

Anatomical Dimensions and Morphology of Incisive Canal in Orthodontic Patients: A CBCT Based Pilot Study

Faisal Arshad¹, Shashi Kumar HC²

¹Senior Lecturer, ²Professor,
Department of Orthodontics,
Rajarajeswari Dental College &
Hospital,
Bangalore, Karnataka, India.

ABSTRACT

Introduction: Incisive canal is an important anatomical landmark in the pre-maxillary segment of the maxilla. This landmark is of quite a significance in Orthodontics especially WHILE doing anterior maxillary intrusion and retraction as well as placing TADs in the pre-maxillary segment. The aim of this study was to determine the anatomical dimensions and morphological forms of incisive canal in Orthodontic patients based on the pre-treatment CBCT findings in south Indian population.

Materials & Methods: This study included 100 CBCT's, 50 each of male and female which were examined for the measurement of nasopalatine canal labiopalatally, Length of the canal, width of the bone anterior to canal, Mesiodistal width of incisive foramen. The morphology of the incisive canal was also examined according to the Mardinger's classification. Patients were classified into two age groups – Group I: age 15-25, Group II: age 26-36. To eliminate bias, three observers did all the measurements, and the average value was taken.

Results: The data was tabulated in excel sheet and Statistical software, namely SPSS 22.0, and R environment ver.3.2.2 was used for the analysis and to generate graphs, tables. Mean, standard Deviation and standard Error was derived. Student t-test was used to determine the correlation. In all the parameters, males had greater dimensions as compared to females. Age wise, the dimensions of all parameters were same with no statistical significance. Cylindrical shape of incisive canal was most commonly prevalent followed by the funnel shape in both the genders.

Conclusion: the study concluded that the dimensions of the incisive canal were greater in males as compared to females. Age wise there was no significant difference in the dimensions. Cylindrical shape of incisive canal was more prevalent. Pre-treatment CBCT of the pre-maxillary region should be included in the diagnostic armamentarium of orthodontics which can be helpful in planning the orthodontic tooth movement & retraction in the incisal region.

Keywords: Incisive Canal (IC), Anatomical Dimensions, CBCT.

Available Online: 30th June 2020

Article History

Received: 02.05.2020

Accepted: 27.05.2020

*Corresponding Author

Dr. Faisal Arshad,
Senior Lecturer,
Department of Orthodontics,
Rajarajeswari Dental College &
Hospital,
Bangalore, Karnataka, India.

Copyright: © the author(s). IABCR is an official publication of Ibn Sina Academy of Medieval Medicine & Sciences, registered in 2001 under Indian Trusts Act, 1882.



This is an open access article distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited and the use is non-commercial

INTRODUCTION


The anatomical location of incisive canal is within the pre-maxillary segment of the Maxilla. The two openings of incisive canal are incisive foramen and nasopalatine foramen¹.

The nasopalatine nerves and vessels traverse through this canal. Mardinger et al.² described various anatomical and morphological differences in the incisive canal shape and classified the shape of the incisive canals based on their appearance in sagittal view of CBCT as: cylindrical, funnel like, banana like, and hourglass like. He further states that the Size, shape, position, and number of foramina are different in number, shape and form in different individuals. Various studies in the literature³⁻⁶ have shown that the anatomical and morphometric features of the incisive canal should be among the key factors in treatment planning procedures causing Orthodontic tooth movement is initiated.

The various procedures that cause Orthodontic tooth movement must take into account the relation to adjacent structures located in the region of the pre-maxilla, such as the nasopalatine canal (NPC).

The evolving diagnostic trends including the introduction of three-dimensional cone beam computed tomography (CBCT) in Orthodontic diagnosis, it is now possible to study the structures which were not clearly visible earlier on two-dimensional radiographs. CBCT is non-invasive, having high resolution, with low dose of radiation. One such major and important structure in the pre-maxillary segment is the incisive canal on palatal aspect of maxillary incisors. A Preoperative CBCT of maxillary region assists in diagnosing any anatomical difficulties before proceeding with Orthodontic tooth movement procedures including the

Access this article online

Website: www.iabcr.org	Quick Response code 
DOI: 10.21276/iabcr.2020.6.2.23	

How to cite this article: Faisal Arshad, Shashi Kumar HC. Anatomical Dimensions and Morphology of Incisive Canal in Orthodontic Patients: A CBCT Based Pilot Study. Int Arch BioMed Clin Res. 2020;6(2): DT1-DT5.

