



Maxillary Sinus Imaging in Dentistry: A Bibliometric Analysis

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ABSTRACT: The maxillary sinus is the largest of the paranasal sinuses and is anatomically associated with the maxillary premolar and molar teeth. This structure has been extensively investigated using various imaging modalities for both dental procedures and the evaluation of pathological conditions. The aim of this study was to evaluate the literature on maxillary sinus imaging in dentistry using bibliometric analysis. The data were retrieved from the Web of Science Core Collection database and included English-language articles and reviews published between 1980 and 2025. Bibliometric analyses were performed using the Bibliometrix package (version 5.3.0) through R (version 4.6.0), RStudio, and Biblioshiny, including annual scientific production, keyword co-occurrence analysis, thematic map analysis, and thematic evolution analysis. Scientific production increased markedly after 2007 and reached its highest level in 2025. The literature was found to be primarily focused on dental implants, sinus floor elevation, bone augmentation, and cone-beam computed tomography. Future studies should include publications from different databases and in multiple languages to provide a more comprehensive evaluation of the field.

KEYWORDS: Bibliometric Analysis, Cone Beam Computed Tomography, Dental Implant, Maxillary Sinus, Maxillary Sinus Imaging..

I. INTRODUCTION

The maxillary sinus is the largest of the paranasal sinuses. It is a pyramidal air-filled cavity located within the maxilla and is lined internally by the Schneiderian membrane. Owing to its anatomical location, the maxillary sinus is closely related to the roots of the maxillary premolar and molar teeth. Its primary functions include reducing the weight of the skull, contributing to voice resonance, and warming and humidifying inspired air. Pathologies involving the maxillary sinus are of particular interest in both otorhinolaryngology and dentistry. In dentistry, the maxillary sinus is associated with a wide range of clinical conditions, including odontogenic sinus diseases, disruption of

sinus integrity during surgical procedures such as tooth extraction, foreign body displacement into the sinus during implant placement or tooth extraction, as well as infectious diseases, cystic lesions, fractures, and benign and malignant tumors. Furthermore, the increasing use of dental implants has been accompanied by a rise in the incidence of maxillary sinus-related complications [1-6]. Therefore, radiographic evaluation of the maxillary sinus is of considerable importance.

In recent years, parallel to technological advancements, maxillary sinus imaging modalities have undergone substantial development. Conventional imaging techniques, including periapical and panoramic radiography, remain the first-line imaging modalities because of their low cost. However, these techniques have several limitations, such as superimposition, magnification, and distortion. In addition, they do not allow three-dimensional evaluation. To overcome these limitations, cone-beam computed tomography (CBCT), computed tomography (CT), and magnetic resonance imaging (MRI) have been introduced. Among these modalities, CBCT is widely used in dentistry for the evaluation of hard tissues associated with the maxillary sinus because it provides relatively lower radiation exposure, lower cost, and higher spatial resolution than CT. In contrast, MRI is primarily used for the assessment of the soft tissues of the maxillary sinus [7-11]. Although numerous studies have investigated maxillary sinus imaging, knowledge regarding the conceptual structure and research trends of this field remains limited. Furthermore, evaluating the research themes and the evolution of the field over time has become increasingly challenging [12]. Therefore, it is necessary to examine the scientific production, research trends, prominent research themes, and conceptual structure of this field. Bibliometric analysis provides an effective approach for addressing these challenges. Through annual scientific production, keyword co-occurrence analysis, thematic map analysis, and thematic evolution analysis, bibliometric analysis enables the quantitative evaluation of the current status, research



trends, and temporal evolution of a given research field [13, 14].

The aim of this study was to examine the literature on maxillary sinus imaging in dentistry

using bibliometric methods and to provide an overview of the current status and temporal development of this research field.

II. MATERIALS AND METHODS

This study was designed as a bibliometric analysis of the literature on maxillary sinus imaging. Owing to the nature of the study, no human or animal subjects were involved. Therefore, ethical approval was not required.

