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Description of maxillary sinus height and width in partial edentulous and full edentulous patients

(A study using panoramic radiographs at RSUD Ulin Banjarmasin and RSGM Gusti Hasan Aman Banjarmasin from 2020 to 2024)

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ABSTRACT

Objectives: This research aims to determine the height and width of the maxillary sinus in partial edentulous and full edentulous patients using panoramic radiographs at RSUD Ulin and RSGM Gusti Hasan Aman Banjarmasin.

Materials and Methods: This research was conducted using a descriptive approach with a cross-sectional method, involving 105 samples that met the inclusion and exclusion criteria through purposive sampling. The research samples consisted of digital panoramic radiograph archives of patients aged 21-80 years from RSUD Ulin and RSGM Gusti Hasan Aman Banjarmasin, recorded in the Radiology Department.

Results: The result showed that the highest average maxillary sinus height was found in full edentulous patients, measuring 32.840 ± 5.652 mm, while the lowest average height was found in partial edentulous patients classified as Kennedy Class IV, measuring 30.736 ± 5.479 mm. The largest average maxillary sinus width was found in partial edentulous patients classified as Kennedy Class I, measuring 35.905 ± 6.576 mm, while the smallest average width was found in full edentulous patients, measuring 31.911 ± 6.342 mm.

Conclusion: The highest average maxillary sinus height was found in full edentulous patients, while the highest average maxillary sinus width was found in partial edentulous patients with Kennedy Class I classification. Conversely, the lowest average maxillary sinus height was found in partial edentulous patients with Kennedy Class IV, and the smallest average maxillary sinus width was found in full edentulous patients.

Keywords: *Maxillary sinus, edentulous, kennedy classification, sinus pneumatization, panoramic radiography*
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INTRODUCTION

Partial or complete tooth loss indicates the level of health and the individual's awareness of their oral cavity.[1] Based on data from the Indonesian Health Survey (SKI) in 2023, the percentage of partial tooth loss in Indonesia was 45.9%, while the percentage of overall tooth loss was 1.3%.[2] Tooth loss in adults increases with age. This can occur due to extraction, due to unrestorable caries, the presence of periodontal disease, which results in tooth loss, and trauma to the dentoalveolar region.[3] Tooth loss patterns can be divided into complete tooth loss and partial tooth loss. Full edentulous tooth loss is a state of complete detachment of the teeth from the jaw arch.[4] Classification of partial edentulous tooth loss patterns can be classified using the Kennedy classification which consists of four classes, class I with a bilateral free-end pattern, class II with a unilateral free-end pattern, class III with a saddle bonded pattern, and class IV with a pattern of anterior tooth loss that crosses the median line and in a toothless area bounded by the mesial-distal of the remaining natural teeth.[1,5] Tooth loss and protrusion of tooth roots into the maxillary sinus can increase the pneumatization of the maxillary sinus. They can reduce the height of the alveolar ridge bone to the base of the maxillary sinus.[6]

Sinus pneumatization is the process of expanding the maxillary sinus into the surrounding anatomical structures.[7] Sinus pneumatization is a continuous physiological process that causes an increase in volume in the paranasal sinuses.[8] Maxillary sinus pneumatization can occur after posterior tooth loss, which results in changes in the shape and size of the maxillary sinus.[7,8] The maxillary sinus has another name, the antrum

highmore, which is the sinus that first develops from the paranasal sinus.[9] Pneumatization of the maxillary sinus continues at an average age of 12 years or as the space is freed by the tooth seed through tooth eruption.[10] Changes in the shape and size of the maxillary sinus can be seen using panoramic radiography.[11]

Panoramic radiography is an extraoral radiograph that is often chosen to see the condition of the maxilla and mandible. Using this technique, radiograph images can detect abnormalities, lesions, dental conditions, a mass, both benign and malignant, and structures around the teeth, such as the maxillary sinus.[11] The advantage of using panoramic radiography is that it can see the teeth and jaw as a whole in one examination.[12]

Based on the description of the problem above, tooth loss can cause pneumatization of the maxillary sinus, which can make it difficult to install implants, so that it can be a consideration in treatment planning; therefore, the authors are interested in conducting research on partial edentulous patients and full edentulous patients using panoramic radiographs. The purpose of this study is to describe the height and width of the maxillary sinus in partial edentulous and full edentulous patients using panoramic radiographs at Ulin Banjarmasin Hospital and Gusti Hasan Aman Dental Hospital, Banjarmasin, for the period 2020-2024.