Source of Support: Nil, **Conflict of Interest:** None

placement of TAD's. Because of the morphological variation of incisive canal, a CBCT-guided diagnosis should be performed to evaluate the position of incisive canal foramen and its approximation with the maxillary incisor root.

There are a numerable study showing the morphological and anatomical related dimensional variations of incisive canal 7-9 in various populations as well as edentulous and dentulous patients. So the purpose of this study was to evaluate the anatomical and morphological characteristics of incisive canal in patients undergoing Orthodontic treatment.

METHODS

The protocol and permission for this study was obtained by the Ethical committee of Rajarajeswari dental college & Hospital RRDCHET/1Ortho/2020.

Sample included the Pre-treatment CBCT, of patients who had given consent for Orthodontic treatment which were analyzed in cross sectional slices to know the Anatomy and Morphology of the incisive canal. The sample size included 100 CBCT images of the sagittal and axial views of the patients (Figure 1 & 2). A total of 50 Female and 50 Male CBCT's were evaluated using an on- demand CS 3D Imaging software.

Age group was classified in two groups: Group I: 15-25 and Group II: 26-336 years. Three operators assessed the CBCT slices for measuring the width of following parameters in sagittal section: nasopalatine canal labiopalatally, Length of the canal, width of the bone anterior to canal and in Axial section: Mesiodistal width of incisive foramen. Mean of all the three readings of the three operators was derived for each measurement. The anatomical shape was decided by the three operators according to Mardinger's classification² and the final shape was agreed on the mutual consensus of the three operators.

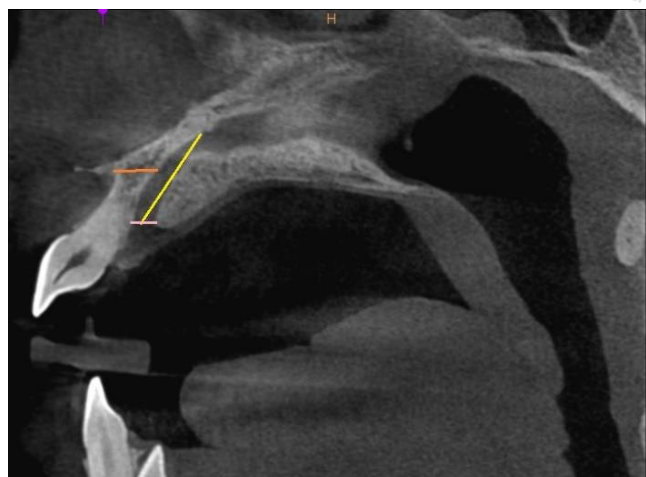


Figure 1: Sagittal view showing the Incisive canal length, width and width of bone present anterior to canal.

Table 1: Gender wise comparison of the mean width of Nasopalatine Canal Labiopalatally, length of canal, width of bone anterior to canal and mesio distal width of canal (axial section) by independent t- test

Dimension of Incisive canal	Gender	Mean	SD	SE	T-value	p-value
Nasopalatine Canal Labiopalatal width	Male	3.22	0.91	0.13	1.2707	0.2038
	Female	2.99	0.90	0.13		
Length of canal	Male	20.01	1.05	0.15	6.2363	0.0001*
	Female	18.01	2.01	0.28		
Width of bone anterior to canal	Male	6.51	1.82	0.26	1.0488	0.2943
	Female	6.11	1.99	0.28		
Mesio distal width of canal	Male	4.10	1.72	0.24	3.0984	0.0019*
	Female	3.10	1.50	0.21		

*p<0.05 indicates significant difference

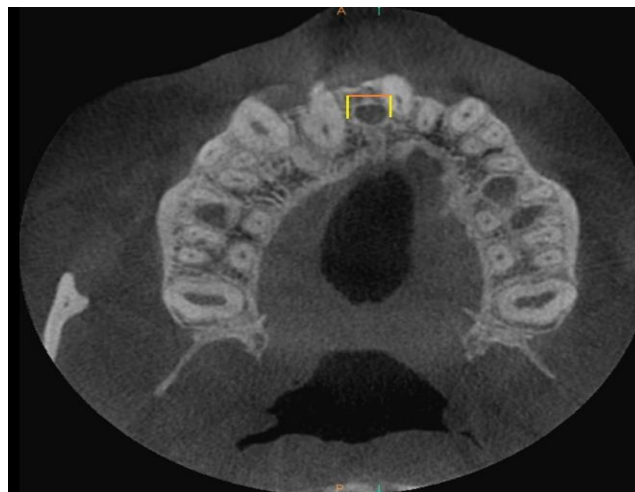


Figure 2: Axial view showing the mesio-distal dimension of the Incisive canal

Inclusion Criteria: Clear reproduction of CBCT image for maxilla, patients with both central maxillary incisors,

