Avicenna J Dent Res. 2018 Sep;10(3):71-76

doi 10.15171/ajdr.2018.16

AJDR
Avicenna Journal of Dental Research

Original Article

The Study of Dentoskeletal Characteristics of Patients With Maxillary Central Impaction and Related Local Factors

Mohammad Esmaeilzadeh[1], Sanaz Afzalsoltani[2*]

Abstract

Background: Permanent tooth impaction is a relatively common abnormality in which early treatment can prevent from other developmental disorders. Maxillary central impaction can occur because of mesiodens, dilacerations, trauma to deciduous tooth and space deficiency. Prevalence of maxillary central impaction is 0.06%-2.0%.

Methods: In this retrospective, case-control study, 28 people with impacted maxillary central incisor and 56 as the control group were studied. All participants were 8-12 years old. The data were collected from private offices of orthodontists and special pediatric dentists and Hamadan dental school. The data required were diagnostic models, initial panoramic radiography and initial lateral cephalometry radiography. Data analysis was done by SPSS software using t test and chi-square test.

Results: The most common causes of maxillary central impaction were: mesiodens (74.4%), dilacerations (14.3%), space deficiency (10.7%) and cyst (3.6%). 89.3% of cases had unilateral maxillary central impaction and 10.7% had bilateral maxillary central impaction. There was a significant relation between skeletal class II and maxillary central impaction. ANB angle was significantly higher in impaction group than in control group ($P<0.05$). In most of the patients with maxillary central impaction, ipsilateral canines had upper position compared with the contralateral side (60%).

Conclusions: Presence of mesiodens was the most important reason for maxillary central incisor impaction, and class II jaw relation is more common in patients with maxillary central incisor impaction, which higher incidence of vertical disorders can be a bigger challenge in these patients.

Citation: Esmaeilzadeh M, Afzalsoltani S. The study of dentoskeletal characteristics of patients with maxillary central impaction and related local factors. Avicenna J Dent Res. 2018;10(3):71-76. doi: 10.15171/ajdr.2018.16.

***Correspondence to**
Sanaz Afzalsoltani, Department of pediatric dentistry, Alborz University of Medical Sciences, Karaj, IR Iran. Tel: +98-9127724973, Email: dr.s.afzalsoltani@gmail.com

Keywords: Maxillary central incisor, Impaction, Dentoskeletal characteristics, Maxilla.

Received May 9, 2018
Accepted Aug. 18, 2018
ePublished Sep. 12, 2018

Background

An impacted tooth is a tooth whose eruption is interrupted by bone or fibrous tissue (1) surrounding it and cannot erupt into the dental arch at expected time. Un-erupted tooth is a more general word and includes both impacted and erupting teeth (2).

Any permanent tooth can be impacted. It is also argued that impaction is seen in the upper jaw 10-20 times more than in the lower jaw (3).

Central maxillary incisors are the most prominent teeth in smiling, and on maximum display during speech in most individuals. The normal eruption, position and morphology of these teeth are crucial to facial aesthetics and phonetics (4).

It is obvious that lack of this tooth in dental arch causes an unpleasant sight that affects one's self-esteem and social life (2). Therefore, diagnosis and early treatment improves occlusal and skeletal condition and resolves eruption disorders (5).

Causes of tooth impaction are classified into local and systemic types:

1. Local factors: hyperdontia, crowding, improper positioning of dental buds, prolonged retention or early loss of deciduous tooth, dental trauma, pathologic lesions (cysts and tumors), dilacerations (6).
2. Systemic factors: the most common example is cleidocranial dysplasia syndrome (7). Besides, recently mutation in parathyroid hormone receptor 1 has also been identified as an etiologic factor (8).

The most common causes of an impacted maxillary central incisor are as follows:

Highlights

- The presence of mesiodens was the most important reason for maxillary central incisor impaction.
- Class II jaw relation is more common in patients with maxillary central incisor impaction.
- Higher incidence of vertical disorders in patients with maxillary central incisor impaction can intensify the challenge.

