Sudan University of Science and Technology
Collage of Graduate Studies

A study of Paranasal Sinuses Diseases using Multi Detectors Computed Tomography

دراسة أمراض الجيوب الأنفية باستخدام التصوير المقطعي المحوسب متعدد الكواشف

A Thesis Submitted for Partial Fulfilment of Requirements of M.Sc Degree in Diagnostic Radiologic Technology

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إستهلال

قال الله تعالى:

﴿ رَبَّنَآ ءَاتِنَا مِن لَّدُنكَ رَحۡمَةٗ وَهَيِّئۡ لَنَا مِنۡ أَمۡرِنَا رَشَدٗا﴾

[الكهف:10]

Dedication

To my first teachers in my life, to my parents

to my brother, to my family

To my friends and everyone who stand beside me.

This research is dedicated to you with love.

Acknowledgment

I would like to express my sincere thanks and gratitude to Allah ,to my teacher a real great master / Dr. Rahma Abdalla Awad for her patient, guiding and wise advices.

Thanks extend to the staff and friends in Department of CT at yastabshiroon medical center, who helped me a lot.

My thanks and appreciations to all my colleagues, for their continuous help in many ways.

Thanks to the patients who agreed to be included in the study.

ABSTRACT

The Computed Tomography imaging (CT) is the gold standard in sufficiently depicting the paranasal sinuses diseases, this study was cross sectional descriptive study.

The objective is to study sinuses diseases using Computed Tomography (CT) and its relations with age, gender, lesion, side and site of paranasal sinuses (PNS). Data were collected from 50 patients from both genders their ages between 10-70 years old came to radiological departments of Yastabshiroon Medical Center for paranasal sinuses Computed Tomography (CT) scan in period from January to June 2020. The data were collected from medical reports and data collecting sheet include the following variables age, gender, lesion, side and site of paranasal sinuses. The data analyzed by Statistical Package Of Social Science (SPSS) (version 21). The study found that the most common CT findings, were chronic sinusitis had higher frequency (34%), antrochoanal polyp (24%), acute sinusitis (10%), while the most common affected site and side of paranasal sinuses is maxillary (30%), bilateral side (62%). The study showed that the paranasal sinuses diseases higher in female (62%) and in age (30-44) (35%). Finally the Study finding that the multidetector computed tomography (MDCT) is more effectively in paranasal sinuses (PNS) diseases.

The study recommended using large sample size for more accurate result.

مستخلص الدراسه

التصوير بالأشعة المقطعية المحوسب هو المعيار الذهبي في تصوير أمراض الجيوب الأنفية بشكل كاف, لذلك هدفت هذه الدراسة إلى تقييم أمراض الجيوب الأنفية باستخدام التصوير بالأشعة المقطعية المحوسبة, هذه دراسة وصفية مقطعية مستقبلية. الهدف منها دراسة أمراض الجيوب الأنفية باستخدام التصوير بالأشعة المقطعية المحوسبة وعلاقته بالعمر, الجنس, المرض, وجانب, وموقع الجيوب الأنفية . تم جمع البيانات من 50 مريضا من كلا الجنسين تتراوح اعمارهم بين 10-70 عاما جاءوا الى اقسام الأشعة في مركز يستبشرون الطبي لفحص الجيوب الأنفية بالتصوير بالأشعة المقطعية المحوسبة في الفترة من يناير إلى يونيو 2020. تم جمع البيانات من التقارير الطبية و ورقة جمع بيانات تتضمن المتغيرات التالية :العمر, الجنس, المرض, وجانب وموقع الجيوب الأنفية. تم تحليل البيانات بواسطة الحزمة الإحصائية للعلوم الاجتماعية (إصدار 21). ووجدت الدراسة أن أكثر نتائج التصوير المقطعي المحوسب شيوعًا كانت التهاب الجيوب الأنفية المزمن ذي التردد العالي (34٪) ، والزوائد اللحمية (24٪) ، والتهاب الجيوب الأنفية الحاد (10٪) ، في حين أن المكان الأكثر لإصابة الجيوب الأنفية هو الفك العلوي(30%), ثنائي الجانب (62٪). وأظهرت الدراسة أن أمراض الجيوب الأنفية أعلى عند الإناث (62٪) وفي العمر (30-44) (35٪). أخيرًا وجدت الدراسة أن التصوير المقطعي المحوسب متعددة الكواشف أكثر فاعلية في أمراض الجيوب الأنفية.

و أوصت الدراسة باستخدام حجم عينة كبير لنتائج أكثر دقة

Table of Contents

List of variables

ACP	AntroChoanal Polyp
B/W	Between
CT	Computed Tomography
CAT	Computed Axial Tomography
FIG	Figure
FD	Fibrous dysplasia
L	Liter
LT	Left
MDCT	Multi Detector Computed Tomography
MPR	Multiplanar Reformatting
OMU	Osteo Meatel Unit
PNS	Para Nasal Sinuses
SSS	Silent Sinus Syndrome
SPSS	Statistical Package for Social Science
SNUC	Sinonasal undifferentiated carcinoma
SNMM	Sinonasal mucosal melanoma
RT	Right
3D	Three Dimensional

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CHAPTER ONE

INTRODUCTION

1.1 Introduction:

The paranasal sinuses are air-filled spaces located within the bones of the skull and face. They are centered on the nasal cavity and have various functions, including lightening the weight of the head, humidifying and heating inhaled air, increasing the resonance of speech, and serving as a crumple zone to protect vital structures in the event of facial trauma. Four sets of paired sinuses exist: maxillary, frontal, sphenoid, and ethmoid, they are communicate with nasal cavity through small apertures (ostia) (Dalgorf, 2013).

Medical Imaging has experiences significant change in both technologic and Clinical aspect in evaluation of paranasal sinuses (PNS) Abnormalities. Computed tomography (CT) is an excellent means of providing anatomical information of this region, assessing disease extent, assisting endoscopic evaluation and guiding treatment (Lund, 2000).

CT scan provides excellent contrast resolution, high spatial resolution and produce images in three dimensions reconstruction Images, CT is ideal Method to evaluate the bony changes and integrity of the bony margins of the PNS wall (Chow, 1993). CT is superior than plain X-ray in defining the extension and potential complication of the PNS diseases and are essential for therapy planning its also capable to define the ostia of PNS and identify possible outflow obstruction (Chow, 1993).

By CT Scans its can easily obtain images in coronal planes and axial plane thin slice. Coronal is ideal for detecting the PNS diseases and displays the osteomeatal unit (OMU) and the relationship of the sinus lesion to the orbits and the brain

Axial planes are important in the evaluation of trauma and neoplasm of PNS and evaluation of inflammatory changes in PNS (Chow, 1993).

1.2 Problem of the Study:

Most PNS examinations done with conventional X-ray such as Water and Caldwell views didn't provide sufficient Clinical Diagnosis.

Conventional CT is not capable to reconstruct the images in coronal planes, unlike spiral CT its can Provide MPR (Axial, Coronal, Sagittal) and 3D Images of the PNS. There is a lack of studies concern the benefits of MDCT with PNS diseases.

1.3 Objectives:

1.3.1 General objective:

To study the (PNS) diseases using multidetector computed tomography (MDCT).

1.3.2 Specific Objectives:

- To determine the most common diseases affecting the PNS.
- To determine the most affected site and side of PNS.
- To correlate between age, gender and diseases.
- To correlate between diseases and side, site of PNS.

1.4 Overview of the Study:

This study is consists of five chapters, chapter one is deals with the introduction, problem of the study, objectives and overview of study. Chapter two deals with theoretical background (Anatomy, physiology and pathology) and previous studies. Chapter three deals with materials and methods then Chapter four presents the results and chapter five the discussion, conclusion, recommendations, References and appendices.