Exclusion Criteria: Pixelated CBCT images of Maxilla, Previous Orthodontic treatment history, presence of supernumerary maxillary incisors, prosthodontic maxillary incisor, Maxilla having prosthetic Implant, History of trauma to maxillary incisors', congenital anomalies such as cleft lip and palate.

Statistical Analysis: The Statistical software, namely SPSS 20.0 and R environment ver.3.2.2 were used for the analysis of the data and Microsoft Word and Excel have been used to generate graphs, tables etc. Mean, Standard deviation and standard Error were determined. Student t- test was used to determine the intergroup correlation.

RESULTS

Table 1 & Graph 1 show the gender wise comparison of the measurements of Nasopalatine Canal Labiopalatally, Length of canal, Width of bone anterior to canal, Mesio distal width of canal which were seen to be greater in Males as compared to females but were statistically significant only in case of Length of canal (p=0.0001) and Mesio distal width of canal (p=0.0019). Table 2 & Graph 2 shows the age wise comparison of the anatomic variables of the incisive canal. Average mean values show that the lesser age group has lesser dimension (in mm) as compared to the higher age group but was not statistically significant. Table 3 & Graph 3 shows the highest overall prevalence of cylindrical type anatomy in Males (40%) and females (45%) followed by Funnel shape in Males (26%) and females (28%), and least prevalence of Banana and Hourglass appearance which was not statistically significant. (p=0.3670)

Graph 1: Gender wise comparison of the Nasopalatine Canal Labiopalatally, length of canal, width of bone anterior to canal and mesio distal width of canal (axial section)

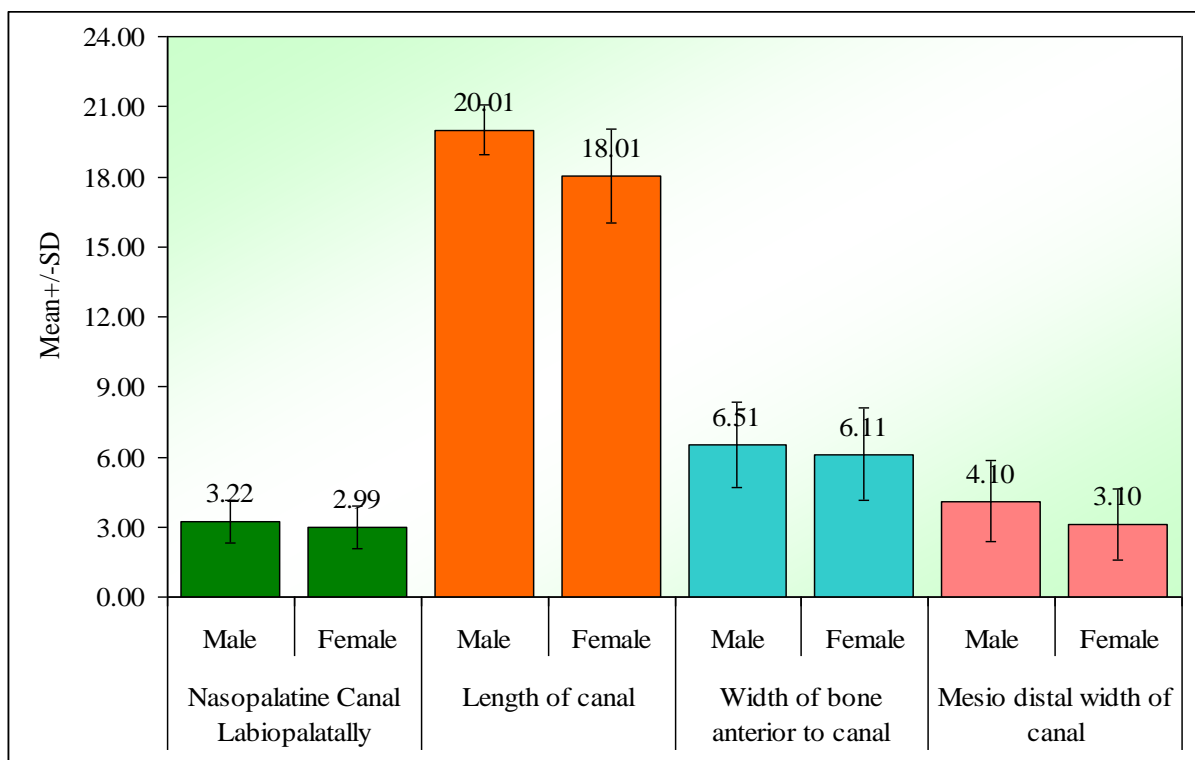


Table 2: Comparison of two Age groups in relation to Anatomic variables of the Incisive canal by independent t-test

