernumerary teeth by region

Author	Year	Mesiodens	Super-numerary laterals	Super-numerary canine	Super-numerary premolars	Fourth molar
Brinkmann et al.	2020				20.10%	37.70%
Bereket et al.	2015	33.37%			17.16%	23.97%
Burhan et al.	2015	39.10%	26.10%		28.30%	4.30%
Anegundi et al.	2014	82.28%				

Table 2 Continued...

Author	Year	Mesiodens	Super-numerary laterals	Super-numerary canine	Super-numerary premolars	Fourth molar
Arikan et al.	2013	36.90%	38.10%	1.20%		
Shorky et al.	2013	27.80%	11.10%	16.60%	33.30%	11.10%
Celikoglu et al.	2010	31.30%	22.90%	2.10%	25.00%	14.50%
Eselink et al.	2009	51.20%	17.90%	10.70%	20.30%	
Salcido-García et al.	2004	48.60%	11.10%		26.40%	9.70%

Most often this pathological form is found in the anterior region and 80% to 90% of the distribution occurs in the upper jaw.^{11,12} Accordingly, the term now mainly refers to an additional tooth between the two

central frontal incisors and in the upper jaw. In some cases, two or more additional mesiodens may also be present (Table 3).

Table 3 Possible number of mesiodens by patient case

Author	Year	Number of patients	Age range (years)	Hyperdonty mesiodens			
				One	Two	Three	Two or more
Aren et al.	2018	58142	6 to 14	61.00%	37.30%	1.70%	
Ledesma-Montes et al.	2016	3522	mean 16.7	14.70%			
Ramesh et al.	2013	55	to 14				49.09%
Patil et al.	2013	4133	4 to 15	87.70%			
Khandelwal et al.	2011		6 to 17				4.03%
Mukhopadhyay et al.	2011	7932			14%		
Kazanci et al.	2011	3351	8 to 16	80.00%	20.00%		
Gündüz et al.	2008	23000		76.80%	23.10%		
Kim et al.	2003	40	4 to 26				25%

As a general cause for mesiodens, three different theories have been named in the literature: the phylogenetic relict of extinct ancestors, the dichotomy suggests and the hyperactivity of the dental lamina.³ However, today the genesis cannot be regarded as conclusively clarified. More and more studies show that polymorphism can increasingly be associated with oral diseases and that certain genes can be associated with the formation of mesiodens. Also, certain alleles are associated with the formation of one or more mesiodens.¹³ In addition a so-called gene co-occurrence network in mesiodens patients with certain functionally enriched gene groups was found.¹⁴ Shokry et al. showed in their publication that blood-related marriages may be set in context with the development of supernumerary teeth because of the special nature of their gene pool.¹⁵

The presence of additional teeth, depending on their positioning and eruption, can be associated with a deterioration in cleanability, an increased likelihood of food impaction, restricted occlusion, or impaired aesthetics.¹⁶⁻¹⁸ Also an impact on root resorption on the neighboring teeth as well as their partial or complete dislocation is possible. As part of the embryonic development, the surplus tooth cyst can also lead to inflammation problems.¹⁹

Best evidenced treatment

There is a concordance, that there is no place for the mesiodens in the palatum, however the optimal timing of the removal, if no spontaneous exeat/furlough/delivery? occurs, is debated. Because of the absence of visible symptoms, a proper anamnesis of the patient is important. Especially in view of the low rate of a combination with syndromes the diagnostic must be based on x-ray examinations.^{20,21} Several studies suggested that the use of three-dimensional x-ray diagnostic is strongly recommended for the diagnosis and removal of supernumerary teeth.^{22,23}

In general, the present of a mesiodens can be seen responsible for complications like delayed eruption of permanent teeth, closure of eruption path, rotations, retention, root resorption, pulp necrosis,

diastema and a nasal eruption.²⁴⁻²⁶ Also the formation of dentigerous and primordial cysts is described.²⁷ In most of the cases they are asymptomatic and can be recognized only radiologically as an incidental finding. While pain, swelling and facial asymmetry can be observed as symptoms only rarely.^{28,19} The relationship to the nasopalatal canal can also be seen as a complication in combination with these cysts or very rarely with a septal cartilage collapse.²⁹ As an additional problem the impaction of upper central incisors is reported in the literature. Yordanova et al.³⁰ described this phenome in 55.5% of his reviewed cases.³⁰

The treatment recommendation is depending on the localization and the position of the respecting supernumerary tooth. In general, the treatment can be divided in three main groups: waiting for spontaneous eruption, an early intervention, and a delayed intervention.¹¹ Beside early diagnosis, a consequent monitoring by x-ray examinations or most of the time the removal of the mesiodens is recommended.^{7,31-33} A systematic review and meta-analysis showed that more than 65,5% because of mesiodens impacted anterior permanent teeth erupted after the removal of the obstacle.³⁴ The necessary waiting time was given as 12 – 36 months.

