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# Research Article
# Role of Computed Tomography in Determining the Spectrum of Paranasal Sinuses Pathologies in Saudi patients

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## Abstract

**Background and Objective:** Now-a-days computed tomography (CT) has become the investigation of choice for the diagnosis of the paranasal sinuses (PNS) pathologies. This study was designed with an aim to determine the role of computed tomography in classification the spectrum of PNS pathologies in Saudi patients. **Materials and Methods:** A total of 100 PNS CT patients were prospectively examined during the period extending from October 2018 to October 2019. A 128 detector CT scanner (Workstation Intellispace ISP; Philips, Netherlands), was applied to investigate patients with suspected PNS abnormalities at Radiology and Medical Imaging Department at King Khalid Hospital and Prince Sultan Center for Health Services in Al-Kharj, Saudi Arabia. **Results:** Out of the 100 patients – 56% males and 44% females with male to female ratio of 1.3:1 – Maxillary sinuses were the most sinuses that affected by sinusitis (68%) and the frontal sinuses was the last one (30%). The most common pathology seen was sinusitis in 79% cases. Atrophy, polyp and hypoplastic disease were detected in (1%) of cases. Most common anatomical variations were closed osteomeatal complex (86%), inferior nasal turbinates muscle hypertrophy (54%) and deviated nasal septum (83%). **Conclusion:** The CT was able to characterize the PNS diseases along with their extension. The most common pathology was sinusitis with 68, 55, 35 and 30% in the maxillary, ethmoid, sphenoid and frontal sinuses, respectively. Most common anatomical variant seen was nasal septum defect while the most commonly sinus involved was maxillary. It proves the better sensitivity (98.04%), specificity (80%) and accuracy (97.02%) of CT in the evaluation of various sinonasal pathologies.

Key words: Computed tomography, nasal septum defect, paranasal sinuses, sinusitis

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Data Availability: All relevant data are within the paper and its supporting information files.

## INTRODUCTION

Computed tomography (CT) has revolutionized the diagnosis and management of many head and neck disorders. CT is complementary in evaluating many conditions, with CT findings used to appraise bony areas providing superior delineation of soft tissue. CT is the established technique for evaluating patients with sinusitis, particularly infections without bony artifacts and brain pathology[1]. The CT of the paranasal sinuses (PNS) has now-a-days become the investigation of choice for the radiological diagnosis of nasal and sinus diseases. Unlike plain radiography, sinus CT shows an excellent anatomical soft tissue and bony details, helps in the diagnosis and gives details of sinonasal anatomy for safe surgery[2].

Since the early 1990s, CT has supplanted plain film radiography of the PNS in the diagnosis of sinonasal diseases, because of increased sensitivity exhibited by CT for mucosal thickening and the ability to delineate other pathological features such as ostiomeatal complex obstruction[3]. Despite its widespread use in the diagnosis of sinonasal diseases, evaluation of the sinus CT as a diagnostic test (rather than a staging tool) has received little rigorous attention. For example, the specificity and predictive values of the sinus CT have not been uniformly established. If the sinus CT is to be trusted as an effective diagnostic and staging tool for sinonasal diseases, its sensitivity and specificity, as well as cutoff values for a normal or abnormal CT, must be determined[4].

The CT provides detailed images of the structures scanned. The use of CT scans in endodontic practice could allow for improved treatment planning of surgical procedures by showing the size and location of the lesion in relation to other anatomic structures. The CT scanning has become the standard in medicine for visualizing the maxillary sinuses because of the ability to visualize both bone and soft tissue in multiple views with thin sectioning[5]. The CT having both axial and coronal views allows the clinician to assess the relationship of a periapical lesion to a sinus floor defect and any resultant changes in the soft tissue of the sinus[6]. In the case of odontogenic sinusitis, using CT technology could allow for improved treatment planning in combining both nonsurgical and surgical dental and medical treatments[7].

Incidental findings of the maxillary sinus also have to be followed-up. Here the comprehensive radiologic examination of the maxillary sinus includes assessment of the maxillary mucosa, fluid levels, bone alterations and position, size and patency of the ostium. Staging of chronic sinusitis based on CT imaging evaluates the level of opacification, the ostiomeatal complex and further abnormalities[8].

In Saudi Arabia, an increase in the prevalence of PNS pathologies has been noted[9]. In one study in Saudi Arabia, it was found that half of the participants had infected with chronic sinusitis[10]. Thus, this study was designed with an aim to determine the role of computed tomography in determining the spectrum of PNS pathologies in Saudi patients.

