DIAGNOSTIC ACCURACY OF X-RAY PARANASAL SINUSES (X-RAY PNS) FOR PARANASAL SINUS PATHOLOGIES WITH COMPUTED TOMOGRAPHY PARANASAL SINUSES (CT PNS) A THE GOLD STANDARD

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ABSTRACT

OBJECTIVES

To determine the diagnostic accuracy of X-ray PNS in different pathologies of paranasal sinuses, using CT PNS as the gold standard, and establishing X-ray PNS as a potential first-line screening tool.

METHODOLOGY

This cross-sectional study was conducted over two years in the Department of Radiology, Rehman Medical Institute Peshawar. 100 patients in the sample with suspected PNS pathologies were selected through the purposive sampling technique, aged 18-70. All patients underwent X-ray PNS initially, followed by CT scans. CT PNS was performed even in cases with normal X-ray findings to check for false negatives or positives.

RESULTS

Out of 100 patients, 56% were male. Most PNS pathologies (55%) were in the 15-35 age group (mean age 24 years, SD ±3.89). The most common symptoms were nasal obstruction (40%) and headache (39%). X-ray PNS showed 67% sensitivity, 60% specificity, 85% PPV, and 64% NPV. The overall diagnostic accuracy of X-ray PNS was 66% compared to CT PNS.

CONCLUSION

X-ray PNS demonstrates a diagnostic accuracy of 66% in diagnosing PNS pathologies. While not as comprehensive as CBCT, X-ray PNS shows potential as a first-line screening tool, particularly for larger sinuses, potentially reducing unnecessary radiation exposure from CT scans.

KEYWORDS: *X-Ray Image, Cone Beam Computed Tomography, Paranasal Sinuses, Diagnostic Accuracy, Radiation Exposure*

INTRODUCTION

The paranasal sinuses (PNS) are hollow air-filled spaces within the bones of the face and the base of the skull surrounding the nasal cavity. Paranasal sinuses are in four pairs: the frontal, ethmoidal, maxillary, and sphenoid sinuses. Many pathological conditions affecting paranasal sinuses include infection, inflammation, neoplasm, foreign body, or post-surgical changes.[1] Sinusitis or inflammation of paranasal sinuses is primarily a clinical diagnosis, and a focused physical examination can help differentiate sinusitis from superficial upper respiratory tract infection.[2,3] A proper patient history, including a physical exam and radiological or lab workup, can enable early detection of pathologies rather than invasive procedures.[4] Imaging modalities for diagnosing PNS pathologies include plain radiographs, CT scans, and MRI.[5] Traditionally, over the years, X-ray imaging of PNS (X-Ray PNS) has been the initial imaging modality for the diagnosis of pathologies in PNS with dedicated view and proper positioning. X-ray PNS is widely popular as it is readily available, affordable to the general population, and has low-dose radiation.[6,7] However, a literature review suggests that X-ray PNS has missed significant sinus abnormalities, including early lesions orbital or cranial involvement of PNS pathologies. Then came the role of computed tomography (CT), which has a multiplanar ability for the assessment of thin bones of PNS. During the early CT years, axial and coronal images of PNS were acquired through a CT scan. MDCT and helical CT techniques have acquired and reconstructed an axial plane in different planes. CT scan plays an essential role in the diagnosis and follow-up of patients with sinus pathologies. However, CT scanning is not without risks to the patient. CT scan is inappropriate in terms of unwanted radiation exposure to the patient and is also costly. A definite diagnosis can be made based on clinical history, physical examination, lab workup, and

radiology and sinus endoscopy to manage and prevent the disease on time. There has been a shift towards using computed tomography (CT) to diagnose PNS pathologies in recent years due to their superior imaging capabilities. However, these modalities expose patients to higher radiation levels than conventional X-rays. This study aims to reassess the role of X-ray PNS as a potential first-line screening tool, particularly for more extensive and less complex sinus structures. X-ray PNS offers several advantages: it is widely available, affordable, and exposes patients to lower radiation doses than CT PNS. However, its limitations in detecting subtle abnormalities, especially in smaller and more complex sinus structures, are not well-documented. Our study seeks to determine the specific scenarios where X-ray PNS can provide sufficient diagnostic information, potentially reducing the need for CT in some instances. We have used CT PNS (Paranasal Sinuses) as the gold standard in our study population. Previous research by Hamdi et al. [10] showed 97% accuracy of CT scans in detecting sinus abnormalities. Given the ongoing clinical preference for X-ray PNS in suspected sinus pathologies, we aim to evaluate its accuracy compared to CT and establish guidelines for its use as a first-line diagnostic tool.