Today the application of a surgical guide for removing the supernumerary tooth is consequent and may help to improve the quality and outcome of the surgery.^{35,36} Using the guided workflow the guides can enhance accuracy, reduce the surgical time facilitate the needed osteotomies and by that postoperative swelling and pain can be reduced.³⁷ Beside the pure extraction, a transplantation of the mesiodens is also discussed for replacing a front tooth after atraumatic loss or a loss due to deep caries.^{38,39} Even a reconstruction by a new positioning of the mesiodens via orthodontic guiding may be an additional solution in such cases.⁴⁰ Concerning the right timing of extraction, the risk of a delayed development of the permanent tooth by the caused impaction must be put into account.⁴¹ Shih at al. is recommending an early removal before the patient age of 5 years to reduce later complications and the possible need for orthodontic treatments.⁴²

Mesiodens as an artistic phenomenon

The head plaque made of clay of the giant demon Humbaba, guardian of the Lebanese Cedar Forest from the first half of the 2nd millennium BCE, is the first known sculpture showing mesiodens and the rest of the set of teeth.

As far as the Middle Ages in Europe concerned, there are demons and evilish creatures having an easily identifiable feature of their malevolent nature: showing the teeth with some sort of abnormality with or without symmetry.

The bizarre world of the gargoyles is definitely a rich source of examples of showing teeth in a more or less intimidating manner. However visible teeth are generating the impression in the viewer of desperation and terror, felt by the characters on the canvas or the stone and wall. Supernumerary frontal teeth, symbol of the sin was brought into the public knowledge by the Italian author, Marco Bussagli in context of the works of Michelangelo (Ref: Marco Bussagli: I denti di Michelangelo. Edizioni Medusa 2014, Milano, Italy). As we demonstrated above, the phenomenon is far from being the product of the artist's imagination; actually, it is an existing dental pathology. However, it was delivered in a theological context, resulting in a deep symbolism.

Discussion

In the Greco-Roman antique art, the unsightly bite and death were associated with the teeth and the ideal was reflected in the noble, closed mouth, in complete contrast to the ignoble, painful teeth and open mouth. Heroes, rulers, or goddesses are always depicted with their mouths closed. Unlike heroes, only warriors showed their teeth. Likewise, only low figures, such as thieves, were allowed to show teeth on representations. This also counts as a representation of work and hardship. Wrinkles, sunken cheeks, or asymmetries, on the other hand, are depicted unadorned, in the style of depiction using death masks. It was the oriental influence that helped to create a more positive image through a relaxed language and in late antiquity through a dangerously beautiful depiction of the sea nymph Thetis. Here, however, the ideal of beauty is reduced to the exclusive showing of the healthy upper incisors. Only the symmetrical center under the upper lip with its front teeth should be shown, but not the two remaining rows of teeth. These were still associated with bite, grinding, and dangerous horror. The white color of the teeth is basically a cause for ridicule, as it is considered artificial or bought and therefore lacks any authenticity. According to the Roman poet Catullus, brushing teeth is compulsory, but the beauty of the teeth should be secondary to its function. He mentioned this in his poem Carmina 39 when talking about the smiling Spaniard Egnatius and his bright white teeth.

This aesthetic of the antiquity underwent a paradigm shift in the Middle Age and the representation of the teeth was a part of it. Rendition of extra number of teeth or the fifth incisor definitely disturbed the expected symmetry of the oral cavity. The portrayal of the phenomenon is elevated into a symbolic role especially in the religious art. The transcendent meaning in terms of artistic and theological context lasted till the late renaissance. It was not before the establishment of dental medicine in the 20th century, that the mesiodens was rediscovered, but now in a secular form and as a very clinical entity. The clinical decision making is guideline supported while the actual procedure in the individual patient with mesiodens must be case tailored. Today removing a supernumerary tooth can be seen as the treatment of choice for preventing damage for neighboring tooth structures, teeth alignments or occlusion. An early diagnosis, mainly done by three-

dimensional x-rays, can help to reduce the risks during the surgery and possible procedural complications. Historical background might help the dental practitioner in orientation of the patient's self-reflection. Patient information infused by cultural references might have an added value in selected cases. The educational aspect of our approach for trainees and junior doctors offers a wider intellectual horizon, a sort of antidote against burning out. Additionally, interdisciplinary research enriches non-medical sciences, educating their experts in factual background. Medical professionals practicing in lesser income nations and cultures might also benefit from examples like mesiodens when coping with congenital abnormalities.