Anatomic variables of Incisive canal	Age groups	Mean (mm)	SD	SE	T-value	p-value
Nasopalatine Canal Labiopalatally	15-25yrs	3.10	0.99	0.14	-0.5961	0.5511
	26-36yrs	3.21	0.85	0.12		
Length of canal	15-25yrs	15.10	1.11	0.16	-0.3572	0.7209
	26-36yrs	15.22	2.10	0.30		
Width of bone anterior to canal	15-25yrs	6.11	1.50	0.21	-0.9862	0.3240
	26-36yrs	6.40	1.44	0.20		
Mesio distal width of canal	15-25yrs	3.20	0.75	0.11	1.8827	0.0597
	26-36yrs	2.96	0.50	0.07		

*p<0.05

Graph 2: Age wise Comparison of the Anatomic variables of the Incisive canal.

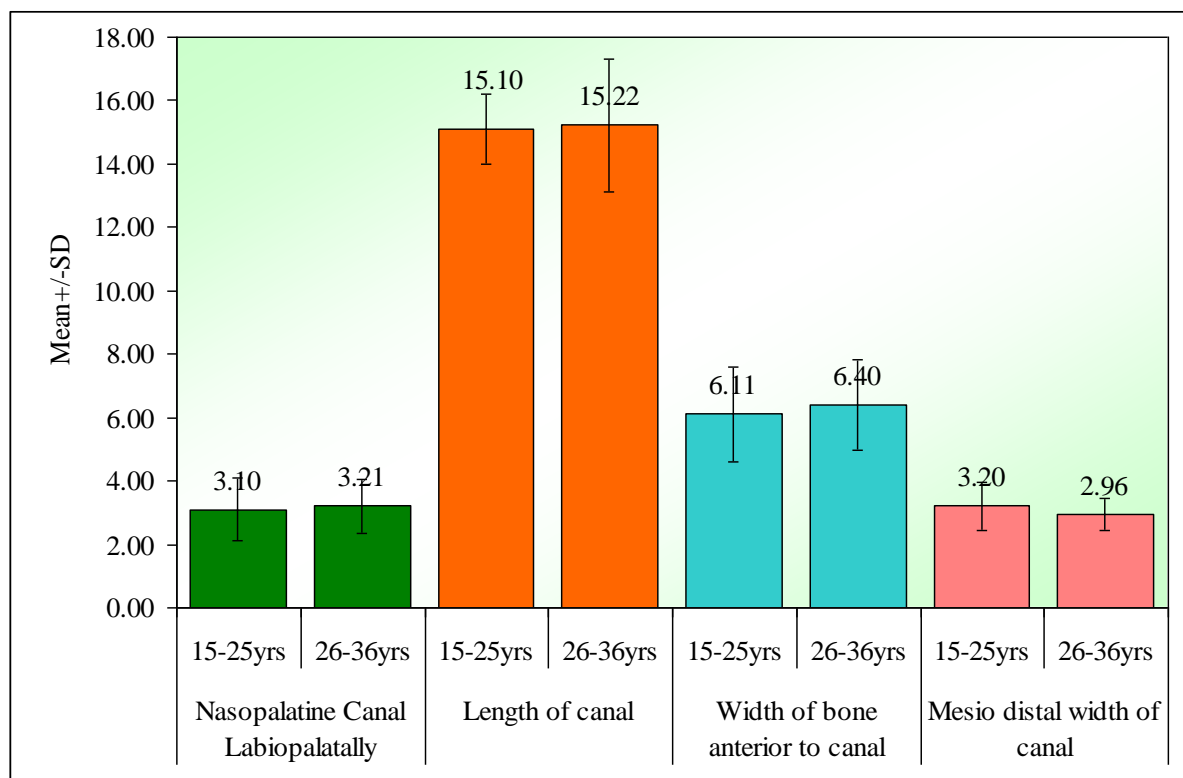


Table 3: Comparison of Male and Female with the type of Incisive canal anatomy

Naso palatine anatomical type	Male	%	Female	%	Total
Banana	10	20.00	4	8.00	14
Hourglass	7	14.00	7	14.00	14
Cylindrical	20	40.00	25	50.00	45
Funnel	13	26.00	14	28.00	27
Total	50	100.00	50	100.00	100

