Received date: 31 December 2024 / **Accept date:** 14 January 2025
DOİ: 10.61139/ijdor.1610182

The Role of Diagnostic Radiology in Orthodontics

Nurbanu Uluisik [1*], Nazlı Gonder Erdede [2]

1. Harran University, Faculty of Dentistry, Department of Dentomaxillofacial Radiology, Sanliurfa, Turkey.
2. Gaziantep University, Faculty of Dentistry, Department of Orthodontics, Gaziantep, Turkey.

***Corresponding author:** Uluisik N, Research Assistant, Department of Dentomaxillofacial Radiology, Faculty of Dentistry, Harran University, Şanlıurfa, Turkey.
E-mail : nurbanuuluisik@harran.edu.tr
Orcid: 0000-0003-2936-2833

Abstract

Diagnostic radiology constitutes an indispensable element of the diagnostic process and treatment planning in orthodontics. Panoramic and cephalometric radyographies, in conjunction with cone beam computed tomography, facilitate a comprehensive examination of tooth and jaw structures. These methodologies are employed in critical applications, including the identification of malocclusion types, the evaluation of growth and development stages, the assessment of impacted teeth positioning, and the monitoring of alterations occurring during orthodontic treatment. However, given the potential risks of radiation exposure, it is imperative to prioritize the acquisition of the most informative images while minimizing the radiation dose. The utilization of advanced imaging techniques should be reserved exclusively for circumstances where their application is medically justified, and patient safety must remain the paramount concern.

Review (HRU Int J Dent Oral Res 2025; 5(1): 45-50)

Keywords: Diagnostic radiology, orthodontics, panoramic radiography, cephalometric radiography, cone beam computed tomography.

Introduction

Diagnostic radiology constitutes the diagnostic branch of radiology, a field that plays an indispensable role in orthodontic treatment planning and patient follow-up. Contemporary radiological methodologies facilitate meticulous evaluation of teeth, jaw bones, and the adjacent tissues, thereby enabling precise identification of orthodontic concerns and the formulation of efficacious treatment modalities (1,2)

The Application of Diagnostic Radiology

1. Evaluating the alignment and positioning of the teeth
2. Determining the type of malocclusion
3. Planning of orthognathic surgery
4. Examination of the location of impacted teeth and their relationship with surrounding tissue
5. Root resorption in orthodontic treatment follow-up, monitoring the effect of orthodontic appliances
6. Evaluation of changes occurring in bone
7. Examination of cysts, tumors and inflammation

Received date: 31 December 2024 / **Accept date:** 14 January 2025
DOİ: 10.61139/ijdor.1610182

8. Diagnosis and follow-up of syndromic conditions (3,4)

The issue of the minimal radiographic recording system that is planned to be used in determining the diagnosis and treatment in orthodontics has been discussed by researchers for years, yet no consensus has been reached (4-7). The presence of risk should be accepted when evaluating the cytocastic effects of radiation, which occur even at low doses. This is due to the fact that patients exposed to radiation usually consist of children and young adults with high radiosensitivity (4). When determining the necessary radiographic records, orthodontists should adopt the principle of "lowest reasonably achievable" radiation and choose the method that provides optimal information with appropriate indications for the patient (4,8). The radiographs obtained in a standard orthodontic clinic consist of panoramic, cephalometric, and wrist radiographs, which are two-dimensional (2). However, these techniques have disadvantages, such as magnification, overlapping of anatomical points, and artifacts related to patient positioning. In light of these limitations, three-dimensional (3D) methods can be used in orthodontic diagnosis and treatment planning (6, 9).

The upper canines, which are planned to be retained for treatment in orthodontics, are the most frequently impacted teeth after the lower jaw third molars, and the frequency of impacted canines varies between 1% and 4% (10). The maxillary canines teeth are developed in the deeper regions of the jawbone and must traverse a greater distance to reach the oral cavity than other teeth (11). In addition to panoramic, periapical, lateral cephalometric, and posteroanterior cephalometric radiography, cone beam computed tomography (CBCT) can be used as a reliable method for visualizing these orthodontically important teeth (8,12). It has been reported that images obtained with CBCT result in alterations to treatment plans created using 2D radiographs (8). Maxillofacial surgeons have recommended CBCT as a fundamental method for diagnosing impacted maxillary canines. However, orthodontists predominantly favor conventional radiographic techniques over CBCT for routine diagnostic purposes (13).