MATERIALS AND METHODS

This study is a descriptive study that aims to see a picture of the height and width of the maxillary sinus in partial edentulous and full edentulous patients with a cross-sectional approach, namely, measuring variables at one time. The data used in this study are panoramic data of partial edentulous and full edentulous patients who are at Ulin Banjarmasin Hospital and Gusti Hasan Aman Dental Hospital, Banjarmasin. The sampling technique of this study was purposive sampling, namely in the form of secondary data of panoramic radiographs selected in accordance with the criteria that became the research objectives determined by the researcher until the minimum sample required was met.

The inclusion criteria used in this study were panoramic radiographs with good quality evaluation, partial tooth loss in the upper and lower jaws with Kennedy's classification, loss of all teeth in the upper and lower jaws, patients aged 20 years and over, panoramic radiograph patient data at Ulin Hospital Banjarmasin and Gusti Hasan Aman Dental Hospital Banjarmasin for the period 2020-2024, panoramic radiographs showing completeness of objects (right and left maxillary sinuses are clearly visible), no lesions in the maxillary sinus, periapical, nasal cavity, maxillary bone. Exclusion criteria of this study are the results of panoramic radiographs that do not contain information about the patient's identity and date of taking pictures, panoramic radiographs that do not cover the sinus, maxillary, and nasal areas, there are ghost images in the sinus, maxillary, and nasal areas, there is distortion so that the size and shape are not the same as the original object, there is overlapping, there is perforation in the maxillary sinus.

The variables of this study were partial edentulous, full edentulous patients, and the height and width of the maxillary sinus in patients of Ulin Banjarmasin Hospital and Gusti Hasan Aman Dental Hospital, Banjarmasin. This research has received ethical approval with No. 133/IX-Reg Research/RSUDU/24. This study was conducted to determine the height and width of the maxillary sinus in partial edentulous and full edentulous patients viewed through panoramic radiographs at Ulin Hospital and Gusti Hasan Aman Dental Hospital, Banjarmasin, who met the inclusion and exclusion criteria of the study, with a total sample of 105.

Data collection procedures in this study were carried out by collecting secondary data of panoramic radiographs of partial edentulous and full edentulous patients at Ulin Hospital, Banjarmasin, and Gusti Hasan Aman Dental Hospital, Banjarmasin, which were carried out automatically using ImageJ software. Measurements were made to find the height of the maxillary sinus by drawing a vertical line from the lowest point of the maxillary sinus floor, drawing a horizontal line from the medial boundary wall to the distal boundary wall, measuring the width of the maxillary sinus, and recording it on a ratio scale with units of mm. The measurement results obtained were then processed and analyzed. The data analysis used in this study was descriptive univariate analysis. This study was made to describe variables in the form of frequency distribution tables.

Table 1. Maxillary Sinus Height Mean Value

Kennedy Classification		n	Maxillary Sinus Height (mm)		Mean Total
Upper	Lower		Left Side	Right Side	
Class			Mean ± SD	Mean ± SD	
I	I	7	34,193 ± 4,076	33,696 ± 4,847	31,708 ± 4,648
	II	7	30,540 ± 4,478	31,144 ± 5,813	
	III	7	30,250 ± 5,601	30,430 ± 3,079	
	IV	0	0	0	
Total		21	31,661 ± 4,718	31,756 ± 4,579	

Kennedy Classification		n	Maxillary Sinus Height (mm)		Mean Total
Upper	Lower		Left Side	Right Side	
Class			Mean ± SD	Mean ± SD	
II	I	7	33,819 ± 6,582	33,391 ± 4,621	31,679 ± 5,302
	II	7	30,470 ± 5,507	29,959 ± 5,607	
	III	7	30,903 ± 3,991	31,539 ± 5,504	
	IV	0	0	0	
Total		21	31,730 ± 5,360	31,629 ± 5,244	
III	I	7	32,323 ± 4,785	31,987 ± 5,654	30,854 ± 4,939
	II	7	32,502 ± 6,301	29,814 ± 5,639	
	III	7	29,511 ± 2,863	28,989 ± 4,395	
	IV	0	0	0	
Total		21	31,445 ± 4,649	30,263 ± 5,229	
IV	I	7	27,985 ± 5,532	29,212 ± 3,651	30,736 ± 5,479
	II	7	31,092 ± 4,408	30,745 ± 6,960	
	III	7	33,078 ± 5,498	32,308 ± 6,883	
	IV	0	0	0	
Total		21	30,718 ± 5,146	30,755 ± 5,831	
Full Edentulous		21	32,839 ± 5,954	32,841 ± 5,351	32,840 ± 5,652