[1]Assistant Professor, Department of Pediatric Dentistry, Hamadan University of Medical Sciences, Hamadan, Iran. [2]Assistant professor, Department of Pediatric Dentistry, Alborz University of Medical Sciences, Karaj, Iran.

Extra dentition and mesiodens, dental malformations or root dilacerations, dental buds improper positioning, crowding, pathologic lesions (like cysts), ankylosis or over-retention of deciduous teeth, dental trauma, early loss of deciduous teeth (due to caries, trauma, etc), endocrine disorders, bone disorders and idiopathic causes (9).

Maxillary central incisor is the second erupted tooth in the maxillary arch. First, permanent molars erupt at the age of 6 years old and then maxillary centrals are erupted at the age of 7-8. Calcifications of dental buds start in the third month. Completion of crown occurs in 4.5 years and completion of root in 10.5 years old (10).

Impaction of central incisor is often seen between ages of 8 and 12 (9,11). In most cases, only one of the central incisors has eruption problem, but in more severe cases, both central incisors have the problem (9). Frequency of central impactions is reported to be 0.06% to 0.2% (6).

The pathognomonic sign that indicates impaction of a central incisor is the presence on the arch of the homolateral lateral incisor, as it also refers to an anomaly in the central incisor eruption process. Another sign can be the time difference of longer than 6 months between eruption of central incisor at one side and the other central incisor on the other side (12).

Diagnosis and treatment of skeletal and occlusion disorders can begin at any stage of occlusion. It is possible to evaluate the developing dentition by evaluation of tooth eruption sequence during regular dental visits (13).

Diagnosis and treatment of impaction is one of the goals of any dentist, pediatric dentist and orthodontist.

Today, it has been established that dental and facial beauty is effective on quality of life (14). And since maxillary central incisors are important for each person's smile and speaking, suffering from an impaction can cause low self-esteem, challenge effective communication and worry parents. Therefore, these patients must be treated as soon as possible. In addition, according to the fact that at this age (mixed dentition), the most changes in growth and development occur, early detection and prevention of these disorders is strongly recommended (15-17).

Study of causes of impaction gives a vaster insight to dentists and enables them to diagnose possible causes of impaction in the first visit. Study of family medical history and knowledge of dentoskeletal effects caused by tooth impaction assists them in providing overall treatment plan for preventing more problems.

Methods

This is a retrospective, case-control study. The minimum sample size was calculated at 18 people according to the formula below (18). Ten people were added to enhance the power of test. Therefore, 28 patients suffering from maxillary central incisor impaction and 56 persons from normal population as the control group were included in the study (Table 1).

$$\Delta = \frac{d}{\sigma} = \frac{4.9}{3.5} = 1.14$$

$$n = \frac{2(Z_{1-\alpha/2} + Z_{1-\beta})^2}{\Delta^2} + \frac{1}{2} Z^2_{1-\alpha/2}$$

$$Z_{1-\frac{\alpha}{2}} = 1.96\,, \qquad Z_{1-\beta} = 1.28,$$

$$\alpha = 0.05, \qquad ß = 0.2$$

$$n = \frac{2(1.96 + 1.28)^2}{1.14^{\,2}} + \frac{1}{2} \times 1.98^2 = 18$$

Patients were selected from individuals referring to private clinics of orthodontics and podiatric dentistry and faculty of dentistry in Hamadan. Both groups were in the age group of 8-12. Patients were included in the study according to the inclusion and exclusion criteria.

Inclusion Criteria

In case group all of the patients were between 8 and 12 years old with at least one upper central incisor un-erupted in the normal eruption course, and their panoramic radiographs, lateral cephalometry and primary diagnostic casts were available.