Chapter two

Theoretical Background and Literature Review

2.1 Theoretical Background

2.1.1 Anatomy of PNS:

The paranasal sinuses are air filled extensions of the respiratory part of the nasal cavity. There are four paired sinuses, named according to the bone they are located in; maxillary, frontal, sphenoid and ethmoid. The function of the sinuses is thought that they may contribute to the humidifying of the inspired air. They also reduce the weight of the skull, The sinuses are formed in childhood by the nasal cavity eroding into surrounding bone. As they are outgrowths of the nasal cavity, they all drain back into it openings to the paranasal sinuses are found on the roof and lateral walls of the nasal cavity Composed of (Dalgorf, 3102).

2.1.1.1 Frontal Sinuses:

These are the most superior in location, found under the forehead. The frontal sinuses are variable in size, but always triangular shaped. They drain into the nasal cavity via the frontonasal duct, which opens out at the hiatus semilunaris on the lateral wall (Keros, 1965).

2.1.1.2 Sphenoid Sinuses:

The sphenoid sinuses also lie relatively superiorly, at the level of the spheno-ethmodial recess. They are found more posteriorly, and are related superiorly and laterally to the cranial cavity. The sphenoid sinuses drain out onto the roof of the nasal cavity. The relationship of this sinus is of clinical importance – the pituitary gland can be surgically accessed via passing through the nasal roof, into the sphenoid sinus and through the sphenoid bone (Reddy, 2012).

2.1.1.3 Ethmoidal Sinuses:

Are hollow spaces in the bones around the nose, they have alining of mucus to help prevent the nose from drying out. also they are three ethmoidal sinuses; anterior, middle and posteior. They empty into the nasal cavity at different places, Anterior (Hiatus semilunaris), Middle (Ethmoid bulla), Posterior (Superior meatus) (medicalnewstoday.com).

2.1.1.4 Maxillary Sinuses:

The largest of the sinuses it is located laterally and slightly inferiorly to the nasal cavities. It drains into the nasal cavity at the hiatus semilunaris, underneath the frontal sinus opening. This is a potential pathway for spread of infection – fluid draining from the frontal sinus can enter the maxillary sinus (Negus, 1958).

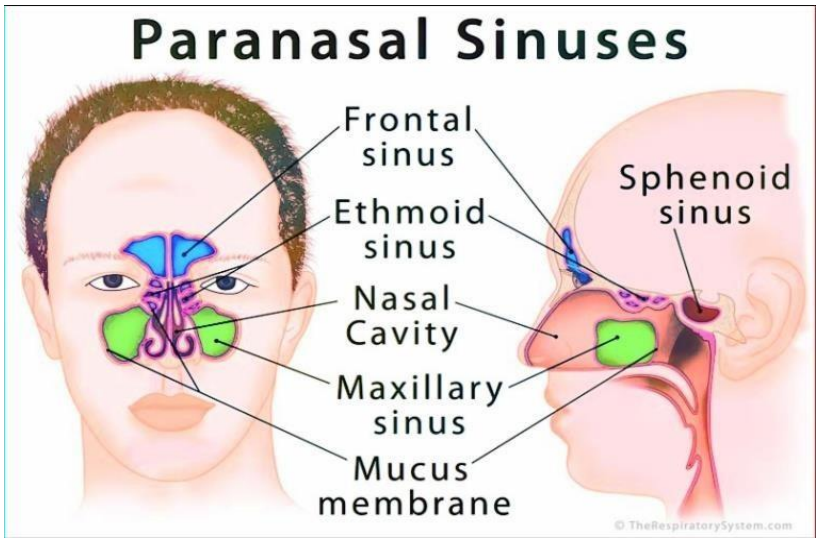


Fig (2.1) showing the region and anatomy of PNS (https://www.therespiratorysystem.com)

2.1.2 Physiology of PNS:

The main functions of the paranasal sinuses are, increasing resonance of the voice, reducing the weight of the bones of the face, give strength and shape to the face and eyes, Supporting immune defence of the nasal cavity and Humidifying inspired air.

The nasal cavity and paranasal sinuses make about 1 L of mucus a day. As the mucus moves through the nasal cavity and sinuses, it moisturizes and cleans the mucous membrane, which filters bacteria, dust and other particles from the air breathed through the nose. The mucus drains into the throat and is swallowed where the acid in the stomach destroys any bacteria that were in the mucus (Lev, 1998).

2.1.3 Pathology of PNS:

2.1.3.1 Sinonasal disease:

The nasal passage and paranasal sinuses (collectively sinonasal) plays host to a number of diseases and conditions, which can be collectively termed sinonasal disease classified as follow (Momeni, 2007).

2.1.3.2 Sinonasal Inflammatory:

Disease with sinus ostial obstruction is a very common cause of an opacified paranasal sinus. An air-fluid level suggests acute sinusitis; in chronic sinus disease, one may see mucosal thickening and sclerosis of the bony sinus walls. The sinus is normal in size (Lev, 1998).

2.1.3.2.1 Sinusitis:

Is a broad and non-specific term referring to the inflammation within the paranasal sinuses. There are several forms which are specific entities based on etiology and clinical features, and hence covered individually (Momeni, 2007).

2.1.3.2.1.1 Acute sinusitis:

Is an acute inflammation of the paranasal sinus mucosa that lasts less than four weeks and can occur in any of the paranasal sinuses. If the nasal cavity mucosa is also involved then the term rhinosinusitis may be used (Momeni, 2007).

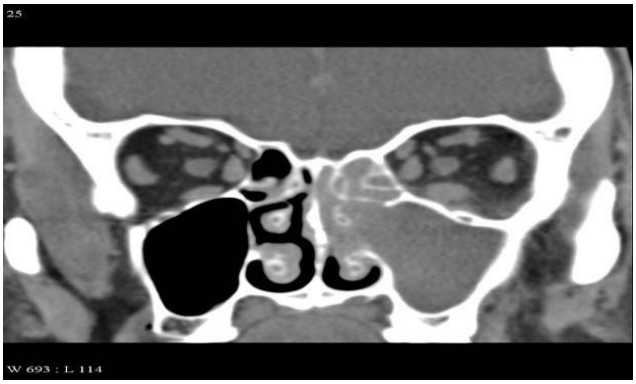


Fig (2.2) coronal CT image with acute sinusitis in lt ethimoid and maxillary (https://radiopaedia.org)

2.1.3.2.1.2 Chronic sinusitis:

Refers to ongoing long-term sinus infection inflammation that often develops secondary to a prolonged/refractory acute sinus infection (Momeni, 2007).

Fig (2.3) shows axial CT bony window with nasal mucosa and maxillary chronic sinusitis (https://radiopaedia.org)

2.1.3.2.1.3 Pott puffy tumor:

Refers to a non neoplastic complication of acute sinusitis. It is characterized by a primarily subgaleal collection, subperiosteal abscess, and osteomyelitis. It is usually related to the frontal sinus but is sometimes secondary to mastoid pathology (Momeni, 2007).

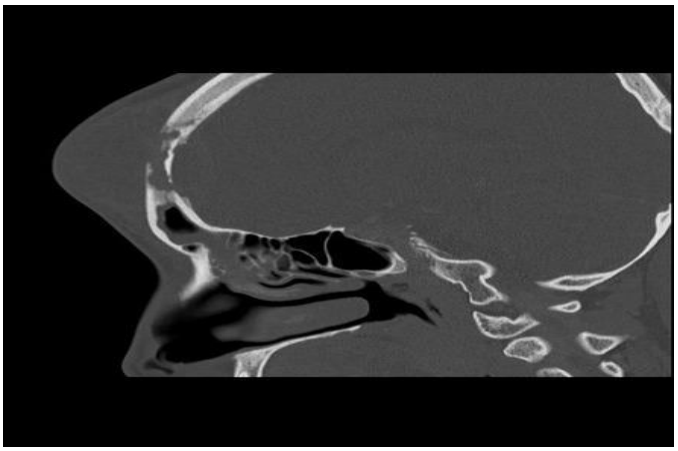


Fig (2.4) sagitall bone window CT image with pott tumor in frontal sinuses

(https://radiopaedia.org/articles)

2.1.3.2.1.4 Fungal sinusitis:

Is a collective term referring to a number of entities, which can be divided into two groups, depending on the presence of fungal hyphae within or beyond the mucosa (Aribandi,2007).

