

Incidental Detection of Maxillary Sinus Hypoplasia on Cone-Beam Computed Tomography: A Case Report

Menduh Sercan Kaya

Dentomaxillofacial Radiology Specialist, Department of Dentomaxillofacial Radiology, Faculty of Dentistry, Dicle University

Abstract

Maxillary sinus hypoplasia is defined as the underdevelopment of the maxillary sinus, resulting in a smaller-than-normal sinus volume. It may remain asymptomatic and be detected incidentally during radiographic examinations or may occasionally present with various clinical symptoms. The present case report describes incidentally detected right maxillary sinus hypoplasia identified during cone-beam computed tomography examination in a 38-year-old Turkish female patient who presented to our clinic following facial trauma. Although clinical and radiographic examinations revealed several dental and restorative findings, no evidence of fractures involving the jaws was observed. Cone-beam computed tomography evaluation demonstrated hypoplasia of the right maxillary sinus, while no additional pathological findings were detected in either maxillary sinus. Accurate recognition of maxillary sinus hypoplasia is clinically important because it may influence the planning of implant surgery, sinus floor elevation procedures, and other surgical interventions involving the posterior maxilla. Cone-beam computed tomography provides a detailed three-dimensional assessment of maxillary sinus morphology and represents a valuable imaging modality for the diagnosis of this developmental anomaly.

Keywords: Cone-beam computed tomography, Dental implant, Maxillary sinus, Maxillary sinus hypoplasia.

1. Introduction

Humans possess four pairs of paranasal sinuses: the maxillary, frontal, ethmoidal, and sphenoidal sinuses. These are air-filled anatomical cavities that perform several physiological functions, including reducing the weight of the skull, warming inspired air, protecting craniofacial structures against trauma, and contributing to voice resonance. The paranasal sinuses begin to develop during the prenatal period and continue to grow and undergo pneumatization after birth, eventually reaching their final morphology in adulthood. The maxillary sinus is the largest of the paranasal sinuses and is closely associated with the roots of the maxillary premolar and molar teeth. Therefore, it has considerable importance in dentistry. From a dental perspective, evaluation of maxillary sinus anatomy is essential for preserving its anatomical integrity during tooth extraction, dental implant placement, and sinus floor elevation procedures, as well as for the diagnosis of maxillary sinus pathologies. Developmental anomalies may also occur in this anatomically important structure. One such anomaly is maxillary sinus hypoplasia, which is characterized by a smaller-than-normal maxillary sinus resulting from insufficient pneumatization. Maxillary sinus

hypoplasia is generally a congenital condition that may occur unilaterally or bilaterally. Although it often remains asymptomatic and is detected incidentally, it may occasionally present with various clinical symptoms [1-6].

Several imaging modalities are available for the evaluation of the maxillary sinus. Magnetic resonance imaging can be used when the assessment of soft tissue pathologies associated with the maxillary sinus is required. In contrast, both two-dimensional and three-dimensional imaging techniques are used to evaluate the anatomical structure of the maxillary sinus. Two-dimensional imaging modalities include Waters projection, lateral cephalometric projection, periapical radiography for assessing the inferior wall of the maxillary sinus, and panoramic radiography. However, due to the inherent limitations of two-dimensional imaging, these techniques are affected by superimposition, distortion, and magnification. Among the three-dimensional imaging modalities, computed tomography and cone-beam computed tomography provide detailed visualization of the maxillary sinus anatomy. Nevertheless, cone-beam computed tomography is more frequently used in dentistry than computed tomography because it offers lower radiation exposure and lower cost while providing high spatial resolution. The present case report aims to describe maxillary sinus hypoplasia that was incidentally detected during cone-beam computed tomography examination [1, 7-12]. The aim of this case report was to present maxillary sinus hypoplasia that was incidentally detected during cone-beam computed tomography examination.