## MATERIALS AND METHODS

**Selection and description of participants:** One hundred patients with clinical suspicion of PNS disease found in the database record by the Radiology and Medical Imaging Department at King Khalid Hospital and Prince Sultan Center for Health Services between October, 2018 to October, 2019 were prospectively collected. The local Institutional Review Board (IRB) (No. 2019-0120 M) and Ethical Committee for Research Involving Human Subject approved this study. All patients were Saudi, with suspected acute or chronic inflammation of the PNS, complete sinus CT scan, no or minimal sinus changes and full set of reconstructions in coronal and sagittal views. The exclusion criteria were: (1) Non-Saudi patients and (2) Saudi and non-Saudi patients present with other brain lesions beside PNS.

A detailed history of the patient, including signs and symptoms, detailed physical examination, biochemical and radiological investigations which included PNS CT were recorded and tabulated. A written informed consent was acquired in all procedures after explaining the nature of the exam. The authors confirmed that all medical devices used in this study were subjected to periodic quality control tests before use to avoid any error in the results obtained.

**Patient preparation and CT protocol for examining PNS:** Regarding patient preparation before the procedures, all patients should wear comfortable, loose-fitting clothing for their CT exam. Metal objects, including jewelry, eyeglasses, dentures and hairpins were removed to avoid formation of any image artifacts. Also, hearing aids and removable dental work were removed. In addition, any other piercings were removed, if possible. Patients were asked not to eat or drink anything for a few hours beforehand, if contrast material will be used in their exam. Authors make sure that all patients were informed their physician of all medications they are taking and if they have any allergies. Recent illnesses or other medical conditions and whether the patient has a history of heart disease, asthma, diabetes, kidney disease or thyroid problems were checked to avoid any increase in the risk of an adverse effect. Female patients were asked by the CT technologist if there is any possibility that they may be pregnant.

The patient was placed on the gantry table in supine position. All data sets were reconstructed with separate kernels for the bone and soft tissue in the axial, coronal and sagittal planes. Coronal and sagittal views were reformatted with 1.0 mm slice thickness. The coronal scan is taken from posterior margin of sphenoid sinus to anterior margin of frontal sinus by using a 128 detector CT scanner (Workstation Intellispace ISP; Philips, Netherlands), with the following imaging parameters: (1) 120 kilovoltage peak (kVp), (2) 180 milliamperage (mA), (3) 0.5 sec rotation time, (4) 0.531 pitch and (v) 0.625 millimeter (mm) section collimation. Iodinated IV contrast agent is given if required. All imaging data for each patient were reviewed by one radiologist had 10 years of experience. The following anatomic landmarks and osseous structures were assessed for each side: (1) Uncinate process of the ethmoid bone, (2) Ostium of maxillary sinus, (3) Ethmoidal infundibulum, (4) Nasolacrimal duct, (5) Cribriform plate, (6) Fovea ethmoidalis and (7) Lamina papyracea. All images were assessed in 2 preset windows with a focus on either bone (window center: 700 Hounsfield unit (HU), window width: 2700 HU) or soft tissue (window center: 50 HU, window width: 400 HU). The above mentioned guidelines and protocols for patient preparation and CT scanning of PNS were in line with Hoxworth and Lal[11] and Schaafs *et al.*[12].

**Statistical analysis:** All measurable data were summed up in a comparison tables and graphs. Statistical analysis was performed using the standard Statistical Package for the Social Sciences (SPSS) (IBM Corporation, Armonk, NY, USA) version 20 for windows. The statistical diagnostic test was used to detect sensitivity, specificity and accuracy of US in the differential diagnosis of breast lesions in Saudi females.

## RESULTS

In this prospective study, a total of 100 patients-56% males and 44% females with male to female ratio of 1.3:1-who presented with clinical complaints of nasal obstruction, nasal discharge and positive ENT examination findings and underwent computed tomographic imaging. The mean±SD age was 39.5±2.4 (age range, 8-73) years (Table 1).

The most common symptoms were headache (75%), nasal obstruction (64%), nasal discharge (42%), face swelling (23%) and epistaxis (7%) of cases.