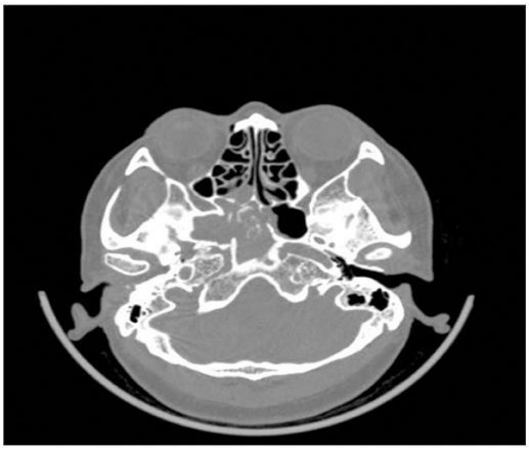


Fig (2.5) CT image of paranasal sinus. Irregular soft tissue intensity was observed in right sphenoid sinus with high density of point stripe calcification and lesion on the sinus wall (https://www.frontiersin.org)

2.1.3.2.1.4.1 Allergic fungal sinusitis:

Is the most common form of fungal sinusitis and is common in warm and humid climates. On imaging, it usually presents as opacification and expansion of multiple paranasal sinuses, unilaterally or bilaterally, with content that is centrally hyperdense on CT (Momeni, 2007).

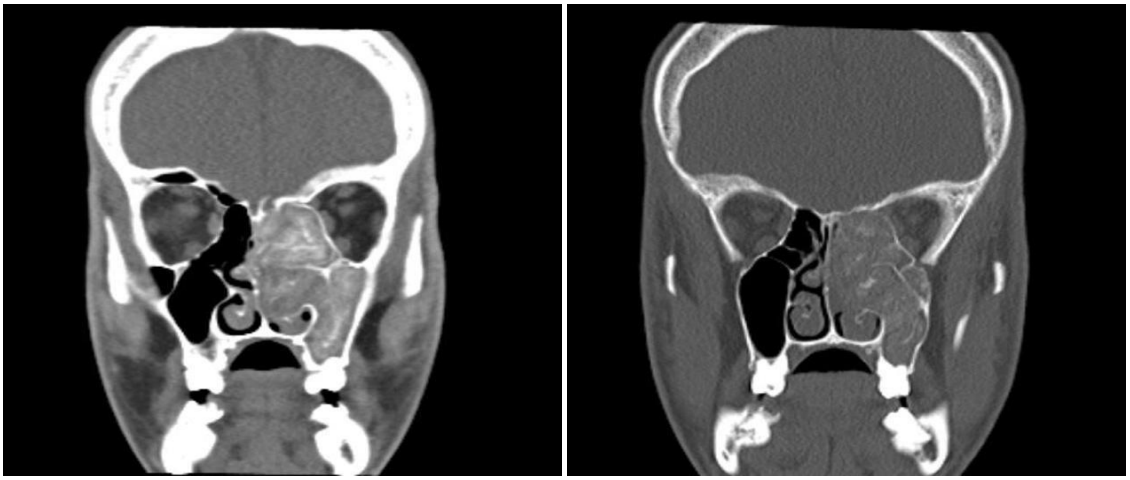


Fig (2.6) coronal soft tissue+c and bone window show allergic fungal in lt ethimoid, maxillary, sphenoid(https://radiopaedia.org)

2.1.3.2.1.4.2 Sinus fungal mycetoma:

Also called Paranasal sinuses mycetomas**,** or fungus balls, can be described as accumulation of non-invasive fungal dense concretions at the level of the paranasal cavities, is more often unilateral although rarely can affect more sinus cavities (Momeni, 2007).

Fig (2.7) coronal CT image with maxillary mycetoma (https://radiopaedia.org)

2.1.3.2.1.4.3 Acute invasive fungal sinusitis:

Is the most aggressive form of fungal sinusitis. It is seen particularly in immunecompromised patients and is the source of significant morbidity and mortality (Momeni, 2007).

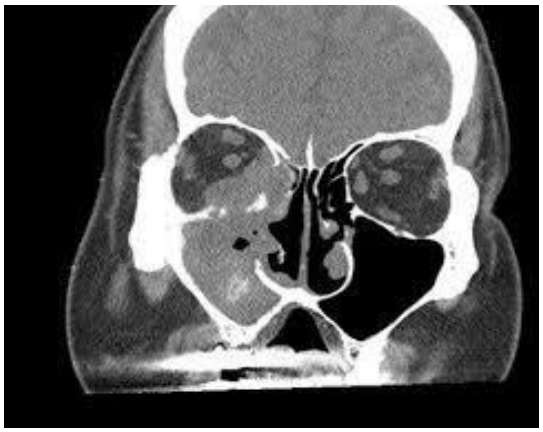


Fig (2.8) soft tissue CT image show acute invasive fungal sinusitis in rt maxillary sinus (https://radiopaedia.org)

2.1.3.2.1.4.4 Chronic invasive fungal sinusitis:

The condition has a more prolonged course than acute invasive fungal sinusitis, usually more than 12 weeks. Patients are usually immunocompetent or have a milder level of immunocompromise. There may be a history of chronic sinusitis (Momeni, 2007).

Fig (2.9) shows axial bony CT image with Chronic invasive fungal sinusitis in rt ethimoid and maxillary (https://radiopaedia.org)

2.1.3.3 Paranasal sinus mucoceles:

Represent complete opacification of one or more paranasal sinuses by mucus, often associated with bony expansion due to obstruction of the nasal sinus drainage (Momeni, 2007).

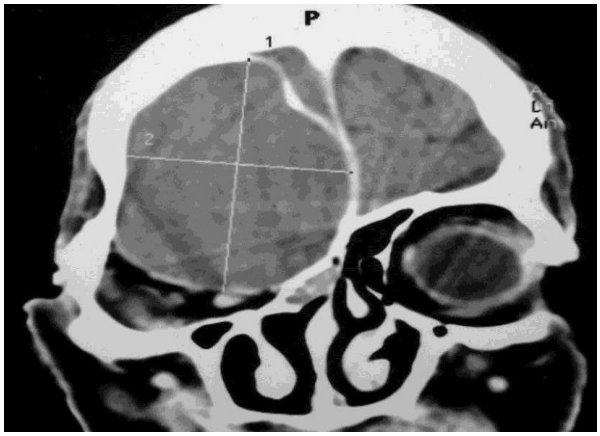


Fig (2.10) shows coronal soft tissue CT image with rt frontal sinus mucocele (https://radiopaedia.org)

2.1.3.4 Neoplasm:

Nasal and paranasal tumors are abnormal growths that begin in and around the passageway within nose (nasal cavity). Nasal tumors begin in the nasal cavity. Paranasal tumors begin in air-filled chambers around the nose called the paranasal sinuses.Nasal and paranasal tumors can be noncancerous (benign) or they can be cancerous (malignant). Several types of nasal and paranasal tumors exist. Which type of tumor you have helps determine the best treatment for you.

Presenting symptoms of sinonasal malignancy can be identical to those caused by inflammatory sinus disease (Madani, 2009).

2.1.3.4.1 Antrochoanal polyp:

Antrochoanal polyps (ACP) are solitary sinonasal polyps that arises within the maxillary sinus but passes through and enlarges the sinus ostium and posterior nasal cavity to the nasopharynx.

Similar, less common, polyps can arise in the sphenoid sinus extending into the nasopharynx these are termed sphenochoanal polyps. likewise, there are nasochoanal, frontochoanal, and ethmochoanal polyps (H Ric,2017).