Radiologic Techniques

1. Panoramic Radiography

Panoramic radiography is frequently regarded as the preferred initial imaging modality for orthodontic patients in the field of dentistry (14). This technique, classified as an extraoral method, generates two-dimensional data regarding the facial-jaw skeleton, teeth, and hard tissue elements of the temporomandibular joint (TMJ). This technique provides crucial insights into various conditions that affect orthodontic treatment planning. These include the examination of impacted or supernumerary teeth, dental age determination, and comprehensive evaluation of the entire dentition (15).

The panoramic radiographic image is formed by the synchronized movement of the X-ray tube and detector along a specific trajectory in the opposite direction around the patient's head (Figure 1). During this process, the X-rays, which are moving away from the tube, rotate around the jaw and teeth, while the detector on the opposite side records the received data. During this movement, only structures in a specific focal plane (focal trough) are clearly visualized, while areas outside this plane appear blurred. This technique is employed to generate a detailed two-dimensional image of the jaw, teeth, and surrounding structures (15,16).

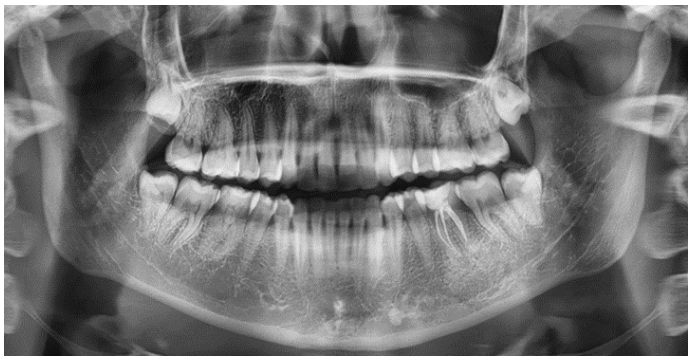

Figure 1. Example of a panoramic radiograph.

In the discipline of orthodontics, panoramic radiographs play a critical role in determining the density of bone tissue, trabeculation, the ratio of spongiosis and cortical bone, and the distance of the maxillary sinus, mental foramen, and mandibular canal to the alveolar crest prior to mini screw placement (2). In the evaluation of the eruption status of the teeth, a decision is made for extraction or surgical exposure of the impacted tooth based on their position in relation to the midline and alveolar crest (17).

According to the findings of studies cited in the literature (18-20), upper canine teeth are more frequently impacted in the palatinal region. It has been documented that these teeth are responsible for inducing root resorption in adjacent teeth (20-22). The limitations of panoramic radiography in providing information regarding the buccopalatinal position of teeth underscore

Received date: 31 December 2024 / **Accept date:** 14 January 2025
DOİ: 10.61139/ijdor.1610182

the necessity of additional diagnostic modalities in the evaluation of impacted canines and the associated root resorption (23). In such cases, the utilization of 3D imaging techniques, such as CBCT, is recommended (24). Furthermore, in cases where the angle of the impacted maxillary canine tooth with the midline exceeds 30 degrees, and/or there is suspicion of inducing root resorption in an adjacent tooth, it is advised to employ CBCT in the smallest imaging area (17).

2. Periapical, Bitewing and Occlusal Radiographs

In addition to panoramic radiography, periapical, bitewing, or occlusal radiographs should be utilized solely when additional detail is required. Periapical radiography is the most informative and simplest of the techniques using X-rays. These radiographs offer superior visual clarity, facilitating the discernment of root structure (length, inclination), periapical tissues, and bone structure of the teeth. The comprehensive nature of this information is paramount in the field of orthodontics. This modality facilitates meticulous examination of the location of impacted teeth, root resorption, periapical lesions, periodontal problems, and post-treatment complications. While this technique offers the advantage of high-resolution evaluation of the targeted area, it is limited in its ability to provide information regarding the buccolingual position of the tooth. A comprehensive evaluation is only achieved when this technique is employed in conjunction with other methods (2,25,26).

In a patient with adequate oral hygiene, panoramic radiography is sufficient if no obvious pathological condition is present. However, if there is suspicion of caries at the interface of the teeth, bitewing radiography should be obtained. In the case of a deep caries, periapical radiography should be obtained from the affected area. In the presence of periodontal disease, periapical or bitewing radiographs should be obtained from the affected area (2).