Chi-square=3.1640, p=0.3670

Graph 3: Comparison of Male and Female with type of Incisive canal anatomy



DISCUSSION

The present pilot study evaluated the anatomical dimensions of incisive canal and its morphology. Anatomically, incisive canal is located in the anterior part of the hard palate and mediates as a communication between the oral and nasal cavities. Various Soft tissue and neurovascular bundles namely, the nasopalatine nerve and sphenopalatine artery, traverse along this canal. With the advent of Cone-beam computed tomography (CBCT) technology, the study of the anatomical and morphometric variability of the incisive canal has become quite a lot easy. Therefore, this study was conducted to determine the dimensions and anatomy of the incisive canal seen in sagittal and axial views of CBCT.

A study¹⁰ reported that the closeness of maxillary incisor roots to the incisive canal might influence the degree of root resorption after large incisal retraction. So, whenever the Orthodontic treatment is being planned it is critical to confirm the exact location and dimension of the incisive canal.

The mean length of the Incisive canal in our study measured from 20.01mm in males and 18.01 mm in females respectively, which is contrary to the study by Mraiwa et al., Mardinger et al., Liang et al., Song et al., Bornstein et al., who reported the range of canal length from from 8 to 12 mm. According to the result of study done by Liang et al.¹¹, men had longer and wider canals which is in agreement with the results of our study. As well as concordant with the findings of a previous study⁴ Where the length of the incisive canal in male patients was significantly greater compared to that in female patients.

The narrowest canal diameter was 1.1 mm and the widest was 6.7 mm in the study by Song et al.¹ while as in our study the canal diameters were 4.10 in males and 3.10 in females. There are a numerous gender related studies on the incisive canal anatomy and morphology^{2,12-14} all the studies concluded the difference of incisive canal and reported greater and statistically significant buccal bone width and canal length values in men as compared to females which is in agreement with the results of our study as well.

There are variously defined morphological types of the canal in the literature^{1,2} cylindrical canal shape was said to be the most prevalent shape, whereas banana like was the least prevalent in both gender¹⁴ which is in agreement with the results of our study which also found cylindrical morphology more common and banana and funnel shape least common. With the advent of temporary anchorage devices (i.e., miniscrew implants) the range of orthodontic treatment has expanded and made it possible to achieve a greater degree of maxillary incisor movement^{10,15}. To manage during and post-orthodontic treatment complications which include root resorption, gingival recession, dehiscence, and fenestration following root deviation from the alveolar bone housing, the anatomical features of the maxillofacial area should be carefully examined in each patient, and diagnosis should be formulated based on three Dimensional information and to ensure precise evaluation of tooth movement-induced.^{15,16} So the Pre and post Orthodontic treatment FOV-limited CBCT analyses for evaluating the anatomical and

morphological changes in the incisive canal are required. Further studies with greater sample size in male and female population and varied age groups should be undertaken.

CONCLUSION

This study concluded that there are gender differences in anatomical structure of incisive canal. Males have greater dimension of nasopalatine canal labiopalatally, length of canal, width of bone anterior to canal and mesiodistal width of canal as compared to females. Age wise, the dimensions of incisive canal were same. Cylindrical shape of the incisive canal was more common, followed by banana and hourglass shape.

Evaluating the incisal canal anatomy and morphology is important in planning the orthodontic tooth movement in the incisor region and while doing retraction of the anterior teeth which leads to bone remodelling in the anterior region causing change in the anatomy and morphology of the incisive canal which can further hamper the nervous and blood supply in the surrounding region.

CBCT is an effective tool in evaluating the pre-maxillary morphology and incisive canal anatomy and should be included in the diagnostic armamentarium of orthodontics.

ACKNOWLEDGEMENTS

We are thankful to the Management, Dean-Dr. Edwin D, Principal, HOD- Dr. Rajkumar A, staff at Dept. of Orthodontics, Rajarajeswari Dental College & Hospital, Bangalore, Karnataka for their support in providing facilities and necessary permissions for conducting this study.