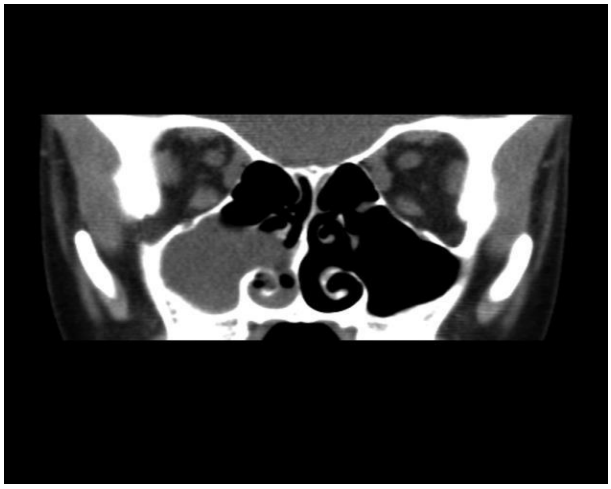


Fig (2.11) shows coronal CT image bony window with maxillary polyp (https://radiopaedia.org)

2.1.3.4.2: Sinonasal polyposis:

Sinonasal polyposis is a typically extensive process with involvement of both the nasal cavity and the paranasal sinuses. By contrast, mucous retention cysts are typically limited to the sinus cavity in location. CT findings of sinonasal polyposis include polypoid masses in the nasal cavity, polypoid soft tissue masses in the sinuses, partial or complete paranasal sinuses opacification, and enlargement of the infundibula (Momeni, 2007).

Fig (2.12) shows soft tissue CT image with sinonasal, paranasal polyp(https://radiopaedia.org)

2.1.3.4.3 Fibrous-osseous lesions:

2.1.3.4.3.1 Osteoma of the paranasal sinuses:

Is a common benign tumor, usually found incidentally.

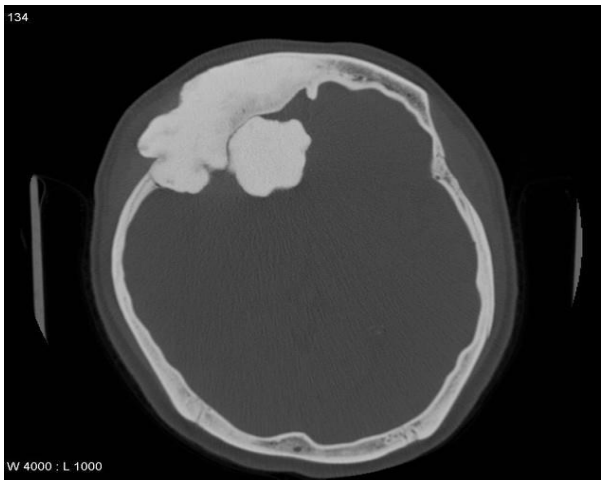


Fig (2.13) shows axial CT image bony window with osteoma in frontal bone(https://radiopaedia.org)

2.1.3.4.3.2 Fibrous dysplasia (FD):

Is a non-neoplastic tumor-like congenital process, manifested as a localized defect in osteoblastic differentiation and maturation, with the replacement of normal bone with large fibrous stroma and islands of immature woven bone. Fibrous dysplasia has a varied radiographic appearance. If asymptomatic, it does not require treatment (Momeni,2007).

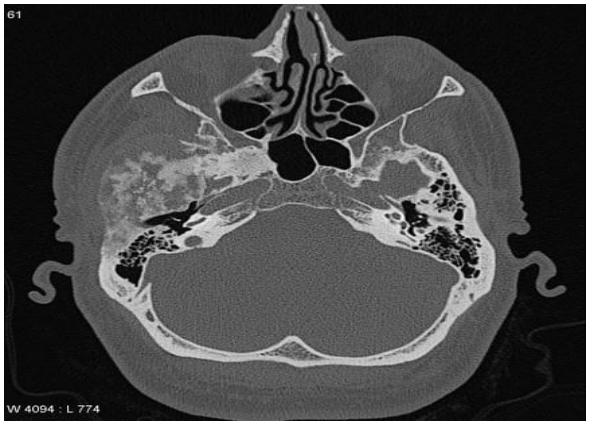


Fig (2.14) shows axial bone window CT image with fibrous dysplasia (https://radiopaedia.org)

2.1.3.4.4 Malignant Tumors:

Different types of cells in the paranasal sinus and nasal cavity may become malignant. The most common type of paranasal sinus and nasal cavity cancer is squamous cell carcinoma. This type of cancer forms in the thin, flat cells lining the inside of the paranasal sinuses and the nasal cavity (Momeni, 2007).

2.1.3.4.4.1 Sinonasal squamous cell carcinoma:

Cancer that begins in squamous cells. Squamous cells are thin, flat cells that look like fish scales, and are found in the tissue that forms the surface of the skin, the lining of the hollow organs of the body, and the lining of the respiratory and digestive tracts (Momeni, 2007).

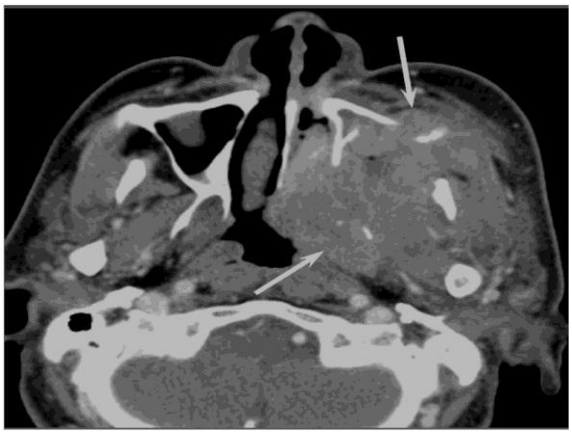


Fig (2.15) Squamous cell carcinoma of the lt maxillary sinus. Contrast-enhanced axial CT image showing an ill-demarcated, heterogeneously enhanced bulky mass with extensive bony destruction (arrows)(https://www.researchgate.net)

2.1.3.4.4.2 Sinonasal adenocarcinomas:

Are primary tumors of the sinonasal region with glandular differentiation. They are grossly classified as salivary and non-salivary subtypes. However, the term Sinonasal adenocarcinoma refers to non-salivary adenocarcinomas unless otherwise specified . This article refers specifically to non-salivary adenocarcinomas (Momeni, 2007).

Fig (2.16) shows axial CT image soft tissue with adenocarcinoma within nasal cavity and rt maxillary sinus (https://radiopaedia.org)

2.1.3.4.4.3 Sinonasal undifferentiated carcinoma (SNUC):

Is a rare and highly aggressive neoplasm arising in the paranasal sinuses. It has recently been characterized as a distinct pathologic entity (Momeni, 2007).

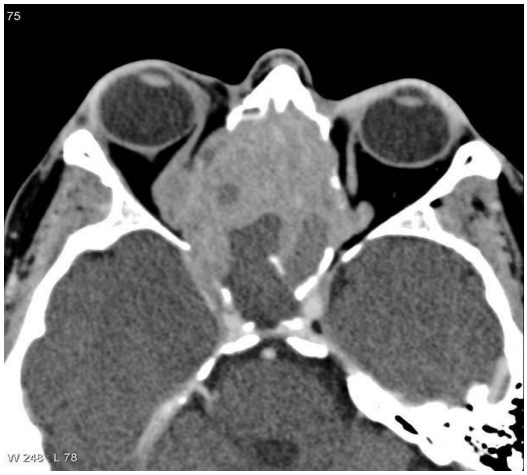


Fig (2.17) shows axial ct image soft tissue with contrast with undeferentiated carcinoma in nasal cavity (https://radiopaedia.org)

2.1.3.4.4.4 Olfactory Neuroblastomas:

Also known as esthesioneuroblastomas**,** (the spelling aesthesioneuroblastoma is archaic) are tumors arising from the basal layer of the olfactory epithelium in the superior recess of the nasal cavity.

They usually present as a soft tissue mass in the superior olfactory recess involving the anterior and middle ethmoid air-cells on one side and extending through the

cribriform plate into the anterior cranial fossa. Contrast enhancement is often marked in both CT (Momeni, 2007).