METHODOLOGY

This cross-sectional study was conducted in the Radiology Department of Rehman Medical Institute, Peshawar, from Jan 2021 to Dec 2022. We included 100 patients aged 18-70 years referred to the radiology department with clinical suspicion of sinonasal pathologies. Both genders were included with detailed demographics, including age, gender, and symptoms, recorded after informed consent. X-ray PNS was performed on all patients using a Toshiba machine (Model: DS-TA-5A), and computed tomography of the same patient was done on a 128-slice MDCT scanner (Aquilion Toshiba, Japan). A CT scan of paranasal sinuses was performed without contrast and was only given in suspected cases of sinonasal neoplasms. Images were acquired in the axial planes with the patient lying supine. CT was performed with the scanning parameters of 0.5-3-mm slice thickness, 5-sec scan time, 3mm reconstruction interval, 450 mAs and 125 kVp, and pitch of 0.8. In contrast-enhanced CT PNS, images were obtained after contrast administration with a dose of 1mg/kg if required. Notably, CT PNS was performed on all patients, including those with normal X-ray findings, to assess for any false negative or false positive results on the PNS X-ray. This approach allowed us to establish the accurate diagnostic accuracy of X-ray PNS across various sinus pathologies. Findings of X Ray PNS were compared with findings of CT PNS, which experienced radiologists reported. Exclusion criteria were pregnancy, patients with a history of craniofacial trauma, and a history of sinonasal surgery. A Microsoft Excel sheet was made for all the 100 patients included in the study, and a statistical analysis was performed using SPSS 24 statistical software. Two tables were used to calculate sensitivity, specificity, and positive and negative predictive values.

RESULTS

Our results showed that out of 100 cases, 44(44%) cases were female and 56 (56%) male. Patients included were 18-70 years old with a mean age of 44, SD +/- 15.44. Most PNS pathologies (55%) were in the age group of 15-35 years (mean age 24 years SD +/- 3.89). The most common anatomical variations seen were deviated nasal septum (28%), more commonly on the right side (21%) and 8% towards the left side. Maxillary sinuses were most commonly involved in 67 cases, followed by the ethmoid sinuses (ant. group 44 cases, post group 24 instances) and frontal sinus in 31 cases. The most common pathology was sinusitis in (33%) cases, followed by retention cysts (11%), sinonasal polyposis (9%), 9% sinonasal masses (4 instances of angiofibroma and 5 cases of neoplasm), fungal infections (7%) Fig 2, mastoiditis (6%), osteomyelitis (5%), 2% orbital cellulitis, mucocele 1%, choanal atresia (1%), and 1 case of pseudoaneurysm of right maxillary artery. Findings in 52 cases were detected on Xray PNS, and 14 cases were labeled as standard, confirmed by CT scan. On x-ray PNS, 52 cases were confirmed positive, 14 were true negative, 25 were false negative, and nine were false positive. X-ray has 67% Sensitivity, 60% specificity, 85% PPV and 64% NPV. The diagnostic accuracy of xray PNS in detecting PNS pathologies was 66%, keeping CT PNS as the gold standard (Figure:1)

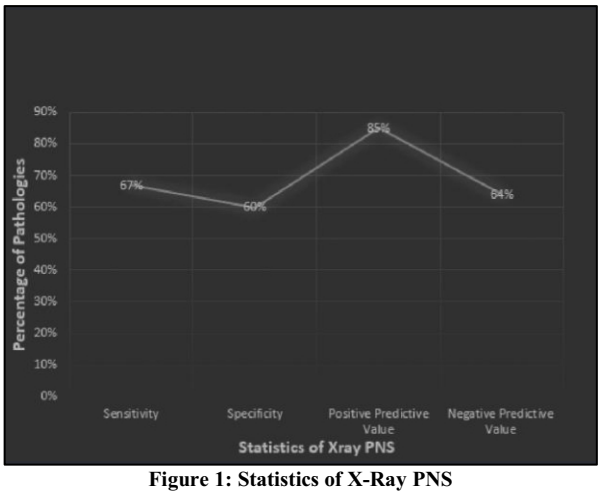

Figure 1: Statistics of X-Ray PNS

In this study, there were few cases in which X-rays showed mild pathology compared to patients' symptoms, but correlation with CT PNS revealed extensive involvement in involved sinuses. (Fig 2) Other cases included false positive findings of sinonasal pathology on X Ray PNS, which, in correlation with CT PNS, turns out to be normal with negative findings. (Fig.3)

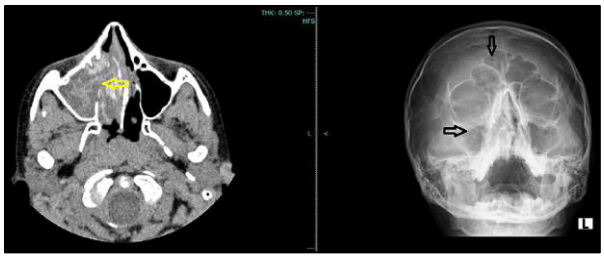

Figure 2: Fungal Sinusitis

An axial CT image of an adult male with fungal sinusitis is evident as soft tissue opacification in the right maxillary sinus and nasal cavity with widened maxillary ostium and internal hyperdensities (yellow arrow). X Ray PNS shows mucosal thickening and haze in the right maxillary and frontal sinuses (black arrows).