Table 1: Distribution of patients age in the study sample

| Age range | Frequency (n) | Mean±SD |
|---|---|---|
| 8-18 | 16 | 14.5±3.1 |
| 19-29 | 29 | 23.6±3.5 |
| 30-40 | 32 | 32.6±2.2 |
| 41-51 | 13 | 45.9±2.8 |
| 52-62 | 8 | 54.6±2.9 |
| 63-73 | 2 | 66.0±0.0 |
| Total | 100 | 39.5±2.4 |

Table 2: Spectrum of PNS pathologies (%) in the study sample

| PNS pathologies | Frontal sinuses (%) | Maxillary sinuses (%) | Ethmoid sinuses (%) | Sphenoid sinuses (%) |
|---|---|---|---|---|
| Sinusitis | 30 | 68 | 55 | 35 |
| Hypoplastic | 1 | 0 | 0 | 0 |
| Atrophy | 0 | 1 | 0 | 0 |
| Polyp | 0 | 1 | 0 | 0 |
| Normal | 69 | 30 | 45 | 65 |

Table 3: Performance of CT in the diagnosis of PNS pathologies

| Absence or presence of PNS pathologies | | Values |
|---|---|---|
| True positive | | 100 |
| True negative | | 4 |
| False positive | | 1 |
| False negative | | 2 |
| Performance of CT in the diagnosis of PNS pathologies | Value (%) | 95% CI |
| Sensitivity (%) | 98.04 | 93.10-99.76 |
| Specificity (%) | 80.00 | 28.36-99.49 |
| Positive likelihood ratio | 4.90 | 0.85-28.30 |
| Negative likelihood ratio | 0.02 | 0.01-0.10 |
| PNS pathologies prevalence (%) | 95.33 | 89.43-98.47 |
| Positive predictive value (PPV) (%) | 99.01 | 94.54-99.83 |
| Negative predictive value (NPV) (%) | 66.67 | 32.14-89.41 |
| Accuracy (%) | 97.20 | 92.02-99.42 |

The spectrum of PNS pathologies was described in Table 2. Maxillary sinuses were the most sinuses that affected by sinusitis (68%) and the frontal sinuses was the last one (30%). Atrophy and polyp were detected in (1%) for each in the maxillary sinuses while frontal sinuses was affected with the hypoplastic disease in (1%) of cases.

There were common anatomical variations seen in PNS during this study. Among these anatomical variations was osteomeatal complex, (14%) patent and (86%) closed, inferior nasal turbinates muscle, (46%) normal and (54%) hypertrophy and nasal septum, (17%) centralized and (83%) deviated (Fig. 1).

The analysis of the levels of the performance of CT in diagnosis of PNS pathologies shows that the level of sensitivity, specificity and accuracy highly determines the level of detection of a model for differential diagnosis of PNS diseases among Saudi patients (Table 3).