In panoramic radiographs, the anterior maxilla is frequently distorted by factors such as magnification and superimposition. This results in various pathologies, impacted/erupting and supernumerary teeth being missed. Occlusal radiography, on the other hand, facilitates the detection of these structures in the maxilla, their palatinal/lingual positioning, maxillary expansion, and asymmetries. Furthermore, mandibular imaging provides crucial information regarding the buccolingual position of impacted teeth (27-30). Panoramic radiography is employed to obtain the requisite data for diagnosis, with the objective of minimizing radiation exposure. Periapical or other radiographs are requested only in select circumstances (2).

3. Cephalometric Radiography

Cephalometric radiography is a diagnostic tool employed in the analysis of malocclusions, the evaluation of basic skeletal incompatibilities, and the assessment of facial and dental proportions. This radiographic technique facilitates the elucidation of the anatomical origins of malocclusions. It demonstrates the relationship between the cervical vertebrae, cranial base, cranium, and jaws, as well as any degenerative changes (2,31). While cephalometry remains a cornerstone of orthodontic imaging, the use of lateral cephalometric radiography offers a distinct advantage in evaluating vertical relationships, though it provides limited insight into the transverse dimensions and bilateral assessment of malocclusions (32). The recommended approach involves the utilization of lateral cephalometry when the objective is to ascertain skeletal relationships and measurements or to determine the inclination and position of the upper and lower incisors (4).

Lateral cephalometric radiography is a diagnostic tool that allows for the observation of changes in airway volume in the sagittal plane, particularly in patients diagnosed with obstructive sleep apnea. The literature has examined alterations in the airway following orthodontic treatment using lateral cephalometry (33, 34). Nevertheless, the utilization of surface area or volume measurements in the diagnosis of airway narrowing has been regarded as more precise, and CBCTs have been employed for this purpose (35).

Posteroanterior cephalometric radiographs are employed to evaluate facial asymmetries by examining dentoalveolar and skeletal relationships in the transverse direction. However, patient positioning is a significant challenge, and its effect on the measurements made must be considered (36).

4. Radiography of the hand and wrist

The identification of the stage of growth and development constitutes the most fundamental element of orthodontic evaluation and treatment planning. For this purpose, hand-wrist radiographs are widely used in orthodontic clinics and are considered the gold standard for determining the pubertal growth stage. However, it is important to note that this procedure does involve the administration of additional radiation to the patient, an

Received date: 31 December 2024 / **Accept date:** 14 January 2025
DOİ: 10.61139/ijdor.1610182

undeniable fact that has been documented in the extant literature (37).

A review of the literature on this subject, conducted as part of the preparation of the clinical practice guideline, revealed that measurements of cervical vertebral maturation made using lateral cephalometric radiography can be used as an alternative to wrist x-rays and provide reliable information (4, 37-42).

5. Cone Beam Computerized Tomography

The CBCT was originally developed for utilization in the field of dentistry in 1987, and its functionality in the domain of orthodontics was thoroughly examined and documented during the Orthodontic and Aesthetic Science and Technology Congress in 2002 (43,44).

In the domain of orthodontics, conventional radiographs are often supplemented by CBCT imaging when a more comprehensive evaluation is necessary (see Figure 2). In contradistinction to 2-dimensional radiographs, CBCT images offer several notable advantages. These include the absence of superposition and magnification, the acquisition of cross-sectional images in different planes, the monitoring of the airway volume, the determination of the exact position of impacted teeth, and the presence of soft tissue contrast (45,46).

Furthermore, the bone density and mineralization amounts can be calculated on CBCT. Indications for CBCT include the following: ectopic impacted/erupting teeth, cleft lip and palate, obstructive sleep apnea, orthognathic surgery planning, patients with facial asymmetry, syndromic conditions and deformities, and bone tissue evaluation of the TMJ. The presence of ectopic teeth, their location, and the potential for resorption of permanent tooth roots can be assessed on CBCT. Furthermore, the direction in which the impacted tooth should be moved to prevent damage to neighboring teeth can be determined. The knowledge of the actual three-dimensional position of the impacted tooth is of paramount importance, as it affects the treatment method to be applied by the orthodontist in a timely manner and the necessary anchorage efficiency (2,8).