2. Case History

A 38-year-old Turkish female patient presented to our clinic one week after sustaining facial trauma. The patient reported that she had initially been evaluated at a general medical center, where the necessary medical management had been completed, and was subsequently referred to our hospital for dental assessment of the trauma. The patient's medical history revealed no systemic diseases, allergies, or previous surgical procedures.

Clinical findings: No facial asymmetry was observed on extraoral examination. Temporomandibular joint examination revealed no limitation in mouth opening, joint sounds, or mandibular deviation. Intraoral examination demonstrated veneer crowns on teeth #25, #26, #33, #42, #43, #45, and #47. A marginal discrepancy between the gingival margin and the splinted crown restoration involving teeth #33, #42, and #43 was observed, whereas the remaining veneer crowns exhibited satisfactory adaptation. Restorative filling materials were present in teeth #16, #25, #35, #36, and #37. Deep carious lesions were detected in teeth #27 and #34. The restorative materials showed satisfactory adaptation to the dental hard tissues. Mild gingivitis was also observed. Based on the patient's history of trauma and the clinical findings, panoramic radiography and cone-beam computed tomography examinations were performed. All radiographic examinations were interpreted by the author of this case report.

Panoramic radiographic evaluation: Root canal treatment was identified in teeth #25, #26, #35, #42, #45, and #47, and a post was present in tooth #25. The restorative findings were consistent with the intraoral examination. Secondary caries was detected beneath the veneer crowns of teeth #26, #45, and #47, while secondary caries was also observed in teeth #16 and #36. An interproximal carious lesion was identified on the mesial aspect of tooth #48. Small radiolucent areas were observed at the mesial root of root canal-treated tooth #47 and at the apex of tooth #35. As the patient was asymptomatic, these findings were interpreted as apical scars, and periodic follow-up was recommended.

Cone-beam computed tomography evaluation: Cone-beam computed tomography images were acquired using an exposure setting of 110 kVp and a mean tube current of 8.63 mAs, with a slice thickness

of 0.3 mm and a field of view of 17×19 cm. The images were evaluated using NNT Viewer version 16.9 software on a 15.6-inch monitor with a maximum resolution of 1920×1080 pixels. The dental findings, restorative materials, root canal fillings, and radiolucent lesions observed on cone-beam computed tomography were consistent with those identified on panoramic radiography. No dentoalveolar pathology or jaw fracture was detected. Two small soft tissue calcifications were incidentally identified lateral to the airway at the level of the second cervical vertebra. Hypoplasia of the right maxillary sinus was detected, whereas no mucosal thickening, polyps, or other pathological findings were observed in either of the paranasal sinuses (Figure 1; Figure 2).



Figure 1. Horizontal cone-beam computed tomography image. The white arrow indicates the hypoplastic maxillary sinus.



Figure 2. Coronal cone-beam computed tomography image. The white arrow indicates the hypoplastic maxillary sinus.

3. Discussion

The maxillary sinus is the largest of the paranasal sinuses and is located within the body of the maxilla. It has a pyramidal configuration, with its walls formed by the lateral wall of the nasal cavity, the floor of the orbit, and the alveolar process. The floor of the maxillary sinus is closely related to the roots of the maxillary premolar and molar teeth. The inner surface of the maxillary sinus is lined by the Schneiderian membrane, which normally consists of pseudostratified ciliated columnar respiratory epithelium. This epithelium plays an essential role in mucociliary clearance. Embryologically, the maxillary sinus is the first paranasal sinus to develop. Following birth, it continues to enlarge through pneumatization and reaches its final dimensions during adulthood. The volume of the maxillary sinus varies considerably among individuals, and this variation is thought to be influenced by genetic, environmental, and developmental factors. Consequently, anatomical variations such as sinus septa, accessory ostia, and differences in sinus volume may be observed. Maxillary sinus hypoplasia is a developmental anomaly characterized by underdevelopment of the maxillary sinus, resulting in a smaller-than-normal sinus volume. Although this condition may occasionally present with clinical symptoms, it may also remain asymptomatic. Therefore, accurate diagnosis by means of appropriate imaging modalities is of considerable clinical importance [1, 4, 13-17]. Conventional radiographic techniques do not allow simultaneous visualization of all walls of the maxillary sinus because of superimposition and the inherent limitations of two-dimensional imaging. In contrast, three-dimensional imaging modalities enable detailed evaluation of the entire maxillary sinus. Cone-beam computed tomography is widely used in dentistry for the assessment of the osseous structures of the maxillary sinus. Compared with other three-dimensional imaging modalities, cone-beam computed tomography offers a relatively shorter scanning time, lower cost, reduced radiation exposure, and high spatial resolution. Therefore, it is considered a highly advantageous imaging modality for the evaluation of maxillary sinus anatomy [7, 10, 17-21].