Table 2. Maxillary Width Mean Value

Kennedy Classification		n	Maxillary Sinus Width (mm)		Mean Total
Upper	Lower		Left Side	Right Side	
Class			Mean ± SD	Mean ± SD	
I	I	7	36,950 ± 6,252	40,435 ± 6,799	35,905 ± 6,576
	II	7	35,442 ± 5,522	34,721 ± 7,064	
	III	7	32,042 ± 7,372	35,844 ± 6,450	
	IV	0	0	0	
Total		21	34,811 ± 6,382	37 ± 6,771	
II	I	7	34,050 ± 2,979	34,877 ± 4,232	35,885 ± 4,417
	II	7	36,160 ± 4,149	37,796 ± 4,673	
	III	7	35,661 ± 5,740	36,771 ± 4,734	
	IV	0	0	0	
Total		21	35,290 ± 4,289	36,481 ± 4,546	
III	I	7	33,825 ± 6,449	35, 318 ± 6,253	35,615 ± 5,237
	II	7	35,644 ± 7,654	37,472 ± 4,205	
	III	7	34,159 ± 3,328	37,278 ± 3,535	
	IV	0	0	0	
Total		21	34,542 ± 5,810	36,689 ± 4,664	
IV	I	7	32,502 ± 5,180	33,070 ± 3,230	35,564 ± 4,504
	II	7	36,300 ± 3,565	35,265 ± 4,597	
	III	7	36,463 ± 5,181	39,789 ± 5,272	
	IV	0	0	0	
Total		21	35,088 ± 4,642	36,041 ± 4,366	

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Kennedy Classification		n	Maxillary Sinus Width (mm)		Mean Total
Upper	Lower		Left Side	Right Side	
Class			Mean ± SD	Mean ± SD	
Full Edentulous		21	32,173 ± 6,666	31,649 ± 6,019	31,911± 6,342