Control group should be selected to represent society's normal population and had primary panoramic radiographs, lateral cephalometry, and primary diagnostic casts. As a result, control group was chosen from patients between 8 and 12, who were referred for simple orthodontic treatments (crowding) and lacked any sort of central impaction or severe skeletal or dental disorders and also had panoramic radiographs and lateral cephalometry and primary diagnostic cast.

Exclusion Criteria

- Patients who were above 12 or under 8 years old;
- Patients with systemic disease (diabetes, kidney disorders, syndromes, bone diseases);
- Patients with craniofacial disorders or with history of palatal or lip expansion; and
- Patients whose maxillary central incisors had not formed (missing).

Both groups were matched for age. A checklist was prepared for each patient, in which factors such as age, sex, cause of maxillary central tooth impaction (according to radiographic findings and patients history), impaction side, jaws positioning and patients jaw relation

Table 1. Evaluation of Gender of the People in the Maxillary Central Incisor Impaction and Control Groups

		Central Incisor Impaction	
		Yes	No (Control)
Gender	Male	14 (50.0%)	20 (37.5%)
	Female	14 (50.0%)	36 (64.3%)
Total		28 (100%)	56 (100%)

(according to SNA, SNB, and ANB angle analysis in lateral cephalometric radiography), occlusion disorders (using diagnostic casts in maximum intercuspal position), maxillary index (arc length/intermolar width)×100) (which shows maxillary arch shape), maxillary arch length (Incisive papilla distance to the line passes from mesial of molars), length of maxilla (CO-ANS distance in lateral cephalometry) and mandibular length (CO-Gn distance in lateral cephalometry), existence of another impacted tooth in panoramic radiography and finally the comparison of affected side and unaffected side in the case group was evaluated.

Results

In this study, 28 people with maxillary central incisor tooth impaction and 56 people as the control group were enrolled. The average age was 10 years and 5 months (SD: 14.7 months) in the group with impacted tooth and 10 years and 4 months (SD: 14.5 months) in control group (Table 2). There were 14 males and 14 females with impacted tooth and 20 males and 36 females in control group. No significant relation between gender and maxillary tooth impaction was seen ($P=0.029$)

In the group with tooth impaction, there were 3 cases with bilateral (10.7%) and 25 cases with unilateral tooth impaction (89.3%).

In the review of maxillary impacted tooth causes, the most common cause was found to be mesiodens with 20 out of 28 cases.

The following leading causes were root dilacerations with prevalence of 4 out of 28, lack of sufficient space with 3 out of 28 cases, and cyst with 3 out of 28 (Table 3).

In the study of jaw relations, in the group with maxillary central incisor impaction 25% had class I, 71.4% had class II, and 3.6% had class III jaw relation. In control group, 51.8% had class I, 41.1% had class II, and 7.1% had class III relation. The prevalence of class II jaw relation was reasonably higher in tooth impaction group than in control group ($P=0.042$; Table 4).

The study of jaw angles in cephalometry analysis showed that average SNA angle in both groups was in a normal range and their comparison did not show any relationship (0.224).

In both groups, average SNB angle was lower than average angle but their difference did not show any statistical significance (0.661)

In impaction groups, ANB angle was higher than normal, with a statistically significant difference ($P=0.015$)

Average maxillary length (CO-ANS) was lower in impaction groups than in control group, but the difference was not statistically significant ($P=0.145$; Table 5)

Average mandibular length (CO-Gn) was lower in impaction groups than in control group, with a statistically significant difference ($P=0.032$; Table 5).

In comparison of maxillary arch form, in tooth impaction group, maxillary index was reduced and maxillary arch was thinned, but the difference was not statistically significant ($P=0.146$; Table 3).

In the study of other impacted teeth, 17.9% or 5 patients with impacted maxillary central incisors had another impacted tooth that mostly was maxillary and mandibular lateral incisors. In addition, 82.1% of members in this group didn't have any other impacted tooth. In control group also 5.4% of people had another impacted tooth. This finding was without any scientific point (P=0.149; Table 6).