The efficacy of orthodontic treatment, as evidenced by the reduction in the dimensions of the buccal cortical bone resulting from accelerated palatal expansion, can be assessed through the use of CBCT (47). While CBCT has been found to produce precise outcomes in the assessment of alveolar bone defects, it has also been observed to yield false positive results in the detection of fenestrations (48, 49).

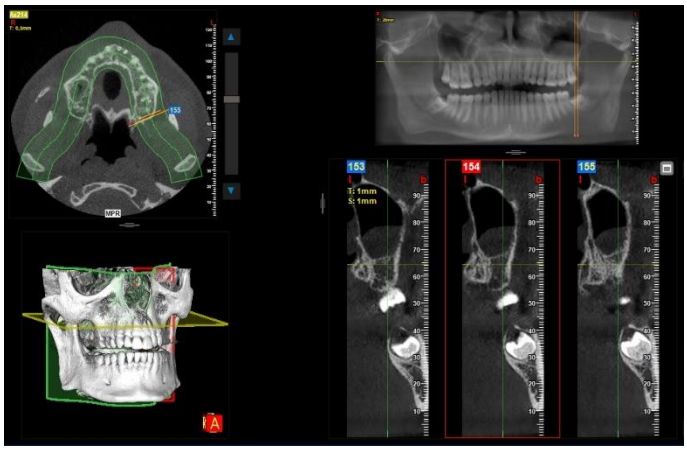

Figure 2. This figure illustrates a cone beam computed tomography image.

While some orthodontists advocate for the routine use of CBCT in addition to panoramic and cephalometric radiography, it is imperative to acknowledge the significant increase in the level of radiation absorbed by patients. When acquiring CBCT images from patients, it is imperative to utilize the smallest feasible imaging area to minimize the overall radiation exposure (2).

6. Magnetic resonance imaging

Magnetic resonance imaging (MRI) is an imaging technique that uses radiofrequency waves as opposed to x-ray-based methods (Figure 3).In dentistry, MRI is mainly used to evaluate soft tissues in the neck region, TMJ disc dislocations and pathologies, TMJ anomalies, and salivary glands. Recent studies have demonstrated its application in the visualization of dentoalveolar structures, periapical and periodontal inflammation, caries, and the location of impacted teeth. The absence of ionizing radiation allows for reproducible recordings, especially in pediatric and adolescent patients (50, 51).

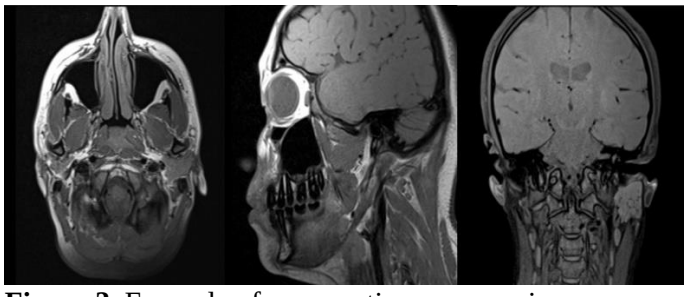

Figure 3. Example of a magnetic resonance image.

Cephalometric analyses can also be performed on MRI; however, they require specialized equipment and settings, which may not be available in all healthcare

Received date: 31 December 2024 / **Accept date:** 14 January 2025
DOİ: 10.61139/ijdor.1610182

institutions. Another limiting factor is the need for a trained radiologist to interpret cephalometric data. Consequently, cephalometric radiographs are frequently the preferred modality due to their convenience, practicality, and accessibility. However, in certain cases where more detailed visualization of soft tissues is required, MRI can be utilized (50).

Metal components in orthodontic appliances, such as brackets and wires, pose a concern as they are susceptible to heating and movement during MRI procedures, potentially causing discomfort to patients. Additionally, these appliances may introduce artifacts in MR images, complicating interpretation. Therefore, in certain circumstances, it may be advisable to remove these appliances prior to undergoing MRI (50, 52).

Minimization of Radiation Dose

Despite the widespread use of diagnostic radiology, it is imperative to minimize patient exposure. In accordance with the ALARA (As Low As Reasonably Achievable) principle, the acquisition of the greatest amount of diagnostic information should be balanced with the requirement of the lowest possible radiation dose. The utilization of advanced techniques, such as CBCT, should be reserved exclusively for cases where there is a clear medical necessity, and the potential risks of radiation exposure to patients must be meticulously evaluated (53,54).