Conclusion

An interdisciplinary approach is needed to explore the medico-cultural complexities of the mesiodens, a rather rare congenital abnormality. State of art treatment aims at optimized anterior tooth substances in the sense of ideal aesthetics. The dental intervention is thus justified today by currently applicable aesthetic parameters and perspectives. Mesiodens is a small element of the greater picture of improving artificially the aesthetics of the anterior teeth through direct or indirect restorations. In our opinion, complementary or even collateral cultural references should have a place in the education of dental medicine as an adjunct of patient care and professional training.

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Conflicts of interest

The authors declare that there are no conflicts of interest.

References

- Capps D, Carlin N. Sublimation and symbolization: the case of dental anxiety and the symbolic meaning of teeth. *Pastoral Psychology*. 2011;60:773–789.
- Tal M, Stern N. References to dentistry in the bible and talmud. *Refuat Hapeh Vehashinayim*. 1976;25(1-2):9–12.
- Perrin M. Shamanistic symptoms or symbols? A case of indeterminism: the body of the guajiro shaman. *Anthropos*. 1987;567–580.
- Crown PL, Marden K, Mattson HV. The social implications of polydactyly and foot-related imagery at pueblo bonito, chaco canyon. *American Antiquity*. 2016;81(3):426–448.
- Luten JR. The prevalence of supernumerary teeth in primary and mixed dentitions. *J Dent Child*. 1967;34(5):346–353.
- Ives R. An unusual double supernumerary maxillary mesiodens in a Middle Iron Age skeleton from South Uist, Western Isles, Scotland. *Arch Oral Biol*. 2014;59(6):625–630.
- Buggenhout GV, Forestier IB. Mesiodens. *Eur J Med Genet*. 2008;51(2):178–181.
- Russell KA, Folwarczna MA. Mesiodens - diagnosis and management of a common supernumerary tooth. *J Can Dent Assoc*. 2003;69(6):362–366.
- Patil S, Pachori Y, Kaswan S, et al. Frequency of mesiodens in the pediatric population in North India: A radiographic study. *J Clin Exp Dent*. 2013;5(5):e223–e226.
- Nagaveni NB, Sreedevi B, Praveen BS, et al. Survey of mesiodens and its characteristics in 2500 children of Davangere city, India. *Eur J Paediatr Dent*. 2010;11(4):185–188.