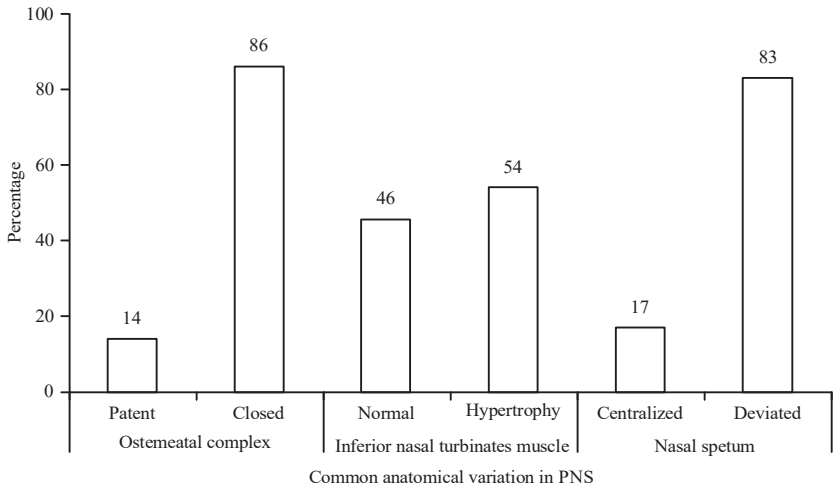


Fig. 1: Common anatomical variations in PNS

## DISCUSSION

In this prospective study, a total of 100 patients-56% males and 44% females with male to female ratio of 1.3:1-who presented with clinical complaints of nasal obstruction, nasal discharge and positive ENT examination findings and underwent computed tomographic imaging in the Radiology and Medical Imaging Department at King Khalid Hospital and Prince Sultan Center for Health Services between October, 2018 to October, 2019. Now-a-days, CT has become the best diagnostic modality for evaluation of PNS diseases. Persistent sinus disease refractory to medical therapy is investigated by CT[13,14]. The present study was a prospective cohort study that evaluated the role of CT in determining the spectrum of PNS pathologies in Saudi patients. It was carried out on 100 symptomatic sinus diseased patients who had undergone CT imaging of PNS and fulfilled the inclusion criteria. In the present study, the patient's age ranged between 8-73 years (Table 1), which was consistent with a study about the aetiology, diagnosis and treatment of chronic rhinosinusitis in a teaching hospital in Telangana and also compatible with another study of evaluation of sinonasal diseases by computed tomography[15,16]. Regarding the current findings, the male to female ratio was 1.3:1 (Table 1) which is in line with Bist *et al.*[17], where they found a male:female ratio of 1.6:1 in their study of the clinic pathological profile of sinonasal masses in light of an experience in a tertiary care hospital of Uttarakhand.

The most common symptoms were headache (75%), nasal obstruction (64%), nasal discharge (42%), face swelling (23%) and epistaxis (7%) of cases. In addition, Dewan *et al.*[18] and Kushwah *et al.*[19] noted similar symptoms in their studies. They all concluded that a headache was the predominant presenting complaint. The findings of this study (Table 2) revealed that the maxillary sinus (68%) was the most commonly involved sinus by sinusitis followed by ethmoid (55%), sphenoid (35%) and frontal (30%). Similar findings were also found in studies done by Kandukuri and Phatak[16], Vijay *et al.*[20] and Dhillon *et al.*[21]. Atrophy and polyp were detected in (1%) for each in the maxillary sinuses while frontal sinuses was affected with the hypoplastic disease in (1%) of cases (Table 2). Such findings could be compared to the findings of Kandukuri and Phatak[16] and Salami[22]. There were common anatomical variations seen in PNS during this study. Among these anatomical variations was osteomeatal complex (14%) patent and (86%) closed, inferior nasal turbinates muscle (46%) normal and (54%) hypertrophy and nasal septum (17%) centralized and (83%) deviated (Fig. 1) which is similar to that seen in a study by Verma *et al.*[23] about CT of PNS for early and proper diagnosis of nasal and sinus pathology.

Kanwar *et al.*[24] evaluated of PNS diseases by CT and its histopathological correlation. They found that there was a high sensitivity, specificity, positive and negative predictive values were noted in all diagnoses except fungal sinusitis which revealed a sensitivity of 66.6%, a specificity of 91%, a positive predictive value of 46.1% and negative predictive value of 96.1%. Such findings could be compared to the findings of the current study in the performance of CT in the diagnosis of PNS pathologies as demonstrated in Table 3.

This study is limited by the unevenness of the population as a result of the randomized selection process, which unfortunately might affect the accuracy of diagnosed PNS diseases using CT and in fact significantly reduce the power of the conclusions, because it makes other age groups have a

lower statistical credibility if applied in future studies. Taking in mind the disadvantages of prospective cohort studies as: (1) Authors may have to follow large numbers of subjects for a long time, (2) It is very expensive and time consuming, (3) Are not good for rare diseases, (4) Not good for diseases with a long latency and (5) Differential loss to follow up can introduce bias. Despite the above limitations, the importance of the current study lies upon it is the first study that concerned with highlighting the role of CT scan in determining the spectrum of PNS pathologies in Saudi patients in Al-Kharj province.

## CONCLUSION

This study emphasizes the significant role of CT in diagnosis and characterization of various sinonasal diseases. CT was able to characterize the PNS diseases along with their extension. In addition, it proves the better sensitivity (98.04%), specificity (80%) and accuracy (97.02%) of CT in the evaluation of various sinonasal pathologies in symptomatic Saudi patients for the diagnosis, staging and thereby better planning of management.

## SIGNIFICANCE STATEMENT

This study shows that CT was able to characterize the PNS diseases along with their extension. It proves the better sensitivity (98.04%), specificity (80%) and accuracy (97.02%) of CT in the evaluation of various sinonasal pathologies in symptomatic Saudi patients for the diagnosis, staging and thereby better planning of management. Thus, CT may be used as a gold standard imaging modality for evaluating the PNS diseases.

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