Conclusion

Diagnostic radiology is vital for both diagnosis and treatment planning in the orthodontic treatment process. Methods such as panoramic, cephalometric and CBCT help to determine the extent and severity of orthodontic problems and allow monitoring of treatment effectiveness. Careful and informed use of these technologies increases both patient safety and treatment success.

Authors Contributions

NB: Lıterature Research: NB **Wrıtıng The Manuscript:** NB, NGE **Designed the study:** NB **Manuscript translation:** NGE

References

1. Boyacıoğlu Doğru H, Uysal S, Avcu N. Konik ışınlı bilgisayarlı tomografi ile ortodontik uygulamalar ve ortognatik cerrahi planlaması. Kamburoğlu K, editör. Dentomaksillofasiyal Konik Işınlı Bilgisayarlı Tomografi: Temel Prensipler, Teknikler ve Klinik Uygulamalar. 1. Baskı. Ankara: Türkiye Klinikleri; 2019; p.94-9.
2. Proffit WR, Fields HW Jr, Sarver DM .Çağdaş ortodonti, dördüncü baskı. St. Louis: Mosby, Inc. 2007; s. 167–233.
3. Kakadiya, A., Tandon, R., Azam, A., Kulshrestha, R., & Bhardwaj, M. Recent advancements in diagnostic aids in orthodontics–A review. SM J Dent, 2017;3(2): 1016.
4. Kapetanović A., Oosterkamp BCM, Lamberts AA. et al. Orthodontic radiology: development of a clinical practice guideline. Radiol med 2021; 126:72–82.
5. American Academy of Oral and Maxillofacial Radiology. Clinical recommendations regarding use of cone beam computed tomography in orthodontics. [corrected]. Position statement by the American Academy of Oral and Maxillofacial Radiology. Oral Surg Oral Med Oral Pathol Oral Radiol 2013;116(2):238–257.
6. Rischen RJ, Breuning KH, Bronkhorst EM, Kuijpers-Jagtman AM .Records needed for orthodontic diagnosis and treatment planning: a systematic review. PLoS ONE 2013;8(11):e74186.
7. European Commission (2004) Radiation Protection no 136. European guidelines on radiation protection in dental radiology. Office for Official Publications of the European Communities, Luxemburg
8. Kapila SD, Nervina JM. CBCT in orthodontics: assessment of treatment outcomes and indications for its use. Dentomaxillofac Radiol. 2015;44(1):20140282. doi: 10.1259/dmfr.20140282. PMID: 25358833; PMCID: PMC4277443.
9. Van Vlijmen OJ, Kuijpers M A, Berge SJ, Schols JG, Maal TJ, Breuning H et al. Evidence supporting the use of cone-beam computed tomography in orthodontics. The Journal of the American Dental Association, 2012;143(3):241-252.
10. Kumar S, Mehrotra P, Bhagchandani J, Singh A, Garg A, Kumar S et al . Localization of impacted canines. Journal of clinical and diagnostic research: JCDR, 2015;9(1), ZE11.
11. Da Silva Santos LM, Bastos LC, Oliveira-Santos C, Da Silva SJA, Neves FS, Campos P SF. Cone-beam computed tomography findings of impacted upper canines. Imaging science in dentistry 2014; 44(4):287-292.
12. Botticelli S, Verna C, Cattaneo P M, Heidmann J, Melsen B. Two-versus three-dimensional imaging in subjects with unerupted maxillary canines. The European Journal of Orthodontics 2011;33(4):344-349.
13. Grybienė V, Juozėnaitė D, Kubiliūtė K. Diagnostic methods and treatment strategies of impacted maxillary canines: A literature review. Stomatologija 2019;21(1):3-12.
14. Jung YH, Liang H, Benson BW, Flint DJ, Cho BH. The assessment of impacted maxillary canine position with panoramic radiography and cone beam CT. Dentomaxillofacial Radiology 2012;41(5):356-360.
15. Różyło-Kalinowska I. Panoramic radiography in dentistry. Clin Dent Rev 2021;**5**:26.
16. Hacıosmanoğlu N, Eren H, Küçükkalem MF, Görgün S. Dijital panoramik radyograflarda çekim sırasında yapılan hatalar. Selcuk Dental Journal 2019; 6(4):209-215.
17. Wriedt S, Jaklin J, Al-Nawas B, Wehrbein H. Impacted upper canines: examination and treatment proposal based on 3D versus 2D diagnosis. Journal of Orofacial Orthopedics/Fortschritte der Kieferorthopädie 2012;73(1):28-40.
18. Karatas OH, Toy E. Three-dimensional imaging techniques: A literature review. European journal of dentistry 2014;8(01):132-140.
19. Ngo CTT, Fishman LS, Rossouw PE, Wang H, Said O. Correlation between panoramic radiography and cone-beam computed tomography in assessing maxillary impacted canines. Angle Orthod 2018;88:384-9.
20. Schroder AGD, Guariza-Filho O, de Araujo CM, Ruellas AC, Tanaka OM, Porporatti AL. To what extent are impacted canines associated with root resorption of the adjacent tooth?: A systematic review with meta-analysis. J Am Dent Assoc 2018;149:765-77
21. Cernochova P, Krupa P, Izakovicova-Holla L. Root resorption associated with ectopically erupting maxillary permanent canines: a computed tomography study. Eur J Orthod 2011;33:483-91