In vertical dimension occlusion disorders in the group with impacted maxillary central incisor, 3 patients with bilateral problem were removed from the study because decision about the type of disorder in vertical dimension was not possible. 24.0% of patients with unilateral impaction had open bite and 16.0% had deep bite. In control group also 1.8% of members suffered from open bite and 7.1% suffered from deep bite.

In the group with maxillary central impaction, occlusal disorders in vertical dimension was more prevalent in order to control group ($P=0.004$; Table 7)

In the study of anterior-posterior or horizontal dimension of occlusal disorders, there was no valuable connection between the prevalence of anterior or posterior cross bite in case and control group ($P=0.585$; Tables 8, 9).

During comparison of canine situation in impacted side and the other side (healthy side) 3 cases with bilateral

Table 2. Evaluation of People's Age in 2 Groups

		Number	Mean Age (mon)	SD
Central incisor impaction	Yes	28	125	14.7087
	No	56	124	14.5802
Total		84	124.3	14.5423

Table 3. Investigation of Maxillary Central Incisors Impaction Causes

The Reason of Maxillary Central Incisor Impaction	No. (%)
Mesiodens	20 (71.4%)
Dilaceration	4 (14.3%)
Space deficiency	3 (10.7%)
Cyst	1 (3.6%)
Total	28 (100%)

Table 4. Amount of Jaw Relation in Cases With Maxillary Central Incisor Impaction

Jaw Relation	Central Tooth Impaction	
	Yes	No
Class I	7 (25%)	29 (51.8%)
Class II	20 (71.4%)	23 (41.1%)
Class III	1 (3.6%)	4 (7.1%)
Total	28 (100%)	56 (100%)

P value = 0.042.

Table 5. Investigation of Mean Maxillary and Mandibular Length and Maxillary Index in 2 Groups

		Number	Maxilla (*P* Value: 0.145)		Mandible (*P* Value: 0.032)		Maxillary index (*P* Value: 0.146)	
			Mean	SD	Mean	SD	Mean	SD
Central tooth impaction	Yes	28	88.12	6.105	101.8	8.280	47.10%	5.1023
	No	56	92.34	6.366	103.25	5.762	45.63%	5.2023

Table 6. Investigation of Tooth Impaction Amount in 2 Groups

		Central Tooth Impaction	
		Yes	No
Tooth impaction	Yes	5 (17.9%)	3 (5.4%)
	No	23 (82.1%)	53 (94.6%)
	Total	28 (100%)	56 (100%)

P value: 0.149.

Table 7. Amount of Vertical Occlusion Disorders

		Central Tooth Impaction	
		Yes	No
Occlusion disorders	Normal	15 (60%)	51 (91.1%)
	Open bite	6 (24%)	1 (1.8%)
	Deep bite	4 (16%)	4 (7.1%)
	Total	25 (100%)	56 (100%)

P value: 0.004.

Table 8. Amount of Antero-posterial Occlusion Disorder

		Central Tooth Impaction	
		Yes	No
Occlusion disorders	Normal	25 (89.3%)	45 (80.4%)
	Anterior cross bite	3 (10.7%)	11 (19.6%)
	Total	28 (100%)	56 (100%)

P value: 0.585.

Table 9. Amount of Horizontal Occlusion Disorders

		Central Tooth Impaction	
		Yes	No
Occlusion disorders	Normal	23 (82.1%)	47 (83.9%)
	Posterior cross bite	5 (17.9%)	9 (16.1%)
	Total	28 (100%)	56 (100%)

P value: 0.585.

central impaction were removed from the study.

In 25 cases of unilateral impacted tooth, in 20% of people (5 cases) both impacted side and healthy sides were at the same level, in 60% of people (15 cases) impacted sides canine was on a higher level than the healthy side and in 20% of people it was on a lower level (Figures 1-3).