Maxillary sinus hypoplasia may remain asymptomatic and be detected incidentally during radiographic examinations, although it may also give rise to various clinical symptoms and complications. This developmental anomaly is of particular importance in endoscopic sinus surgery. In severe cases associated with hypoplasia or aplasia of the uncinate process, surgical procedures may result in inadvertent injury to the medial orbital wall. In addition, maxillary sinus hypoplasia may be associated with mucosal thickening, headache, chronic sinusitis, and nasal obstruction. From a dental perspective, this anomaly may also influence the planning of surgical procedures involving the posterior maxilla, particularly dental implant placement and maxillary sinus floor elevation. Therefore, accurate recognition of maxillary sinus hypoplasia is essential for appropriate diagnosis, treatment planning, and the prevention of potential surgical complications [1, 22-26]. Therefore, it is important for dental practitioners to recognize maxillary sinus hypoplasia. Accurate identification of this developmental anomaly facilitates appropriate planning of surgical procedures involving the posterior maxilla, particularly dental implant placement and maxillary sinus floor elevation.

4. Conclusion

Maxillary sinus hypoplasia is a developmental anomaly that may remain asymptomatic and is often detected incidentally during radiographic examinations. Accurate recognition of this anatomical variation is important in dentistry, as it contributes to safer planning and performance of surgical procedures involving the posterior maxilla, particularly dental implant placement and maxillary sinus floor elevation.

Cone-beam computed tomography provides a detailed evaluation of maxillary sinus morphology and is a valuable imaging modality for the diagnosis of this anomaly.