REFERENCES

1. W.-C. Song, D.-I. Jo, J.-Y. Lee et al. Microanatomy of the incisive canal using three-dimensional reconstruction of microCT images: an ex vivo study. *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology* 2009;:108(4):583–590.
2. O. Mardinger, N. Namani-Sadan, G. Chaushu, and D. SchwartzArad. Morphologic changes of the nasopalatine canal related to dental implantation: a radiologic study in different degrees of absorbed maxillae. *Journal of Periodontology*, 2008;79(9):1659–62.
3. Cho EA, Kim SJ, Choi YJ, Kim KH, Chung CJ. Morphologic evaluation of the incisive canal and its proximity to the maxillary central incisors using computed tomography images. *Angle Orthod*2016;86:571-6.
4. Güncü GN, Yıldırım YD, Yılmaz HG, Galindo-Moreno P, Velasco-Torres M, Al-Hezaimi K, et al. Is there a gender difference in anatomic features of incisive canal and maxillary environmental bone? *Clin Oral Implants Res* 2013;24:1023-6.
5. Matsumura T, Ishida Y, Kawabe A, Ono T. Quantitative analysis of the relationship between maxillary incisors and the incisive canal by cone-beam computed tomography in an adult Japanese population. *Prog Orthod* 2017;18:1-6.
6. Al-Amery SM, Nambiar P, Jamaludin M, John J, Ngeow WC. Cone beam computed tomography assessment of the maxillary incisive canal and foramen: Considerations of anatomical variations when placing immediate implants. *PLoS One* 2015;10:01-16.
7. Chatriyanuyoke P, Lu CI, Suzuki Y, Lozada JL, Rungcharassaeng K, Kan JY, et al. Nasopalatine canal position relative to the maxillary central incisors: A cone beam computed tomography assessment. *J Oral Implantol* 2012;38:713-17.
8. Asami R, Kawai T, Sato I, Yoshida S, Yosue T. Three-dimensional observations of the incisive canal and the surrounding bone using cone-beam computed tomography. *Oral Radiol* 2010;26:20-28.
9. Bornstein MM, Balsiger R, Sendi P, Von Arx T. Morphology of the nasopalatine canal and dental implant surgery: A radiographic analysis of 100 consecutive patients using limited cone-beam computed tomography. *Clin Oral Implants Res* 2011;22:295-301.
10. Chung CJ, Choi YJ, Kim KH. Approximation and contact of the maxillary central incisor roots with the incisive canal after maximum retraction with temporary anchorage devices: Report of 2 patients. *Am J Orthod Dentofac Orthop.* 2015;148:493–502.
11. Liang X, Jacobs R, Martens W, Hu Y, Adriaenssens P, Quirynen M, et al. Macro- and micro-anatomical, histological and computed tomography scan characterization of the nasopalatine canal. *J Clin Periodontol.* 2009;36:598–603.
12. Mraiwa, N., Jacobs, R., Van Cleynenbreugel, J., Sanderink, G., Schutyser, F., Suetens, P., van Steenberghe, D. & Quirynen, M. The nasopalatine canal revisited using 2D and 3D CT imaging. *Dento maxillo facial Radiology.* 2004. 33: 396–402.
13. Tozum, T.F., Guncu, G.N., Yildirim, Y.D., Yilmaz, H.G., Galindo-Moreno, P., Velasco-Torres, M., Al-Hezaimi, K., Al-Sadhan, R., Karabulut, E. & Wang, H.L. Evaluation of incisive canal characteristics related to dental implant treatment with computerized tomography: a clinical multicenter study. *Journal of Periodontology*, 2012; 83: 337–343.
14. Güncü GN, Yıldırım YD, Yılmaz HG, Galindo-Moreno P, Velasco-Torres M, Al-Hezaimi K, Al-Shawaf R, Karabulut E, Wang HL, Tözüm TF. Is there a gender difference in anatomic features of incisive canal and maxillary environmental bone? *Clin Oral Implants Res.* 2013 Sep;24(9):1023-6.
15. Ackerman JL, Proffit WR, Sarver DM. The emerging soft tissue paradigm in orthodontic diagnosis and treatment planning. *Clin Orthod Res.* 1999;2:49–52.
16. Ahn HW, Moon SC, Baek SH. Morphometric evaluation of changes in the alveolar bone and roots of the maxillary anterior teeth before and after enmasse retraction using cone-beam computed tomography. *Angle Orthod.* 2013;83:212–21.