Discussion

Tooth impactions can cause problems like tooth decay, pulp disorders (e.g., pulpal involvement of second molars because of third molars impaction or lateral incisors involvement because of canine impaction), periodontal disorders, facial space infections, root resorption of adjacent teeth and even cysts and maxillofacial tumors (11). Therefore, early detection of impacted teeth and removal of its etiologic causes not only prevent further problems but also promote dental beauty and function. Most of the patients referred for maxillary central incisor impaction are in age ranges of 8-12, which is because of normal age range of 7-8 for maxillary central incisor so that eruption of opposite side tooth when the other side tooth has not yet erupted may cause parental concern.

In the study of impaction causes, it was found that most common causes are mesiodens (71.4%), followed by root dilacerations (14.3%), space insufficiency (10.7%) and cyst (3.6%).

In agreement with this study, in the study of Bettes and Camilleri, supernumerary teeth were the most common cause of maxillary tooth impaction with the prevalence

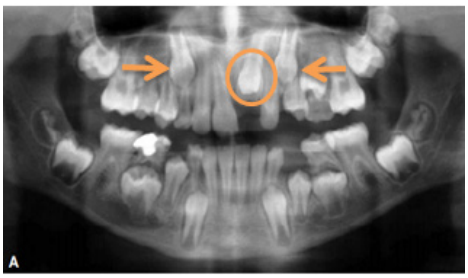

Figure 1. Canines of the both sides are in the same level.

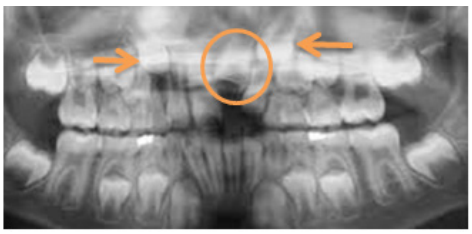

Figure 2. Canine of impaction side is in superior position compared to nun impaction side.

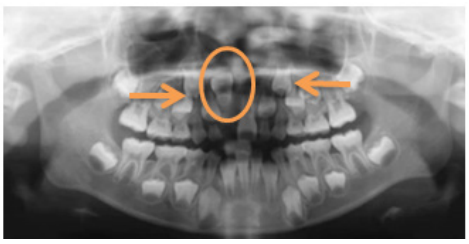

Figure 3. Canine of impaction side is in lower position compared to nun impaction side..

of 47%. The following causes were dental buds improper positioning (12%), dilacerations (9%), odontoma (9%), crowding (4%) and odontogenic cyst (2%) (9).

In the study of Chaushu and colleagues, the most common causes were physical obstruction (42.8%), trauma (20.6%) and dilacerations (20.6%) (18).

In the current study, in group with maxillary central incisor tooth impaction, 25% had class I jaw relation, 71.4% had class II jaw relation, and 3.6% had class III jaw relations. Comparison of this group with control group shows that class II jaw relation is significantly more common than that in the control group ($P=0.042$)

In the current study, for the first time, we studied dentoskeletal aspects of patients with central maxillary tooth impaction. There have yet been no similar studies to compare our results with theirs. However, there are some similar studies about canine impaction.

Cernochova and Izakovicova-Holla studied dentoskeletal characteristics in patients with impaction, and concluded patients with palatal impaction of maxillary canines have a significantly higher class I skeletal relations. In addition, class III skeletal relation was more common in patients with buccal maxillary tooth impaction (19).

Furthermore, Sacerdoti and Baccetti found no relations in different skeletal classifications and maxillary tooth impaction (20). Soltani and colleagues reported no significant difference between any kind of jaw relation and maxillary canine impaction (21). In the study of Ludicke and colleagues, only the class II division 2 jaw relation was considered a risk factor for palatal impaction of maxillary canine (21). However, in the current study, class II jaw relation was significantly more prevalent in impaction group.

In both groups (group with maxillary canine impaction and control), SNA (82 ± 2) was in normal ranges and did not show any significant difference. SNB also was less than normal (80 ± 2) in both groups although was not significant.