Figure 3: Xray PNS (Water's View)

showing opacified frontal sinuses and partially opacified bilateral maxillary sinuses. CT PNS coronal and sagittal revealed absent bilateral frontal sinuses and no pathology in maxillary sinuses, indicating false positive results on X-ray PNS.

DISCUSSION

In our study, male patients (56%) had the majority of PNS pathologies in the age group of 15-35 years. These results are similar to the study conducted in 2020 by Hamdi et al., in which there was male predominance (56%) out of 100 patients with a male-female ratio of 1.3:1.[8] This study also showed maxillary sinus (68%) as the most involved sinus with the most common pathology of sinusitis (79%) as in our study. Another study conducted by Ahmed et al. also had the same results in which the male patient population was high (33% out of a total of 55 patients), and the majority of patients were in the middle age group (40-45 years).[9] The most common anatomical variant in our study was the deviated nasal septum (28%), which was more on the right side than the left, similar findings consistent with a survey by Ahmed et al.[9] This study shows that nasal obstruction and headache were the most common symptoms, comparable with several previous studies in which nasal discharge, nasal obstruction, and headache were the common symptoms among sinusitis patients.[10] In another study, Kanwar et al. had a headache as the most common symptom, followed by nasal discharge and nasal obstruction.[11] In the present study, we found that 52 patients were true positive, nine were false positive, 25 were false negative, and 14 were true negative. Sensitivity, specificity, PPV, and NPV of X - ray were 94.7%, 95.8%, 98.6% and 85.1% respectively. A study by Kanwar et al. reported that a CT scan resulted in higher accuracy than an X-ray examination for diagnosing acute sinusitis.[11] They reported a sensitivity of 97.7% and a specificity of 97.8% for diagnosing sinusitis. Several studies demonstrated that CTscan for diagnosing paranasal sinuses was highly accurate and considered the gold standard.[12,13] In this study, the most common PNS finding was sinusitis in 33% of cases. In our study, the most commonly involved sinus by PNS pathologies was the maxillary sinus (67%), followed by the anterior ethmoid sinus (44%), which is consistent with the findings of another study by Dong et al.[14] Gendeh HS et al. In our study, seven patients had findings of fungal sinusitis, which is comparable with a study done by Huan J et al.[15,16] This study included 9 cases of sinonasal polyposis in patients with 66% involvement of sinonasal, and 7% showed bone remodeling, consistent with the study done by Gupta et al.[17] In the present study, we had 9 cases of sinonasal masses (4 cases of angiofibroma and 5 cases of neoplasm) causing bony erosion, destruction of adjacent structures, and post-contrast enhancement, which is consistent with the study of Verma J et al.[18] Our study's unique approach of performing CT PNS on all patients, even those with normal X-ray findings, allowed us to assess the true diagnostic capability of X-ray PNS accurately. X-ray PNS was particularly effective in diagnosing pathologies in larger sinus structures, such as the maxillary sinuses. X-ray PNS demonstrated high accuracy for these areas, suggesting its potential as a first-line screening tool. However, X-ray PNS showed limitations for smaller and more complex sinus structures, particularly the ethmoid sinuses. In these cases, CT PNS provided crucial additional information, highlighting the continued importance of advanced imaging techniques in specific scenarios. Based on our findings, we propose a tiered approach to PNS imaging.

X-ray PNS can be an initial screening tool, particularly for suspected pathologies in larger sinuses. Further imaging may be unnecessary if X-ray findings are conclusive for these areas. However, CT PNS should be employed for comprehensive evaluation in cases where symptoms persist despite normal X-ray findings, especially concerning smaller, more complex air sinuses. This approach balances the need for accurate diagnosis with minimizing radiation exposure to patients. It also offers a cost-effective strategy, potentially reducing the number of unnecessary CT scan exposures.

LIMITATIONS

Our study had limitations, including a time delay between a few patients' X-rays and CT scans, ranging from 10 to 15 days. Also, an endoscopic assessment of the PNS could have supplemented the research. There is a radiation hazard with both modalities. The mean effective dose in X-ray PNS is 0.0398 mSv, and for CT PNS ranges from 0.70 mSv - 0.76 mSv.[19,20] CT of the paranasal sinuses should only be recommended if it can offer additional information to the clinician.

CONCLUSIONS

X-ray PNS has a diagnostic accuracy of 66% in diagnosing PNS pathologies, with sensitivity and specificity of 67% and 60%, respectively. While not as comprehensive as CBCT, X-ray PNS shows potential as a valuable first-line screening tool, particularly for larger sinus structures. This approach could help minimize unnecessary radiation exposure and reduce healthcare costs. However, CBCT remains crucial for evaluating complex cases and smaller sinus structures. Future research should focus on developing clear guidelines for when X-ray PNS is sufficient and when CBCT is necessary for optimal patient care.

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