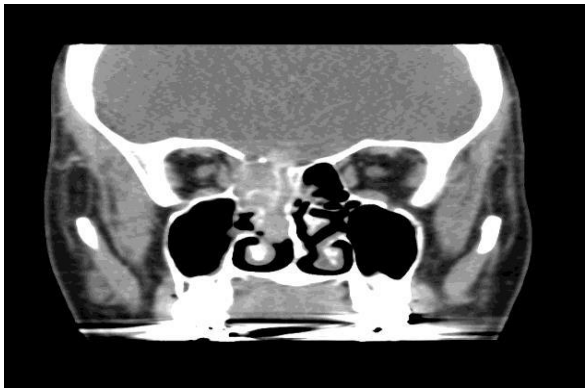


Fig (2.18) shows coronal CT image soft tissue with esthesioneuroblastomas (https://radiopaedia.org)

2.1.3.4.4.5 Sinonasal lymphoma:

Refers to the involvement of the nasal cavity and/or paranasal sinuses with lymphoma. It can be primary or secondary (Momeni, 2007).

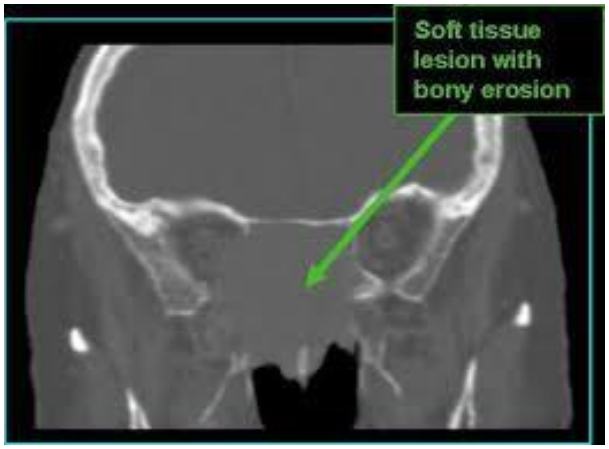


Fig (2.19) shows coronal bony CT image with lymphoma within nasophrenx (https://medicine.uiowa.edu)

2.1.3.4.4.6 Sinonasal mucosal melanoma (SNMM):

Is a very rare and unique subtype of malignant melanoma (Momeni, 2007).

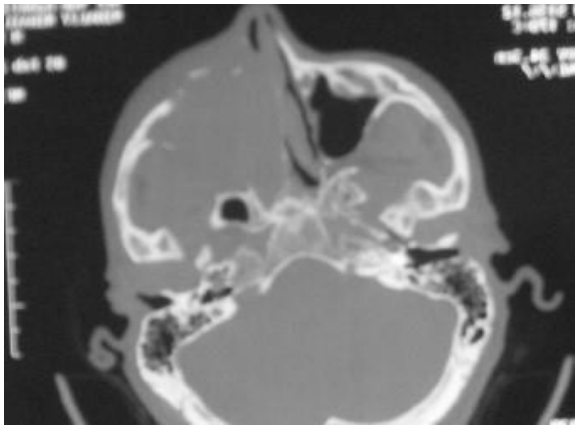


Fig (2.20) shows axial CT bony window with melanoma in rt maxillary and nasal sinuse (https://www.sciencedirect.com)

2.1.3.5 Silent sinus syndrome (SSS):

Both silent sinus syndrome (SSS) and the mucocele, are characterized by abnormal sinus size, with reduced sinus volume in SSS and sinus expansion in mucocele.

The term “silent sinus syndrome” is characterized by unilateral progressive painless enophthalmos, hypoglobus and facial asymmetry due to chronic maxillary sinus atelectasis (IIner, 2002).

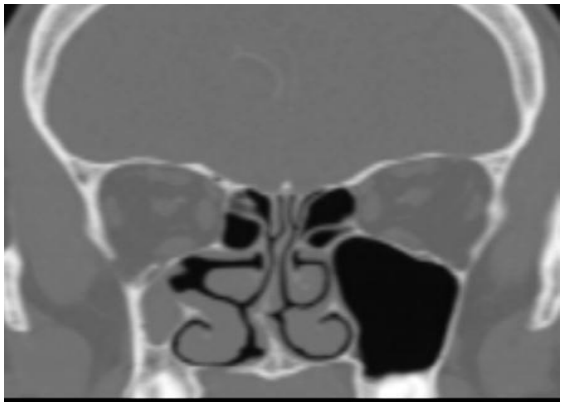


Fig (2.21) coronal bony CT image with maxillary silent syndrome (https://radiopaedia.org)

2.1.4 Computed Tomography Scanners:

Formerly known as a computed axial tomography or CAT scan is a medical imaging technique that uses computer-processed combinations of multiple X-ray measurements taken from different angles to produce tomographic (cross-sectional) images (virtual "slices") of a body, allowing to see inside the body

without cutting. The personnel that perform CT scans are called radiographers or radiologic technologists.(Patient Page, 2014) (Individual State Licensure, 2013).

The 1979 Nobel Prize in Physiology or Medicine was awarded jointly to South African American physicist Allan M. Cormack and British electrical engineer Godfrey N. Hounsfield "for the development of computer assisted tomography (Nobel Prize, 1979).

Initially, the images generated in CT scans were in the transverse (axial) anatomical plane, perpendicular to the long axis of the body. Modern scanners allow the scan data to be reformatted as images in other planes. Digital geometry processing can generate a three-dimensional image of an object inside the body from a series of two-dimensional radiographic images taken by rotation around a fixed axis (Herman, 2009).

These cross-sectional images are widely used for medical diagnosis and therapy (Merriam, 2011).

2.1.4.1 Equipment:

CT scanners are composed of many different connected parts, with many different components involved in the process of creating an image. More to the complexity, different CT scan manufacturers often modify the design of various components. all make and models of CT scanner are similar in that they consist of a scanning gantry, x-ray generator, computer system, operator's console or the console panel and physician's viewing console. Although hard copy filming has largely been replaced by workstation viewing and electronic archiving, most CT system still include a laser printer for transferring CT images to film (http://www.radtechonduty.com).

Fig (2.23) shows CT machine (http://www.megsyssolutions.com)

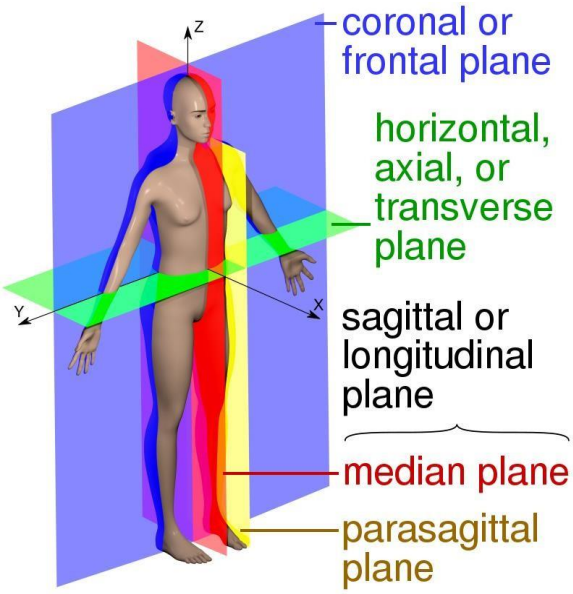


Fig (2.23) shows imaging plane in CT (https://en.wikipedia.org)

2.1.4.2 CT scan technique:

Traditionally, CT imaging of the sinus has been acquired in the axial and coronal planes, using noncontrast high-resolution 3-mm thick contiguous scans. Axial images are obtained with the patient supine on the scanning table and maintaining neutral position of the scanning gantry. This differs from the coronal scans, which are enabled by extension of the patient's neck in either prone or supine position and angling of the scanning gantry. To approximate the sinus coronal plane. An increasing number of institutions have abandoned the separate coronal acquisition, because the very thin over-lapping sections obtained on newer multidetector

scanners can be reformatted to nearly the same quality as coronal acquisition. The coronal imaging plane offers best visualization of the drainage pathways of the sinuses, whereas some drainage pathways (such as sphenoid sinus ostia) and sinus walls oriented close to the coronal plane are better seen on axial images.