IMAGE PRESENTATION

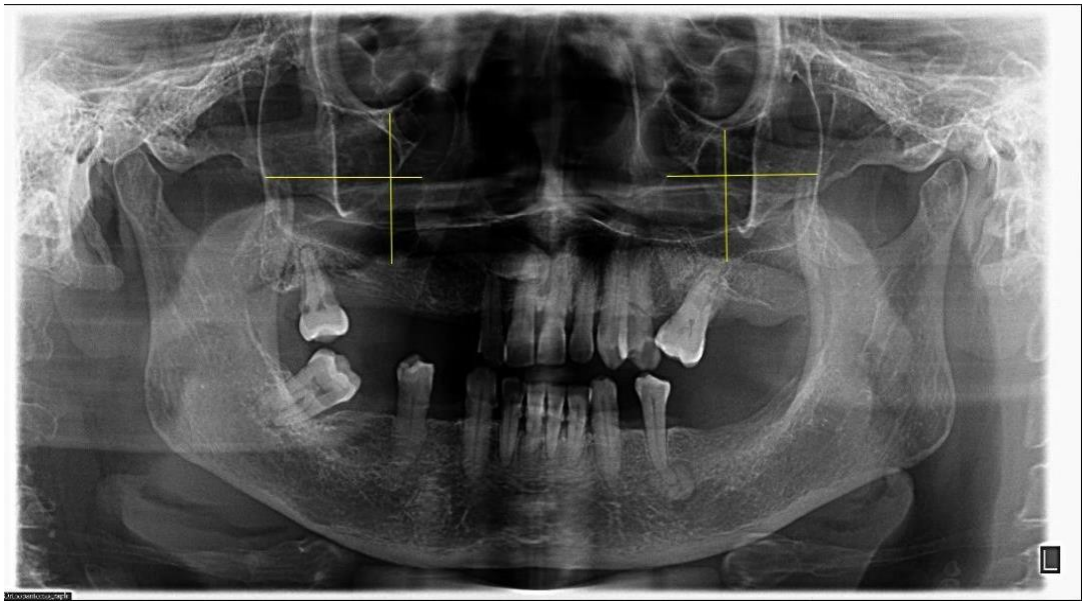

Figure 1. Partially edentulous sample

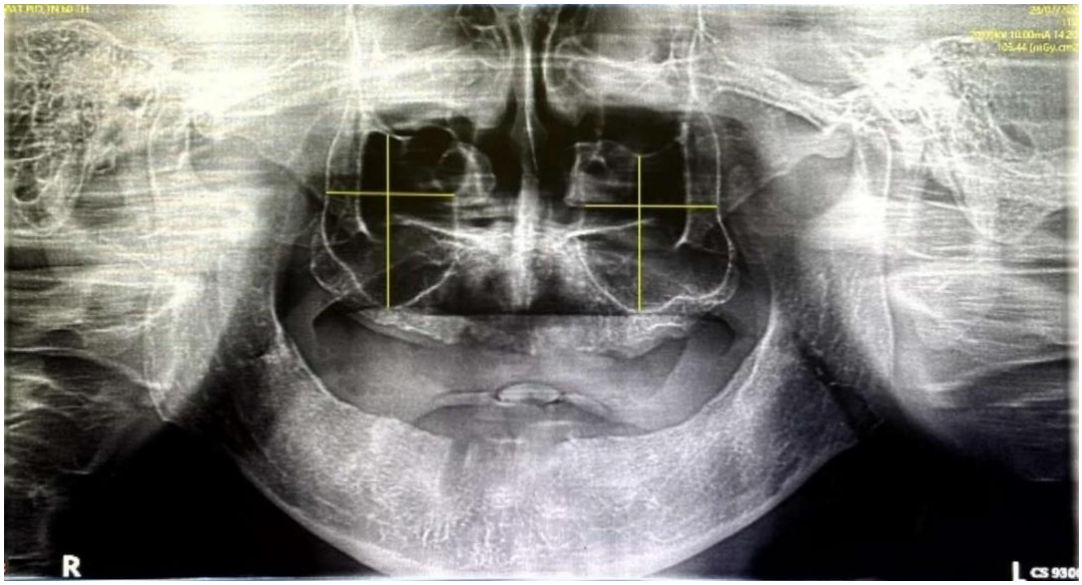

Figure 2. Full edentulous sample

RESULTS

The results of the analysis from Table 1 show that the highest mean value of maxillary sinus height is in full edentulous, with a value of 32.840 ± 5.652 mm, while the smallest mean maxillary sinus height is in partial edentulous, Kennedy classification class IV, with a value of 30.736± 5.479 mm. The highest mean value on the left side of the maxillary sinus height is full edentulous, which is 32.839± 5.954 mm, and the smallest mean is in class IV, which is 30.718± 5.146 mm. The highest mean on the right side of the maxillary sinus height is full edentulous, which is 32.841± 5.351 mm, and the smallest is in class III, which is 30.263± 5.229 mm.

The results of the analysis of Table 2 show that the largest mean value of maxillary sinus width is in partial edentulous Kennedy classification class I, which is 35.905± 6.576 mm, while the smallest mean maxillary sinus width is in full edentulous, which is 31.911 ± 6.342 mm. The largest mean value on the left side of the maxillary sinus width is in class II, which is 35.290± 4.289 mm, and the

smallest mean is full edentulous at 32.173 ± 6.666 mm. The largest mean on the right side of the maxillary sinus width was in class I, which was 37 ± 6.771 mm, and the smallest was full edentulous, which was 31.649 ± 6.019 mm.

DISCUSSION

This study used a sample of 105 samples consisting of 63 women and 42 men aged 21-80 years. The samples of this study were obtained from secondary data in the form of digital panoramic radiograph results that had been recapitulated in the form of soft files. The results of the photo were then measured, and the height and width of the maxillary sinus were computerized using ImageJ software.