The data for the present study were retrieved from the Web of Science Core Collection (WoSCC) database using the advanced search function with the following search query: (("maxillary sinus" OR "maxillary sinuses" OR "antrum of Highmore" OR "Schneiderian membrane") AND (dent OR oral OR maxillofacial OR orthodont OR endodont* OR periodont* OR prosthodont* OR implant*) AND (radiolog* OR radiograph* OR imaging OR "diagnostic imaging" OR "dental imaging" OR "oral radiology" OR "maxillofacial radiology" OR CBCT OR "cone beam computed tomography" OR CT OR "computed tomography" OR MDCT OR MSCT OR "multidetector computed tomography" OR "multislice computed tomography" OR MRI OR "magnetic resonance imaging" OR ultrasonograph* OR ultrasound OR sonograph* OR "panoramic radiography" OR panoramic OR orthopantomograph* OR OPG OR "periapical radiography")). Articles and reviews published between 1980 and 2025 were included in the

analysis. Publications in languages other than English, conference proceedings, editorial letters, and studies unrelated to maxillary sinus imaging were excluded.

Bibliometric analysis was performed using the Bibliometrix package (version 5.3.0) through R (version 4.6.0), RStudio, and Biblioshiny. To analyze the research trends and conceptual structure of the field, "annual scientific production", "keyword co-occurrence analysis", "thematic map analysis", and "thematic evolution analysis" were performed.

For the "keyword co-occurrence analysis", author keywords were used. The conceptual structure of the literature was examined using a network-based clustering approach. In the network, different colors represent different thematic clusters, node size indicates the frequency of keyword occurrence, and line thickness represents the strength of co-occurrence. In the "thematic map analysis", thematic groups were classified as basic themes, motor themes, niche themes, and emerging/declining themes. To evaluate the temporal evolution of research themes in the field, "thematic evolution analysis" was performed using a single time-slice.

III. RESULTS

A total of 2,294 publications published between 1980 and 2025 constituted the final dataset of this study. According to the "annual scientific production", the annual scientific output remained relatively low until 2007 but showed a marked increase in the following years despite occasional fluctuations. The highest scientific production was recorded in 2025 (Figure 1).

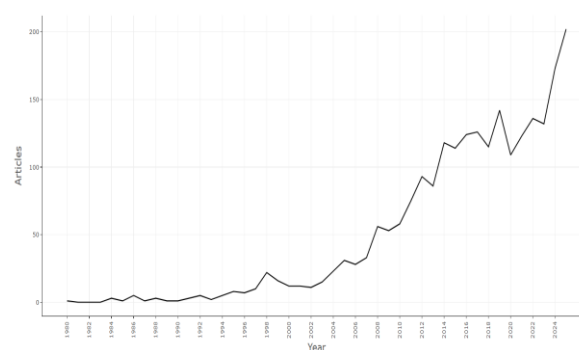


Figure 1. Annual Scientific Production on Maxillary Sinus Imaging in Dentistry.

According to the "keyword co-occurrence analysis", the term "dental implant" occupied the central position in the network, exhibiting the largest node size and the strongest connections. Four distinct thematic clusters were identified within the network. The red cluster included the terms "dental implant", "cbct", "sinus floor elevation",

"Schneiderian membrane", "bone grafting", "bone graft", "maxillary sinus augmentation", "sinus lift", "bone", "dental", "maxilla", "radiography", and "tomography". The green cluster comprised the terms "augmentation", "sinus floor", "elevation", "bone substitutes", and "bone regeneration", whereas the blue cluster contained the terms "sinus", "maxillary", and "sinus augmentation". Finally, the purple cluster consisted of the terms "computed tomography", "sinusitis", and "maxillary sinusitis" (Figure 2).

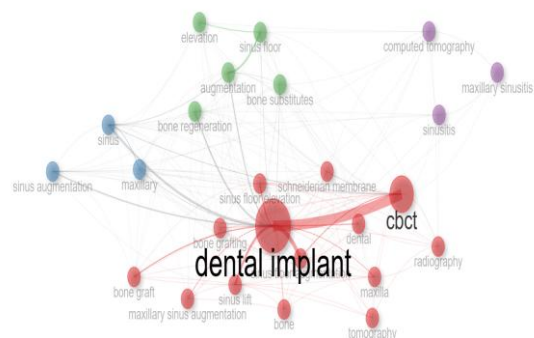


Figure 2. Keywords co-occurrence network of maxillary sinus imaging research..

According to the "thematic map analysis", the motor themes included the terms "elevation", "autogenous bone", and "floor augmentation". The basic themes comprised "dental implant", "augmentation", and "bone", whereas the niche themes included "cbct", "prevalence", and "complications". The emerging/declining themes consisted of the terms "maxilla", "posterior", and "mucosa" (Figure 3).