The initial scanning data are typically reconstructed with two different imaging algorithms. The bone, or edge, algorithm enhances the interface between tissues of substantially differing densities, so that osseous margins and intact bone are easily distinguished from demineralized or eroded bone. However, this bone algorithm causes artifact noise in structures of similar density, such as mucosal thickening of the sinus margin. Therefore, soft-tissue algorithm images are also generated to eliminate this artifact noise in homogeneous structures and allow better visualization of soft-tissue structures and abnormalities. Because evaluation of both bone and soft tissue is crucial in the assessment of sinuses, both algorithms are scrutinized for evidence of pathology.

Scans enhanced with iodine-based intravenous contrast are obtained only in patients who are acutely ill and suspected of having a complication (Babbel R,1991).

Fig (2.24) shows patient position in CT for PNS scan(https://www.radiologyinfo.org)

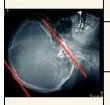
BASIC HEAD												
	Anatomical scan range	Scan type	Localizer scans	kVp	mAs	FOV	Scan slice thickness	Recon slice thickness	Gantry tilt	Recon kernel	IV contrast	Oral contrast
	Skull base thru vertex of head	Axial sequential	AP, LAT	120	250 auto	22cm	5mm	2.5mm	Match skull base	Medium average	No	No
	Place patient in supine position with head in head holder. Assure that patient is not rotated or tilted. Elevate table to bring coronal alignment light to the center of the skull. Landmark per equipment requirements (table movement for scout images). Perform scout images. Prescribe scan locations from skull base to vertex of head. Angle gantry to match skull base (occipital bone) (foramen magnum) and frontal bone (roof of orbit).											
CORONAL SINUSES												
	Anatomical scan range	Scan type	Localizer scans	kVp	mAs	FOV	Scan slice thickness	Recon slice thickness	Gantry tilt	Recon kernel	IV contrast	Oral contrast
	Entire sphenoid sinus thru entire frontal sinus	Axial sequential	AP, LAT	120	200 auto	16cm	5mm 3mm	2.5mm 1.5mm	90° to max. sinus	Sharp bone	No	No
	OPTION 1: Direct coronals - Place patient in prone position with extended chin resting in head holder (see diagram). OPTION 2: Place patient in supine position with head in head holder (basic head positioning). Assure that patient is not rotated or tilted. Elevated table to bring coronal alignment light to the center of the skull. Landmark per equipment requirements (table movement for scout images). Perform scout images. Prescribe scan locations to include entire sphenoid sinus thru entire frontal sinus Angle gantry to 90° orientation to floor of maxillary sinus. Volume scans can be performed with either positioning option with MPR's in opposite planes. Direct coronal positioning provides better information about maxillary meatus.											

Fig (2.25) shows CT protocol of PNS

(https://radiologykey.com)

Fig (2.26) shows imaging plane for PNS (https://www.medicalnewstoday.com)

2.2 Previous Studies:

Olackan – 2013 studies incidental P.N.S. abnormality on coronal C T in a valerian population and result that : Total of 100 Pt consist of 63 males and 37 females with age range of 11 - 76 years mucosal abnormality was commonest in anterior ethmoide 34% . Maxillary antrum (30%) frontal sinuses (13%) posterior ethomide(12%) and in sphenoid sinuses (11%) he correlated with symptomatic assessment- 27% has sinuses opacification , The study illustrates the importance of careful clinical correlation when interpreting C T scan of P.N.S.

(Gamareldin E. Eltayb, Fahad A. Mohamed, Malaz M. Ahmed, Rowida B. Mehassi 2020) study aimed to evaluate the CT findings in patients with paranasal sinus pathologies in two planes. Descriptive, cross sectional study design has been used, conducted on 45 patients (from September 2018 to May 2019), at Prince Saud Bin Jalawy hospital. Both male and female patients of different age groups from 12 to 60 years old with clinically suspected PNS diseases were enrolled for the study. Both axial and coronal images were acquired using multi-detector CT unit. The paranasal sinuses were evaluated for: mucosal thickening, nasal polyposis, chorionic sinusitis, acute sinusitis, fungal and pattern of bony involvement. There was a male predominance of 62% as compared to females 38%. Most common pattern of involvement was chronic sinusitis (31.2%) followed by polyposis (26.9%), mucosal thickening (22.8%), acute sinusitis (11.8%), fungal sinusitis (7.5%) and bone erosion (4.2%). Maxillary sinus was the most commonly involved sinus (39.9%) followed by frontal sinus (29%), sphenoid sinus (16.7. %) and ethmoid sinus (14.5%). The study concluded that the two image planes were performed together and used as an essential technique in diagnosing of pathological change of PNS.

R Murali - 216.10.240.19 Paranasal sinus diseases include a wide spectrum of conditions including inflammatory, non-neoplastic and neoplastic causes with a reported incidence of 1 to 4 % of the population Aims & Objectives: To assess the role of CT in evaluation of inflammatory sinonasal diseases Materials and Methods: All Patients referred from Department of Otorhinolaryngology for Paranasal Sinus CT to the Department of Radio diagnosis From December 2017 to October 2019 Results: Sinusitis is the most common pathology detected on CT and on final pathological diagnosis followed by polyp.Acute/chronic sinusitis -100% sensitivity and 79.6 % specificity. Polyps - sensitivity of 70.4% and specificity of 98.2%. Fungal sinusitis- sensitivity of 83.3% and specificity of 100%. Mucocele

and rhinosporidiosis was diagnosed with 100% accuracy. Inverted papilloma and carcinoma (poorly differentiated)- specificity 100% for both, sensitivity 66.7% and 75 % respectively. Conclusion: Pathological diagnosis correlated well with the CT diagnosis, proving that it is an ideal modality to evaluate sinonasal pathologies.

(Rege etal 2012) Studied occurrence of maxillary C T in a symptomatic patients and result that abnormalities were diagnosed in 68.2% of cases, There was a significant difference between genders (P≤ 0.001) and there was no difference in age groups, mucosal thickening was most prevalent (66%) followed by retention cysts (10.1%) and opacification (7.8%).

Sheetal D et al. in 2011 conducted a study to correlate between CT findings and endoscopic findings in FESS. This was a time bound cross sectional study design.

45 patients with chronic rhinosinusitis underwent pre-operativeCT paranasal sinuses ,followed by functional endoscopic sinus surgery (FESS).In this study , the uncinate process attachment, the agger nasi,cells and the, anterior and posterior ethmoid sinuses showed excellent correlation .The maxillary sinus did not show good correlation, but this was acceptable. Most of the anatomical abnormalities can be studied on by CT scan and it is mandatory as a pre operative work up in patients who have to undergo FESS.

R. Zojaji MD.et al. in 2008 conducted a study on paranasal sinus CTs of 51patients aged between 15 and 77 who subsequently underwent FESS for chronic rhinosinusitis at two training hospitals during a 2-year period, was performed. They concluded that , combined sinus endoscopy and CT can be considered complementary techniques for effective demonstration of nasal anatomy and paranasal sinuses . CT would be more specific for the assessment of paranasal sinuses and can serve as an anatomic map for the surgeon.

A M M Shahizon,et al in 2008 conducted a cross sectional study of 40 patients diagnosed with chronic rhinosinusitis using nasal endoscopy , and on computer

tomography (CT) of the paranasal sinuses. The purpose of the study is to demonstrate the effectiveness and limitations of CT, and NE in the assessment of chronic rhinosinusitis. This study shows that CT was superior in detecting OM

involvement, presence of concha bullosa, paradoxical turbinate and nasal septal deviation.

Dua K et al. in 2006 conducted a study on all patients undergoing functional endoscopic sinus surgery. Fifty patients of chronic sinusitis were evaluated by CT Scan PNS - coronal and axial views. The anatomical variations and changes in osteomeatal complex on CT Scan were studied. In majority of patients, osteomeatal complex and anterior ethmoids were involved (88%). Agger nasi cells (40%) were the most common anatomical variations followed by concha bullosa (16%). Apart from this deviated nasal septum was found in 44% of patients. The variations found on CT Scan were later confirmed on nasal endoscopy. All the patients then underwent endoscopic sinus surgery.