22. Strbac GD, Foltin A, Gahleitner A, Bantleon HP, Watzek G, Bernhart T. The prevalence of root resorption of maxillary incisors caused by impacted maxillary canines. Clin Oral Investig 2013;17:553-64
23. Chaushu S, Kaczor-Urbanowicz K, Zadurska M, Becker A. Predisposing factors for severe incisor root resorption associated with impacted maxillary canines. Am J Orthod Dentofacial Orthop 2015;147:52-60
24. Çolakoğlu G, Yiğit M. Panoramik Radyografik Parametreler ile Üst Gömülü Kanin Dişlerin Konumları ve Komşu Dişlerde Meydana Getirdiği Rezorpsiyonların Değerlendirilmesi. ADO Klinik Bilimler Dergisi. 2023;12(1):53-62
25. Poornima R, Kannan N, Krishnaraj R, Kamal Kanthan DM. Radiographic assessment of impacted canine: a systematic review. Int Healthc Res J 2018;1(10):304-308.
26. Meusburger T, Wülk A, Kessler A, Heck K, Hickel R, Dujic H et al. The Detection of Dental Pathologies on Periapical Radiographs—Results from a Reliability Study. Journal of clinical medicine 2023;12(6): 2224.
27. Kim H, Song JS, Shin TJ, Kim YJ, Kim JW, Jang KT et al. Image segmentation of impacted mesiodens using deep learning. Journal of Clinical Pediatric Dentistry 2024;48(3).
28. Valappila NJ, Beena V. Panoramic radiography: A review. J Oral Med SurgPathol 2016; 1(1):21-31.
29. Witcher TP, Brand S, Gwilliam JR, McDonald F. Assessment of the anterior maxilla in orthodontic patients using upper anterior occlusal radiographs and dental panoramic tomography: a comparison. Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology 2010; 109(5):765-774.
30. White SC, Pharoah MJ. Oral radiology: principles and interpretation. 2013. Elsevier Health Sciences.
31. Ghodasra R, Brizuela M. Orthodontics, Cephalometric Analysis. [Updated 2023 Jul 17]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2025 Jan-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK594272/
32. Scarfe WC, Azeved, B, Toghyani S, Farman AG. Cone Beam Computed Tomographic imaging in orthodontics. Australian Dental Journal 2017;62: S1 33–50. doi: 10.1111/adj.12479
33. Han S, Choi YJ, Chung CJ, Kim J Y, Kim K H. Long-term pharyngeal airway changes after bionator treatment in adolescents with skeletal Class II malocclusions. The korean journal of orthodontics 2014;44(1):13-19.
34. Vinoth SK, Thomas AV, Nethravathy R. Cephalomteric changes in airway dimensions with twin block therapy in growing Class II patients. Journal of Pharmacy and Bioallied Sciences, 5(Suppl 1) 2013; S25-S29.
35. Celikoglu M, Bayram M, Sekerci AE, Buyuk SK, Toy E. Comparison of pharyngeal airway volume among different vertical skeletal patterns: a cone-beam computed tomography study. The Angle Orthodontist 2014;84(5), 782-787. doi: 10.2319/101013-748.1
36. Altuğ B, Demirel E, Özdiler E. Posteroanterior Radyografi Ölçümlerinde Kullanılan Noktaların Tekrarlanabilirliği. Ankara Üniversitesi Diş Hekimliği Fakültesi Dergisi 2020; 47(1-3), 75-80.
37. Goyal S. Assessment of skeletal maturation and pubertal growth spurt using cervical vertebrae maturation indicators. Rwanda Med J 2013;70(3):28-33
38. Alhadlaq AM, Al-Shayea EI .New method for evaluation of cervical vertebral maturation based on angular measurements. Saudi Med J 2013;34(4):388–394