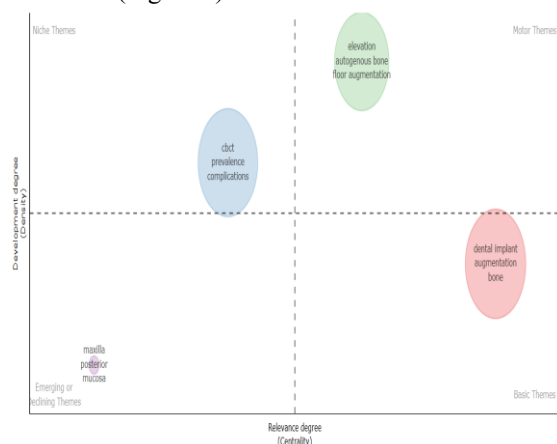


Figure 3. Thematic map of maxillary sinus imaging research.

According to the "thematic evolution analysis", the themes "tomography", "temporomandibular joint", "maxillary sinus

augmentation", "maxillary", "titanium implants", "bone", and "alveolar bone" were predominant during the period from 1980 to 2005. In contrast, the themes "cbct", "floor elevation", and "maxilla" became predominant during the period from 2005 to 2025. The theme "dental implant" remained prominent throughout both periods (Figure 4).

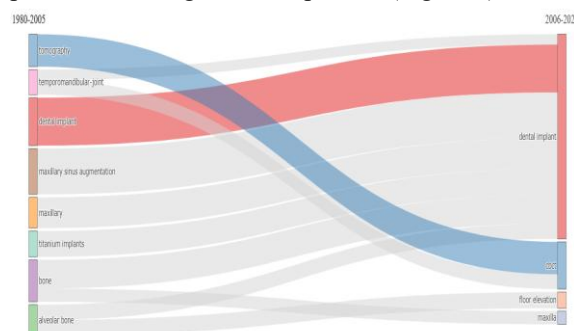


Figure 4. Thematic evolution of maxillary sinus imaging research.

IV. DISCUSSION

The maxillary sinus is of considerable importance in dentistry. Owing to its anatomical location, it is closely associated with the maxillary premolar and molar teeth. Maxillary sinus pneumatization and alveolar ridge resorption may reduce the amount of available bone surrounding the maxillary sinus. Therefore, preserving the structural integrity of the maxillary sinus is essential during procedures such as dental implant placement and tooth extraction. In addition, because of its anatomical proximity to the dentition, the maxillary sinus may be affected by odontogenic pathologies, including infections. Likewise, certain pathologies originating from the maxillary sinus may present with dental-related symptoms [4, 15, 16]. Therefore, imaging of the maxillary sinus is of considerable importance. Maxillary sinus imaging enables the diagnosis of pathological conditions, facilitates preoperative planning by allowing the evaluation of the morphological characteristics of the region, and allows the assessment of treatment outcomes following surgical procedures. Although various imaging modalities are available for evaluating the maxillary sinus, cone-beam computed tomography is one of the most widely used modalities in dentistry because it enables three-dimensional cross-sectional assessment while providing relatively low radiation exposure and lower cost [17-19]. Although numerous studies have been conducted on maxillary sinus imaging, knowledge regarding the conceptual structure of this research field remains limited. Consequently, evaluating the current status and research trends of the field has become increasingly challenging. Bibliometric analysis addresses these



challenges by enabling the evaluation of scientific production, the conceptual structure of the research field, and research trends [13, 14]. Therefore, the present study was designed as a bibliometric analysis of the literature on maxillary sinus imaging.

According to the "annual scientific production", the annual scientific output increased markedly after 2007 and reached its highest level in 2025. This finding indicates that the topic remains current in the literature and continues to attract substantial academic interest. The increase in scientific production may be attributed to the widespread clinical adoption of three-dimensional imaging modalities and their integration into digital workflows as a result of technological advancements. Another possible explanation is the growing use of dental implants and the increasing frequency of sinus lift procedures associated with implant therapy, which have intensified academic interest in the evaluation of the maxillary sinus [4, 20-25]. In addition, another possible explanation for the increase in scientific production is the growing number of academic journals, which has provided researchers with more opportunities to publish their work [26].