Chapter Three

MATERIALS AND METHODS

3.1 Materials

3.1.1 Study Design

Descriptive crosssectional study.

3.1.2 Area and duration

The study was conducted at Yastabshiroon Medical Center Khartoum from January to June 2020.

3.1.3 Population

50 patients were enrolled in this study (25 male, 25 female) their age between (10 to 70), referred to CT department for PNS scan.

3.1.4 Equipment used

Japanese Toshiba 16 slices, MDCT scanner using a system of digital image processing.

Fig (3.1) shows the CT scan Toshiba 16 slice machine used (by researcher)

3.1.5 Image Interpretation

All data were evaluated by technologist and diagnosed by radiologist

3.1.6 Data Collecting Tool:

The data was collected using data collecting sheet include the following variables age, gender, lesion, side and site of PNS.

3.2 Methods:

3.2.1 Technique used:

All patients underwent paranasal CT scan using comparaple protocol, 3mm thickness, axial (bone window, soft tissue) and coronal cuts. All patients used head holder. The images were diagnosed by highly experienced radiologists.

3.3 Data analysis:

Descriptive statistics was used to describe the study variables, using the Statistical Package of Social Science (SPSS) version 21 to analyze variables.

3.4 Ethical Consideration:

The data was collected and based on CT findings from reports considering the patient privacy and department approval.

Chapter Four

THE RESULTS

4.1 The Results:

Table (4.1) shows the gender Distribution

GENDER	Frequency	Percent(%)
Male	25	50%
Female	25	50%
Total	**50**	**100%**

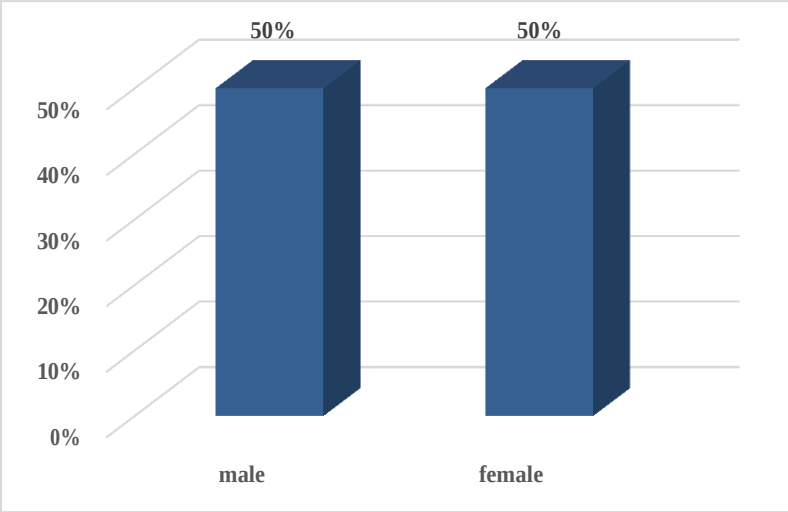


Fig (4.1) shows the gender Distribution

Table (4.2) shows the age Distribution

Age	Frequency	Percent
UNDER 14 YEARS	3	6%
15-29	18	36%
30-44	16	32%
45-59	9	18%
OVER 60 YEARS	4	8%
Total	**50**	**100%**

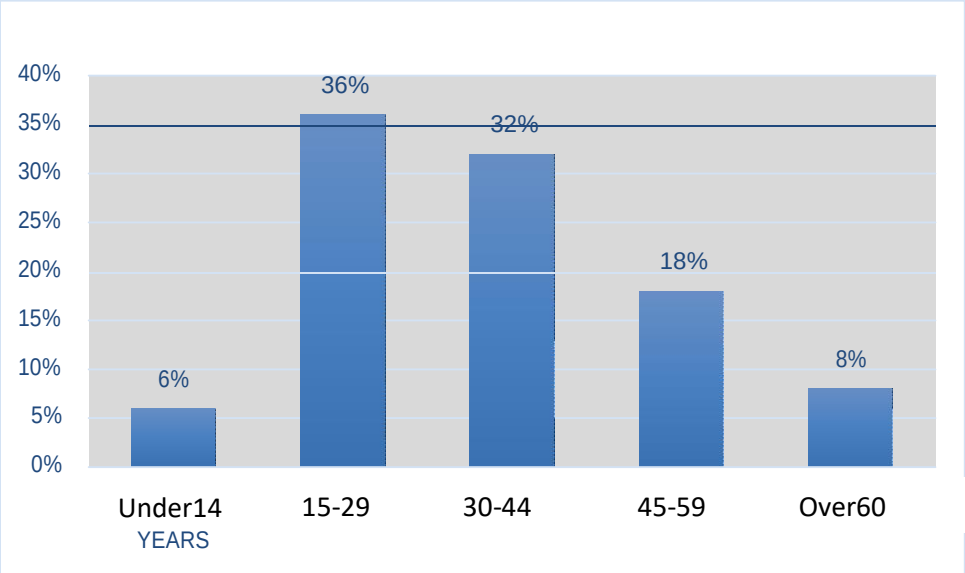


Fig (4.2) shows the age Distribution

Table (4.3) shows the side of pathological lesions

Pathological lesion	Frequency	Percent
Unilateral	19	38%
Bilateral	31	62%
Total	**50**	**100%**

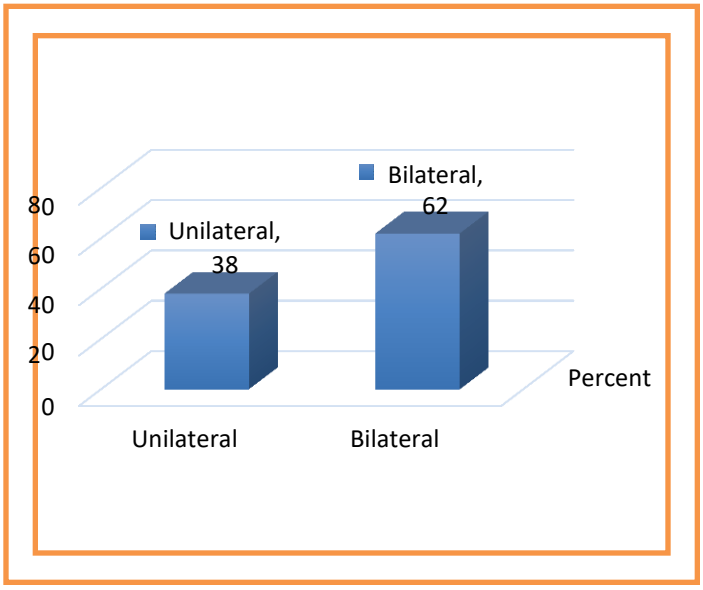


Fig (4.3) shows the side of pathological lesions

Table (4.4) shows the site of paranasal sinuses lesions

site of lesion	Frequency	Percent
Maxillary	25	30%
Sphenoid	21	26%
Ethimoid	22	27%
Frontal	14	17%

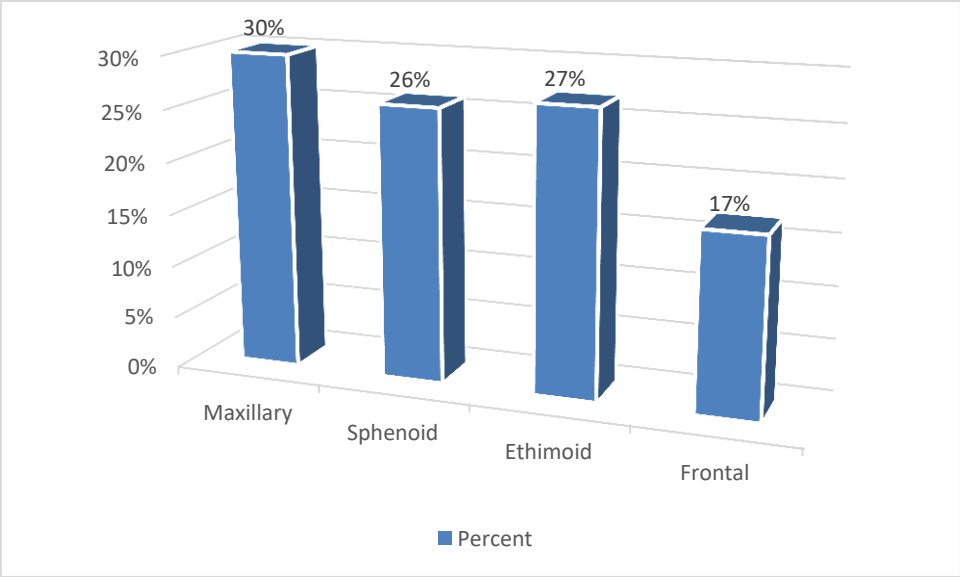


Fig (4.4) shows the site of paranasal sinuses lesions.