But for ANB, however, the measurements indicated that in the impaction groups, ANB angle (5.50°) was greater than normal range (3.92°), with a significant difference. This again confirms the findings of our study (significantly higher prevalence of class II jaw relation in impaction group).

Ludicke and colleagues claimed that patients with palatal canine impaction have wider SNA angle and argued that this situation can confirm greater palatal space availability in the apical of the incisors (22).

In the study of occlusion disorders in vertical dimension, results indicated that occlusal disorders in vertical dimension, such as open bite and deep bite, are more common in patients with maxillary central tooth impaction than in control group. However, horizontal and anterior-posterior disorders did not show any relationship with maxillary central tooth impaction.

In the current study, maxillary index was 47.1% in central impaction group and 45.63% in control group. Given these findings, maxillary arc in maxillary central impaction group is thinner without any significant difference. Kim and colleagues in one study of patients with canine impaction indicated that in this group maxilla index showed a thinner arc than the group with buccal maxillary canine impaction (23).

In most cases (60%), canines of the same side of maxillary central impaction were positioned upper than the opposite side. Chaushu and colleagues reported that after treatment, canine displacement is more common in central impacted side (18). Wasserstein and colleagues also reported evidence of canine and lateral incisor transposition on the same side of central incisor impaction (24). According to these findings, Chaushu and colleagues suggested that early treatment for central incisor impaction can be effective to prevent a canine impaction on the same side (18). Although the main cause of dental transpositions is still unknown, etiologic causes such as trauma, genetics, and displacement of developing dental bud, mechanical interruptions, early loss of primary teeth and over retention of primary dentition (6) and dental transposition of lateral and canine on the same side can lead to greater challenges.

Conclusions

According to this study, the presence of mesiodens was the most important reason for maxillary central incisor impaction. Results indicate that class II jaw relation is more common in patients with maxillary central incisor impaction. Besides that, higher incidence of vertical disorders in patients with maxillary central incisor impaction can intensify the challenge.

Authors' Contribution

All authors contributed equally to this work.

Ethical Statement

Not applicable.

Conflict of Interest Disclosures

The authors declare that they have no conflict of interests.

References

1. Papadopoulos MA, Ioannodou I, Gianniou E, Kolokithas G. Impacted teeth in a Greek malocclusion population. Hellenic Orthodontic Review. 2001;4:103-17.
2. Hupp J, Ellic E, Tucker M. Contemporary oral and maxillofacial surgery. Mosby; 2008. 229-31.
3. Patil S, Pachori Y, Kaswan S, Khandelwal S, Likhyani L, Maheshwari S. Frequency of mesiodens in the pediatric population in North India: A radiographic study. J Clin Exp Dent. 2013;5(5):e223-6. doi: 10.4317/jced.51162.
4. Huber KL, Suri L, Taneja P. Eruption disturbances of the maxillary incisors: a literature review. J Clin Pediatr Dent. 2008;32(3):221-30.
5. Cozza P, Marino A, Lagana G. Interceptive management of eruption disturbances: case report. J Clin Pediatr Dent. 2004;29(1):1-4.