11. Altan H, Akkoc S, Altan A. Radiographic characteristics of mesiodens in a non-syndromic pediatric population in the Black Sea region. *J Investig Clin Dent*. 2019;10(1):e12377.
12. Bergstrom K. An orthopantomographic study of hypodontia, supernumeraries and other anomalies in school children between the ages of 8–9 years. An epidemiological study. *Swed Dent J*. 1977;1(4):145–157.
13. Liu S, Li J, Xu J, et al. Lack of association between PAX6/SOSTDC1/FAM20B gene polymorphisms and mesiodens. *BMC Oral Health*. 2019;19(1):90.
14. Kim YY, Hwang J, Kim HS, et al. Genetic alterations in mesiodens as revealed by targeted next-generation sequencing and gene co-occurrence network analysis. *Oral Dis*. 2017;23(7):966–972.
15. Shokry SM, Alenazy MS. Consanguinity-related hyperdontia: an orthopantomographic study. *Dent Res J (Isfahan)*. 2013;10(6):732–736.
16. Mahabob MN, Anbuselvan GJ, Kumar BS, et al. Prevalence rate of supernumerary teeth among non-syndromic South Indian population: An analysis. *J Pharm Bioallied Sci*. 2012;4(Suppl 2):S373–S375.
17. Syriac G, Joseph E, Rupesh S, et al. Prevalence, characteristics, and complications of supernumerary teeth in nonsyndromic pediatric population of south india: a clinical and radiographic study. *J Pharm Bioallied Sci*. 2017;9(Suppl 1):S231–S236.
18. Alberti G, Mondani PM, Parodi V. Eruption of supernumerary permanent teeth in a sample of urban primary school population in Genoa, Italy. *Eur J Paediatr Dent*. 2006;7(2):89–92.
19. Khan MH, Alam MT, Haque S, et al. Upper lip swelling caused by a large dentigerous cyst with mesiodens. *Mymensingh Med J*. 2008;17(2 Suppl):S100–S103.
20. Chen KC, Huang JS, Chen MY, et al. Unusual supernumerary teeth and treatment outcomes analyzed for developing improved diagnosis and management plans. *J Oral Maxillofac Surg*. 2019;77(5):920–931.
21. Kim KS, Mun SK. Extensive dentigerous cyst associated with a mesiodens: CT findings. *Ear Nose Throat J*. 2013;92(8):E6–E8.
22. Schaibany FSA, Marzouk HM, Salama FS. Cone beam computed tomography evaluation of inverted mesiodentes. *J Dent Child (Chic)*. 2016;83(2):88–93.
23. Sane VD, Chandan S, Patil S, et al. Cone beam computed tomography heralding new vistas in appropriate diagnosis and efficient management of incidentally found impacted mesiodens. *J Craniofac Surg*. 2017;28(2):e105–e106.
24. Alaçam A, Bani M. Mesiodens as a risk factor in treatment of trauma cases. *Dent Traumatol*. 2009;25(2):e25–e31.
25. Cogulu D, Yetkiner E, Akay C, et al. Multidisciplinary management and long-term follow-up of mesiodens: a case report. *J Clin Pediatr Dent*. 2008;33(1):63–66.
26. Sharma VK, Yadav K, Tandon P, et al. Management of unusual rotation of maxillary central incisor with impacted mesiodens: case report. *Int J Orthod Milwaukee*. 2016;27(3):29–31.
27. Kalaskar RR, Kalaskar AR. Multidisciplinary management of impacted central incisors due to supernumerary teeth and an associated dentigerous cyst. *Contemp Clin Dent*. 2011;2(1):53–58.
28. Hasan S, Ahmed SA, Reddy LB. Dentigerous cyst in association with impacted inverted mesiodens: Report of a rare case with a brief review of literature. *Int J Appl Basic Med Res*. 2014;4(Suppl 1):S61–S64.
29. Misirovs R, Kanodia AK, Green R, et al. Supernumerary tooth in nasopalatine canal: a rare cause of septal cartilage collapse. *BMJ Case Rep*. 2021;14(9):e245103.
30. Yordanova G, Gurgurova G. Impacted upper central incisors - frequency and factors complicating the treatment protocol. *Folia Med (Plovdiv)*. 2021;63(3):405–412.
31. Jain A, Taneja S. Bilateral presentation of different supernumerary teeth in nonsyndromic patients: case reports. *Gen Dent*. 2020;68(2):39–42.
32. Maddalone M, Rota E, Amosso E, et al. Evaluation of surgical options for supernumerary teeth in the anterior maxilla. *Int J Clin Pediatr Dent*. 2018;11(4):294–298.
33. Ayers E, Kennedy D, Wiebe C. Clinical recommendations for management of mesiodens and unerupted permanent maxillary central incisors. *Eur Arch Paediatr Dent*. 2014;15(6):421–428.
34. Pescia R, Kiliaridis S, Antonarakis GS. Spontaneous eruption of impacted maxillary incisors after surgical extraction of supernumerary teeth: a systematic review and meta-analysis. *Clin Oral Investig*. 2020;24(11):3749–3759.
35. Zheng X, Zhao J, Liu S, et al. Application of a surgical guide in the extraction of impacted mesiodentes: a randomized controlled trial. *Clin Oral Investig*. 2021;25(5):2999–3006.
36. Sane VD, Chandan S, Patil S, et al. Cone beam computed tomography heralding new vistas in appropriate diagnosis and efficient management of incidentally found impacted mesiodens. *J Craniofac Surg*. 2017;28(2):e105–e106.
37. Hu YK, Xie QY, Yang C, et al. Computer-designed surgical guide template compared with free-hand operation for mesiodens extraction in premaxilla using “trapdoor” method. *Medicine (Baltimore)*. 2017;96(26):e7310.
38. Dharmani U, Rajput A, Kamal C, et al. Successful autotransplantation of a mature mesiodens to replace a traumatized maxillary central incisor. *Int Endod J*. 2015;48(6):619–626.
39. Lee Y, Chang SW, Perinpanayagam H, et al. Autotransplantation of mesiodens for missing maxillary lateral incisor with cone-beam CT-fabricated model and orthodontics. *Int Endod J*. 2014;47(9):896–904.
40. Ephraim R, Dilna NC, Sreedevi S, et al. A labially positioned mesiodens and its repositioning as a missing central incisor. *J Int Oral Health*. 2014;6(5):114–117.
41. Kim Y, Jeong T, Kim J, et al. Effects of mesiodens on adjacent permanent teeth: a retrospective study in Korean children based on cone-beam computed tomography. *Int J Paediatr Dent*. 2018;28(2):161–169.
42. Shih WY, Hsieh CY, Tsai TP. Clinical evaluation of the timing of mesiodens removal. *J Chin Med Assoc*. 2016;79(6):345–350.