The results of measuring the height of the maxillary sinus in partial edentulous and full edentulous patients in this study showed that the highest average value was in full edentulous patients, while those with the smallest average value were partial edentulous patients in Kennedy class IV classification. The results of research by Alqahtani et al., (2020) state that pneumatization of the maxillary sinus can occur after posterior tooth loss, in conditions of posterior tooth loss, especially in the upper jaw, it contributes directly to the pneumatization process of the maxillary sinus, this occurs because the posterior tooth area has a close anatomical relationship with the base of the maxillary sinus.[7,8] The results of research conducted by Elsayed et al., (2023) showed that the average height and density of alveolar bone were significantly reduced in the edentulous area.[13] Alveolar bone resorption in the edentulous area occurs because, functionally, the bone does not receive chewing load distribution. Complete tooth loss (full edentulous) results in significant alveolar bone resorption due to the absence of teeth that support and receive chewing load, so that the alveolar bone loses mechanical stimulation to maintain its mass and density.[3] Alveolar bone resorption in full edentulous patients will cause the maxillary sinus pneumatization process to become more significant, which is the cause of alveolar bone loss.[7] Posterior tooth loss causes the alveolar bone in the area to lose the mechanical stimulation usually obtained from masticatory activity, resulting in faster alveolar bone resorption, and the sinus cavity slowly expands vertically to fill the empty space.[13,14] Partially edentulous patients with Kennedy classification class IV have a smaller mean maxillary sinus height because tooth loss only involves the anterior teeth. Anterior tooth loss does not have a direct relationship with the maxillary sinus floor, so the sinus pneumatization process does not occur significantly in that area.[8]

The measurement of maxillary sinus width in this study obtained the largest average result in the partial edentulous Kennedy class I classification, while the smallest average was in the full edentulous classification. The remaining anterior teeth help maintain alveolar bone structure, prevent excessive bone resorption, and maintain bone thickness and height. The presence of remaining teeth reduces the potential for excessive pneumatization of the maxillary sinus, because the bone around the sinus is maintained from significant resorption.[15,16] Complete tooth loss will result in significant alveolar bone resorption characterized by a decrease in bone height and thickness. Resorption of the alveolar bone will cause changes in the maxillary sinus; the maxillary sinus will experience pneumatization, which is expanding towards the resorbed alveolar bone.[8] Excessive bone resorption makes the lateral bone that supports the maxillary sinus become thinner due to resorption, so that the sinus develops more in the vertical direction to compensate for the empty space due to bone loss.[13,16] The width of the maxillary sinus changes in edentulous patients due to changes in the alveolar bone structure that supports the maxillary sinus, which is influenced by the presence or loss of teeth. Loss of all teeth in fully edentulous patients leads to loss of functional stimulation of the alveolar bone, which accelerates bone resorption. Bone resorption causes the maxillary sinus to undergo pneumatization that extends towards the resorbed alveolar bone, resulting in the sinus expanding in a vertical direction to balance the empty space due to bone loss. Complete tooth loss will result in progressive and significant resorption of the alveolar bone which will create a vertical empty space where the maxillary sinus will expand in that direction to fill the empty space, but in full edentulous it does not expand significantly towards the horizontal because the lateral wall of the sinus is more stable and is a physiological process of the maxillary sinus to balance internal and external pressure in the sinus cavity. Partial tooth loss (partial edentulous), especially in patients with posterior tooth loss, causes alveolar bone resorption in the posterior part, which reduces the bone thickness around the sinus, but the remaining teeth can help maintain bone structure to avoid excessive resorption. The maxillary sinus in partial edentulous patients can expand horizontally due to resorption in the posterior part. This is because the remaining anterior teeth in the area can still maintain the height and thickness of the anterior alveolar bone, so that the sinus can expand horizontally.[8,13,16-18]

CONCLUSION

The conclusion of the research that has been carried out is that the maxillary sinus height in partial edentulous and full edentulous patients has the highest average in full edentulous of 32.840 ± 5.652 mm, while the lowest average is in partial edentulous Kennedy classification class IV of 30.736 ± 5.479 mm. Measurement of maxillary sinus width in partial edentulous and full edentulous patients in this study, which has the greatest average width, is in partial edentulous Kennedy class I classification, which is 35.905 ± 6.576 mm, while the smallest average maxillary sinus width is in full edentulous, which is 31.911 ± 6.342 mm.

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FOOTNOTES

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