According to the "keyword co-occurrence analysis", the term "dental implant" exhibited the largest node size and the strongest connections within the network. This finding suggests that research in this field has been predominantly centered on dental implant applications. Furthermore, the presence of the terms "sinus floor elevation", "Schneiderian membrane", "bone grafting", and "maxillary sinus augmentation" within the network further supports this observation. The prominent representation of dental implant-related approaches in the network may be attributed to the necessity for detailed evaluation of the maxillary sinus floor, the Schneiderian membrane, and the available bone volume associated with the maxillary sinus during implant placement in the posterior maxilla [27-29]. The presence of the terms "CBCT" and "computed tomography" within the same network indicates that both cone-beam computed tomography and computed tomography are commonly used imaging modalities for the evaluation of the maxillary sinus. However, considering the larger node size of the term "CBCT", cone-beam computed tomography appears to be the more prominent imaging modality for maxillary sinus assessment in dentistry. This may be attributed to its advantages over computed tomography in hard tissue evaluation, including lower radiation exposure, lower cost, shorter acquisition time, and higher spatial resolution, making it the preferred imaging modality among

dental practitioners [30-33]. The presence of the terms "augmentation", "bone substitutes", and "bone regeneration" within the network suggests that research has also focused on surgical procedures related to bone regeneration and bone graft materials [34-36]. Furthermore, the presence of the terms "sinusitis" and "maxillary sinusitis" within the network associated with maxillary sinus imaging suggests that inflammatory diseases of the maxillary sinus constitute an important research topic in the literature [37].

According to the "thematic map analysis", the inclusion of the terms "dental implant" and "augmentation" within the basic themes indicates that research in this field has primarily focused on implant therapy and related bone augmentation procedures. It also suggests that studies on dental implant applications occupy a central position in the literature on maxillary sinus imaging in dentistry [38]. The presence of the terms "elevation", "autogenous bone", and "floor augmentation" within the motor themes indicates that maxillary sinus elevation procedures and autogenous bone grafting are well-developed and extensively investigated research topics. This may be attributed to the use of imaging modalities for the evaluation of bone morphology, bone volume, and surgical outcomes associated with maxillary sinus elevation and bone grafting procedures [22, 39]. The inclusion of the terms "cbct", "prevalence", and "complications" within the niche themes suggests that the use of cone-beam computed tomography for prevalence studies and the evaluation of complications related to the maxillary sinus represents a specialized research area within the field [40, 41].

According to the "thematic evolution analysis", the research themes in this field have evolved over time. The prominence of the theme "tomography" during the first period and the emergence of the theme "cbct" during the second period indicate that the primary imaging modality in maxillary sinus imaging research has shifted from conventional computed tomography to cone-beam computed tomography. This transition may be attributed to the increasing use of cone-beam computed tomography in dentistry because of its advantages, including lower cost, lower radiation exposure, and higher spatial resolution for hard tissue evaluation [21]. The prominence of the themes "maxillary sinus augmentation", "titanium implants", "bone", and "alveolar bone" during the first period indicates that research was primarily focused on implant placement and bone augmentation procedures. In contrast, the emergence of the more specific theme "floor elevation" during the second period suggests that research related to



implant surgery has shifted toward more specialized topics, particularly sinus floor elevation procedures. The persistence of the theme "dental implant" throughout both periods indicates that studies on maxillary sinus imaging have remained largely centered on dental implant applications.

V. CONCLUSION

In conclusion, the literature on maxillary sinus imaging in dentistry has shown a marked increase in recent years. Research has primarily focused on dental implants, sinus floor elevation, bone augmentation, and cone-beam computed tomography. Furthermore, the "thematic evolution analysis" demonstrated that conventional computed tomography was the predominant imaging modality during the earlier period, whereas cone-beam computed tomography became the predominant modality in the later period. Future studies should include publications from different databases and in multiple languages to provide a more comprehensive understanding of the field.