6. Fu PS, Wang JC, Wu YM, Huang TK, Chen WC, Tseng YC, et al. Unilaterally impacted maxillary central incisor and canine with ipsilateral transposed canine-lateral incisor. Angle Orthod. 2013;83(5):920-6. doi: 10.2319/010213-5.1.
7. Kuroda S, Yanagita T, Kyung HM, Takano-Yamamoto T. Titanium screw anchorage for traction of many impacted teeth in a patient with cleidocranial dysplasia. Am J Orthod Dentofacial Orthop. 2007;131(5):666-9. doi: 10.1016/j.ajodo.2005.06.026.
8. Frazier-Bowers SA, Simmons D, Wright JT, Proffit WR, Ackerman JL. Primary failure of eruption and PTH1R: the importance of a genetic diagnosis for orthodontic treatment planning. Am J Orthod Dentofacial Orthop. 2010;137(2):160. e1-7; discussion -1. doi: 10.1016/j.ajodo.2009.10.019.
9. Betts A, Camilleri GE. A review of 47 cases of unerupted maxillary incisors. Int J Paediatr Dent. 1999;9(4):285-92.
10. Proffit WR, Fields HW Jr, Sarver DM. Contemporary orthodontics. 4th ed. Canada: Mosby; 2007:93-7.
11. Hou R, Kong L, Ao J, Liu G, Zhou H, Qin R, et al. Investigation of impacted permanent teeth except the third molar in Chinese patients through an X-ray study. J Oral Maxillofac Surg. 2010;68(4):762-7. doi: 10.1016/j.joms.2009.04.137.
12. Chokron A, Reveret S, Salmon B, Vermelin L. Strategies for treating an impacted maxillary central incisor. Int Orthod. 2010;8(2):152-76. doi: 10.1016/j.ortho.2010.03.001.
13. Guideline on management of the developing dentition and occlusion in pediatric dentistry. Pediatr Dent. 2009;3(6):239-51.
14. Chang CA, Fields HW Jr, Beck FM, Springer NC, Firestone AR, Rosenstiel S, et al. Smile esthetics from patients' perspectives for faces of varying attractiveness. Am J Orthod Dentofacial Orthop. 2011;140(4):e171-80. doi: 10.1016/j.ajodo.2011.03.022.
15. Rafatjou R, Ronasi N, Rastegar Y, Safe M, Khezri Sarijeh N. Comparison of Fluoride Content in Drinking Water and Prevalence of Dental Fluorosis in 6 - 12-Year-Old Students in Mariwan (a Cold Region) and Behbahan (a Warm Region) during the 2013 - 2014 Educational Year. Avicenna J Dent Res. 2016;8(4):1-8. doi: 10.17795/ajdr-28153.
16. Ahmadi-Motamayel F, Soltanian AR, Basir A. Evaluation of Factors Related to the First Deciduous Tooth Eruption Time in Infants Born in Hamadan, Iran. Avicenna J Dent Res. 2017;9(2):6. doi: 10.5812/ajdr.60714.
17. Ramezani G, Hosseini MA. Association Between Dental Caries in Primary Dentition with Low Birth Weight and Premature Birth: A Case-Control Study. Avicenna J Dent Res. 2017;9(3):1-6. doi: 10.5812/ajdr.13247.
18. Chaushu S, Zilberman Y, Becker A. Maxillary incisor impaction and its relationship to canine displacement. Am J Orthod Dentofacial Orthop. 2003;124(2):144-50; discussion 50. doi: 10.1016/s0889540603003445.
19. Cernochova P, Izakovicova-Holla L. Dentoskeletal characteristics in patients with palatally and buccally displaced maxillary permanent canines. Eur J Orthod. 2012;34(6):754-61. doi: 10.1093/ejo/cjr069.
20. Sacerdoti R, Baccetti T. Dentoskeletal features associated with unilateral or bilateral palatal displacement of maxillary canines. Angle Orthod. 2004;74(6):725-32.
21. Soltani MK, Mollaei N, Mohammadi O. Prevalence of canine impaction and its relation with other occlusal characteristics. Iranian Journal of Orthodontists. 2011;6:45-50.
22. Ludicke G, Harzer W, Tausche E. Incisor inclination--risk factor for palatally-impacted canines. J Orofac Orthop. 2008;69(5):357-64.
23. Kim Y, Hyun HK, Jang KT. The position of maxillary canine impactions and the influenced factors to adjacent root resorption in the Korean population. Eur J Orthod. 2012; 34(3):302-6. doi: 10.1093/ejo/cjr002.
24. Wasserstein A, Tzur B, Brezniak N. Incomplete canine transposition and maxillary central incisor impaction--a case report. Am J Orthod Dentofacial Orthop. 1997;111(6):635-9.