39. Pichai S, Rajesh M, Reddy N, Adusumilli G, Reddy J, Joshi B. A comparison of hand wrist bone analysis with two different cervical vertebral analysis in measuring skeletal maturation. Journal of international oral health: JIOH 2014;6(5), 36.
40. Szemraj A, Wojtaszek-Słomińska A, Racka-Pilszak B. Is the cervical vertebral maturation (CVM) method effective enough to replace the hand-wrist maturation (HWM) method in determining skeletal maturation?—A systematic review. European journal of radiology 2018; 102: 125-128.
41. Apaydın BK. Pubertal büyüme evresinin belirlenmesinde el bilek radyografileri ve lateral sefalometrik radyografilerin karşılaştırılması. Selcuk Dental Journal 2019;6(4):93-99.
42. Uysal T, Ramoglu SI, Basciftci FA, Sari Z. Chronologic age and skeletal maturation of the cervical vertebrae and hand-wrist: is there a relationship?. American Journal of Orthodontics and Dentofacial Orthopedics 2006; 130(5): 622-628
43. Jacobs R, Salmon B, Codari M, Hassan B, Bornstein MM. Cone beam computed tomography in implant dentistry: recommendations for clinical use. BMC oral health 2018;18: 1-16.
44. Kapila S, Farman AG. Craniofacial imaging in the 21st century. In Proceedings of the 2002 COAST Conference, Asilomar Conference Center, Pacific Grove, California. Orthod Craniofac Res 2003;(Vol. 6, pp. 7-8).
45. White SC. Cone-beam imaging in dentistry. Health physics. 2008;95:628-37
46. Aktan A, Güngör E, Çiftçi M, İşman Ö. Diş hekimliğinde konik işinli bilgisayarli tomografi kullanimi. Atatürk Üniversitesi Diş Hekimliği Fakültesi Dergisi 2015;25(1): 71-76.
47. Kapila SD, Nervina JM. CBCT in orthodontics: assessment of treatment outcomes and indications for its use. Dentomaxillofacial radiology 2015;44(1): 20140282.
48. Peterson AG, Wang M, Gonzalez S, Covell Jr DA, Katancik J, Sehgal HS. An In Vivo and Cone Beam Computed Tomography Investigation of the Accuracy in Measuring Alveolar Bone Height and Detecting Dehiscence and Fenestration Defects. International Journal of Oral & Maxillofacial Implants 2018;33(6).
49. Patcas R, Müller L, Ullrich O, Peltomäki T. Accuracy of cone-beam computed tomography at different resolutions assessed on the bony covering of the mandibular anterior teeth. American journal of orthodontics and dentofacial orthopedics 2012;141(1): 41-50. doi: 10.1016/j.ajodo.2011.06.034
51. Niraj LK, Patthi B, Singla A, Gupta R, Ali I, Dhama K et al. MRI in dentistry-A future towards radiation free imaging–systematic review. Journal of clinical and diagnostic research: JCDR 2016; 10(10): ZE14. doi: 10.7860/JCDR/2016/19435.8658
52. Camci H. Manyetik Rezonans Görüntüleme Öncesi Braketler Çıkarılmalı mı?. Turkiye Klinikleri. Dishekimligi Bilimleri Dergisi 2018;24(1): 39-46.
53. Sağlam H, Yeşilova E, Bayrakdar İŞ. Eskişehir Osmangazi Üniversitesi Diş Hekimliği Fakültesindeki Konik Işınlı Bilgisayarlı Tomografi (KIBT) İncelemesi İstem Nedenlerinin Değerlendirilmesi 2021
54. Aydoğdu A, Aydoğdu Y, Yakıncı ZD. Temel Radyolojik İnceleme Yöntemlerini Tanima. İnönü Üniversitesi Sağlık Hizmetleri Meslek Yüksek Okulu Dergisi 2017;5(2):44-53.