REFERENCES

- [1]. Al-Salman WT, Almas K: **Maxillary sinus and success of dental implants: an update.** *General dentistry* 2015, **63**(4):47-54.
- [2]. Amid R, Kadkhodazadeh M, Moscowchi A, Nami M: **Effect of Schneiderian membrane thickening on the maxillary sinus augmentation and implantation outcomes: a systematic review.** *Journal of maxillofacial and oral surgery* 2021, **20**(4):534-544.
- [3]. Galindo-Moreno P, Testori T, Padial-Molina M, Olaechea A, O'valle F, Galindo-Fernandez P: **Long-term stability of sinus complication management.** *Periodontology* 2000 2025.
- [4]. Lyu M, Xu D, Zhang X, Yuan Q: **Maxillary sinus floor augmentation: a review of current evidence on anatomical factors and a decision tree.** *International journal of oral science* 2023, **15**(1):41.
- [5]. Somayaji K, Muliya VS, Kg MR, Malladi UK, Nayak SB: **A literature review of the maxillary sinus with special emphasis on its anatomy and odontogenic diseases associated with it.** *The Egyptian Journal of Otolaryngology* 2023, **39**(1):173.
- [6]. Farman AG, Nortjé C: **Pathologic conditions of the maxillary sinus.** *Panoramic imaging news* 2002, **2**(3):1-7.
- [7]. White SC, Pharoah MJ: **Oral radiology-E-Book: Principles and interpretation:** Elsevier Health Sciences; 2014.
- [8]. Cooke LD, Hadley DM: **MRI of the paranasal sinuses: incidental abnormalities and their relationship to symptoms.** *The Journal of Laryngology & Otology* 1991, **105**(4):278-281.
- [9]. Ahmed J, Gupta A, Shenoy N, Sujir N, Muralidharan A: **Prevalence of Maxillary Sinus Anomalies on CBCT Scans: A Radiographic Study.** 2023.
- [10]. Kim K, Lim CY, Shin J, Chung MJ, Jung YG: **Enhanced artificial intelligence-based diagnosis using CBCT with internal denoising: clinical validation for discrimination of fungal ball, sinusitis, and normal cases in the maxillary sinus.** *Computer Methods and Programs in Biomedicine* 2023, **240**:107708.
- [11]. Ege B, Kurt MY, Koparal M, Geyik A, Kaplanoglu K: **Comparison of diagnostic accuracy of panoramic radiography to CBCT in maxillary sinus diseases.** *Indian Journal of Otolaryngology and Head & Neck Surgery* 2023, **75**(Suppl 1):881-892.
- [12]. Fardi A, Kodonas K, Lillis T, Delantoni A, Dabarakis N: **Top cited articles in Oral Radiology: A bibliometric network analysis.** *Journal of Clinical and Experimental Dentistry* 2024, **16**(7):e815.
- [13]. Donthu N, Kumar S, Mukherjee D, Pandey N, Lim WM: **How to conduct a bibliometric analysis: An overview and guidelines.** *Journal of business research* 2021, **133**:285-296.
- [14]. Passas I: **Bibliometric analysis: the main steps.** *Encyclopedia* 2024, **4**(2).
- [15]. Psillas G, Papaioannou D, Petsali S, Dimas GG, Constantinidis J: **Odontogenic maxillary sinusitis: A comprehensive review.** *Journal of dental sciences* 2021, **16**(1):474-481.
- [16]. Iwanaga J, Wilson C, Lachkar S, Tomaszewski KA, Walocha JA, Tubbs RS: **Clinical anatomy of the maxillary sinus:**