5. References

1. Whyte A, Boeddinghaus R. The maxillary sinus: physiology, development and imaging anatomy. *Dentomaxillofacial Radiology*. 2019; 48(8):20190205.
2. Fahrioglu SL, VanKampen N, Andaloro C. Anatomy, head and neck, sinus function and development. *StatPearls [Internet]: StatPearls Publishing*; 2023.
3. Papadopoulou A-M, Chrysikos D, Samolis A, Tsakotos G, Troupis T. Anatomical variations of the nasal cavities and paranasal sinuses: a systematic review. *Cureus*. 2021; 13(1).
4. Standring S. *Gray's anatomy e-book: the anatomical basis of clinical practice*: Elsevier Health Sciences; 2021.
5. Erdem T, Aktas D, Erdem G, Miman MC, Ozturan O. Maxillary sinus hypoplasia. *Rhinology*. 2002; 40(3):150-53.
6. Alsufyani N, El-Hakim H, Major P. Prevalence of maxillary sinus hypoplasia and association with variations in the sinonasal complex: a cone beam CT study. *Clinical Oral Investigations*. 2021; 25(9):5463-71.
7. Mallya S, Lam E. *White and Pharoah's Oral Radiology: Principles and Interpretation*: Mosby; 2018.
8. Suomalainen A, Pakbaznejad Esmaeili E, Robinson S. Dentomaxillofacial imaging with panoramic views and cone beam CT. *Insights into imaging*. 2015; 6(1):1-16.
9. Fischborn AR, Andreis JD, Wambier LM, Pedroso CM, Claudino M, Franco GCN. Performance of panoramic radiography compared with computed tomography in the evaluation of pathological changes in the maxillary sinuses: a systematic review and meta-analysis. *Dentomaxillofacial Radiology*. 2023; 52(5):20230067.
10. Ebrahimnejad H, Zarch SHH, Langaroodi AJ. Diagnostic efficacy of digital waters' and Caldwell's radiographic views for evaluation of sinonasal area. *Journal of Dentistry (Tehran, Iran)*. 2016; 13(5):357.
11. Bell G, Joshi B, Macleod R. Maxillary sinus disease: diagnosis and treatment. *British dental journal*. 2011; 210(3):113-18.
12. Shahbazian M, Vandewoude C, Wyatt J, Jacobs R. Comparative assessment of periapical radiography and CBCT imaging for radiodiagnostics in the posterior maxilla. *Odontology*. 2015; 103(1):97-104.
13. Mularczyk C, Welch K. Maxillary sinus anatomy and physiology. *Otolaryngologic Clinics of North America*. 2024; 57(6):991-1006.
14. Rosano G, Vacher C, Lazaroo B, Strappa EM, Gaudy JF. Anatomy of the maxillary sinus and the role of CT scans in maxillary sinus augmentation surgery. *Clinical Implant Dentistry and Related Research*. 2025; 27(2):e70019.
15. Lorkiewicz-Muszyńska D, Kociemba W, Rewekant A, et al. Development of the maxillary sinus from birth to age 18. Postnatal growth pattern. *International journal of pediatric otorhinolaryngology*. 2015; 79(9):1393-400.
16. Abdalla MA. Human maxillary sinus development, pneumatization, anatomy, blood supply, innervation and functional theories: An update review. *Siriraj Medical Journal*. 2022; 74(7):472-79.
17. Laine FJ. Diagnostic imaging of the maxillary sinus. *Oral and maxillofacial surgery clinics of north america*. 1999; 11(1):45-67.

18. Ilgüy D, Ilgüy M, Dolekoglu S, Fisekcioglu E. Evaluation of the posterior superior alveolar artery and the maxillary sinus with CBCT. *Brazilian oral research*. 2013; 27(05):431-37.
19. Bodner L, Tovi F, Bar-Ziv J. Teeth in the maxillary sinus—imaging and management. *The Journal of Laryngology & Otology*. 1997; 111(9):820-24.
20. Park Y-B, Jeon H-S, Shim J-S, Lee K-W, Moon H-S. Analysis of the anatomy of the maxillary sinus septum using 3-dimensional computed tomography. *Journal of oral and maxillofacial surgery*. 2011; 69(4):1070-78.
21. Malina-Altzinger J, Damerau G, Grätz KW, Stadlinger PB. Evaluation of the maxillary sinus in panoramic radiography—a comparative study. *International journal of implant dentistry*. 2015; 1(1):17.
22. Bolger WE, Woodruff Jr WW, Morehead J, Parsons DS. Maxillary sinus hypoplasia: classification and description of associated uncinat process hypoplasia. *Otolaryngology–Head and Neck Surgery*. 1990; 103(5):759-65.
23. Souza DAS, Costa FWG, de Mendonca DS, Ribeiro EC, de Barros Silva PG, Neves FS. Computed tomography assessment of maxillary sinus hypoplasia and associated anatomical variations: a systematic review and meta-analysis of global evidence. *Oral Radiology*. 2024; 40(2):124-37.
24. Jafari-Pozve N, Sheikhi M, Ataie-Khorasgani M, Jafari-Pozve S. Aplasia and hypoplasia of the maxillary sinus: A case series. *Dental research journal*. 2014; 11(5):615.
25. Park W-B, Sadilina S, Han J-Y, Thoma DS, Lim H-C. Maxillary sinus hypoplasia relevant to dental implant treatment: a narrative review. *Journal of Periodontal & Implant Science*. 2025; 55(6):425.
26. Dedeoğlu N, Duman SB. Clinical significance of maxillary sinus hypoplasia in dentistry: A CBCT study. *Dental and medical problems*. 2020; 57(2):149-56.