- application to sinus floor augmentation.** *Anatomy & cell biology* 2019, **52**(1):17-24.
- [17]. Luz J, Greutmann D, Wiedemeier D, Rostetter C, Rücker M, Stadlinger B: **3D-evaluation of the maxillary sinus in cone-beam computed tomography.** *International journal of implant dentistry* 2018, **4**(1):17.
- [18]. Kaasalainen T, Ekholm M, Siiskonen T, Kortensniemi M: **Dental cone beam CT: An updated review.** *Physica Medica* 2021, **88**:193-217.
- [19]. Parks ET: **Computed tomography applications for dentistry.** *Dental Clinics of North America* 2000, **44**(2):371-394.
- [20]. Reda R, Zanza A, Mazzoni A, Cicconetti A, Testarelli L, Di Nardo D: **An update of the possible applications of magnetic resonance imaging (MRI) in dentistry: a literature review.** *Journal of imaging* 2021, **7**(5):75.
- [21]. Jain A, Shil M, Sreepradha C, Rai S, Kaur I, Banka A: **A review on cone-beam computed tomography and its application in dentistry.** *Journal of Pharmacy & Bioallied Sciences* 2023, **16**(Suppl 1):S38.
- [22]. Morgan N, Meeus J, Shujaat S, Cortellini S, Bornstein MM, Jacobs R: **CBCT for diagnostics, treatment planning and monitoring of sinus floor elevation procedures.** *Diagnostics* 2023, **13**(10):1684.
- [23]. Misăiloaie A, Tărăboanță I, Budacu CC, Sava A: **Preoperative cone beam computed tomography assessment of maxillary sinus variations in dental implant patients.** *Diagnostics* 2024, **14**(17):1929.
- [24]. Küçük Kurt S: **Maxillary sinus pathologies in dental implant candidates: CBCT-based prevalence and odontogenic risk factors.** *BMC oral health* 2025, **25**(1):776.
- [25]. Bulut DG, Bayrak S: **Evaluation of the effects of implant treatment and sinus augmentation applied to the maxilla posterior region on the changes in CBCT findings of maxillary sinus pathologies.** *Current Problems in Surgery* 2025, **67**:101760.
- [26]. Thelwall M, Sud P: **Scopus 1900–2020: Growth in articles, abstracts, countries, fields, and journals.** *Quantitative Science Studies* 2022, **3**(1):37-50.
- [27]. Bathla SC, Fry RR, Majumdar K: **Maxillary sinus augmentation.** *Journal of Indian Society of Periodontology* 2018, **22**(6):468-473.
- [28]. Janner SF, Caversaccio MD, Dubach P, Sendi P, Buser D, Bornstein MM: **Characteristics and dimensions of the Schneiderian membrane: a radiographic analysis using cone beam computed tomography in patients referred for dental implant surgery in the posterior maxilla.** *Clinical oral implants research* 2011, **22**(12):1446-1453.
- [29]. Toprak M, Ataç M: **Maxillary sinus septa and anatomical correlation with the dentition type of sinus region: a cone beam computed tomographic study.** *British Journal of Oral and Maxillofacial Surgery* 2021, **59**(4):419-424.
- [30]. Al Abduwani J, ZilinSkienne L, Colley S, Ahmed S: **Cone beam CT paranasal sinuses versus standard multidetector and low dose multidetector CT studies.** *American journal of otolaryngology* 2016, **37**(1):59-64.
- [31]. Bozdemir E, Gormez O, Yıldırım D, Erik AA: **Paranasal sinus pathoses on cone beam computed tomography.** *Journal of Istanbul University Faculty of Dentistry* 2016, **50**(1):27.
- [32]. Kemp P, Van Stralen J, De Graaf P, Berkhout E, Van Horssen P, Merkus P: **Cone-beam CT compared to multi-slice CT for the diagnostic analysis of conductive hearing loss: a feasibility study.** *The Journal of International Advanced Otology* 2020, **16**(2):222.
- [33]. Almashraqi AA, Ahmed EA, Mohamed NS, Barnkgkei IH, Elsherbini NA, Halboub ES: **Evaluation of different low-dose multidetector CT and cone beam CT protocols in maxillary sinus imaging: part I—an in vitro study.** *Dentomaxillofacial radiology* 2017, **46**(6):20160323.
- [34]. Saleh MH, Sabri H, Di Pietro N, Comuzzi L, Geurs NC, Semaan LB, Piattelli A: **Clinical Indications and Outcomes of Sinus Floor Augmentation With Bone Substitutes: An Evidence-Based Review.** *Clinical Implant Dentistry and Related Research* 2024, **27**(1):e13400.
- [35]. Sleman N, Khalil A: **A Comprehensive Review of Biomaterials for Maxillary Sinus Floor Augmentation: Exploring Diverse Bone Graft Options.** *The Open Dentistry Journal* 2025, **19**(1).
- [36]. Al-Moraissi E, Alkhutari A, Abotaleb B, Altairi N, Del Fabbro M: **Do osteoconductive bone substitutes result in similar bone regeneration for maxillary**



- sinus augmentation when compared to osteogenic and osteoinductive bone grafts? A systematic review and frequentist network meta-analysis. *International journal of oral and maxillofacial surgery* 2020, **49**(1):107-120.
- [37]. Whyte A, Boeddinghaus R: **Imaging of odontogenic sinusitis**. *Clinical radiology* 2019, **74**(7):503-516.
- [38]. Starch-Jensen T, Jensen JD: **Maxillary sinus floor augmentation: a review of selected treatment modalities**. *Journal of oral & maxillofacial research* 2017, **8**(3):e3.
- [39]. Tavelli L, Borgonovo AE, Re D, Maiorana C: **Sinus presurgical evaluation: a literature review and a new classification proposal**. *Minerva stomatologica* 2017, **66**(3):115-131.
- [40]. Ritter L, Lutz J, Neugebauer J, Scheer M, Dreiseidler T, Zinser MJ, Rothamel D, Mischkowski RA: **Prevalence of pathologic findings in the maxillary sinus in cone-beam computerized tomography**. *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology* 2011, **111**(5):634-640.
- [41]. Hsu Y-H, Pan W-L, Chan C-P, Pan Y-P, Lin C-Y, Wang Y-M, Chang C-C: **Cone-beam computed tomography assessment of Schneiderian membranes: Non-infected and infected membranes, and membrane resolution following tooth extraction: A retrospective clinical trial**. *biomedical journal* 2019, **42**(5):328-334.