Table (4.5) shows the diseases of PNS

Iesion	**Frequency**	**Percent**
chronic sinusitis	17	34%
acute sinusitis	5	10%
antrochoanal polyp	12	24%
mucocoele	2	4%
Malignant mass	4	8%
Cyst	2	4%
nasal septal deviation	1	2%
Fangal infection	2	4%
Rhinosinusities	4	8%
Benign mass	1	2%
Total	**50**	**100**

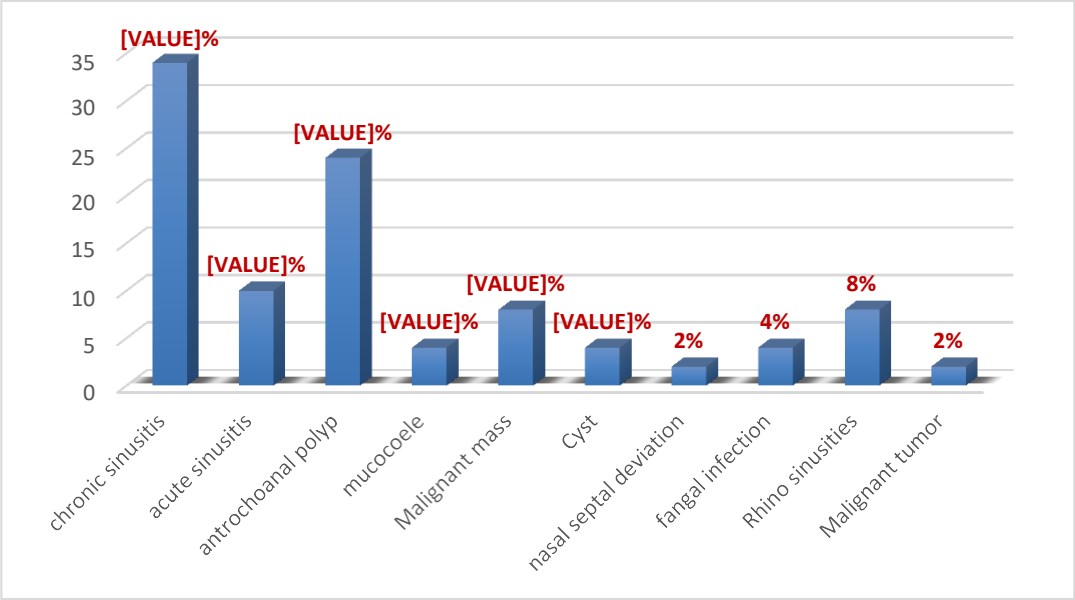


Figure (4.5) shows the common diseases of PNS.

Table (4.6) shows the correlation of the PNS common diseases with gender

Lesion	**Gender**		**Total**
	male	**female**	
Chronic sinusitis	8	9	17
	47%	53%	100%
Acute sinusitis	3	2	5
	60%	40%	100%
Antrochoanal polyp	4	8	12
	33%	67%	100%
PV : 0.013			

Table (4.7) shows the correlation of PNS common diseases with age

Lesion	Age					Total
	Under 15 Years	15-30	30-45	45-60	Over 60 Years	
Chronic sinusitis	1	5	6	2	3	17
	6%	29%	35%	12%	18%	100%
Acute sinusitis	1	2	0	2	0	5
	20%	40%	0%	40%	0%	100%
Antrochoanal polyp	0	7	4	1	0	12
	0%	58%	33%	8%	0%	100%
PV : 0.03						

Table (4.8) shows the correlation of the PNS common diseases with side of Lesion

Lesion	**Side of Lesion**		**Total**
	Unilateral	**Bilateral**	
chronic sinusitis	2	15	17
	11%	48%	34%
acute sinusitis	4	1	5
	21%	3%	10%
antrochoanal polyp	6	6	12
	32%	19%	24%
PV :0.031			

Table (4.9) shows the correlation of the PNS common diseases with site of lesion

Iesion	Maxillary	Sphenoid	Ethimoid	Frontal	Maxillary,Sphenoid,Ethimoid	Maxillary,Sphenoid,Frontal	Maxillary, Sphenoid, Ethimoid, Frontal	Sphenoid,Ethimoid	Sphenoid,Ethimoid,Frontal	Ethimoid,Frontal	Total
chronic sinusitis	7	0	1	0	1	1	2	2	2	1	17
	12%	0%	6%	0%	6%	6%	12%	12%	41%	6%	100%
acute sinusitis	0	1	4	0	0	0	0	0	0	0	5
	0%	20%	80%	0%	0%	0%	0%	0%	0%	0%	100%
antrochoanal polyp	2	4	5	0	0	0	0	1	0	0	12
	17%	33%	42%	0%	0%	05	0%	8%	0%	0%	100%
PV : 0.10											

Chapter Five

Discussions, Conclusion And Recommendations

5.1 Discussions

This study is performed in 50 patient the gender distribution as follow: 50 %(male) and 50% (female) as explain in fig (4.1) their age between (10 -70) years old, in table (4.1).

Referred to CT department, their age frequency as following: Under 14 Years (6%) ,15-29 (36%) ,30-44 (32%) ,45-59(18%) ,Over 60 Years (8%) in
table (4.2) fig (4.2)

Explain the incidence of pathological lesion as follow 25 (50%) bilateral and 25 (50%) unilateral in table (4.3) fig (4.3)

The site of lesions as follow 25 patient (30%) in the maxillary sinus just ,21 patient (26%) in ethmoid sinus just ,22 patient (27%) in sphenoid sinus just, 14 patient (17%) in frontal sinus just , in table (4.4) fig (4.4)

Through the result of the analysis, to the common diseases of PNS we find that 17 patient (34%) having chronic sinusitis, 5 patient (10%) having acute sinusitis, 12 patient (24%) having polyps , 2 patient (4%) having Mucocoele,4 patient (8%) having Malignant mass ,2 patient (4%) having cyst , 1 patient (2%) having nasal septal deviation ,2 patient (4%) having fungal infection ,4 patient (8%) having Rhinosinusities, 1 patient (2%)having Benign mass , All of them were explain in table (4.5) and fig (4.5) .

Table (4.6) shows the correlation of chronic sinusitis, acute sinusitis and antrochoanal polyp with gender, the result found chronic sinusitis is higher in female than male with **Pv : 0.013** the result does not agree with (R. Zojaji MD.et al. in 2008) found that the higher frequency of chronic sinusitis abnormalities in maxillary and ethmoid sinuses, but did not determined the gender. Also relative to

(Rege etal 2012) result was a significant difference between genders ($P \leq 0.001$)

Table 4-7 shows the correlation of chronic sinusitis, acute sinusitis and antrochoanal polyp with Age, determined the chronic sinusitis more occurred in age range (30-44) with **PV : 0.03,** relative to (Olackan – 2013) the age range (11-76) but did not determine the recurrent range age .

Table (4.8) shows the coloration of the diseases of PNS with side of Lesion. Resulted that the higher percentage of PNS on bilateral sides of PNS with **Pv : 0.031**

Table (4-9) shows the coloration of the diseases of PNS with site of paranasal sinuses. Determine the maxillary sinuses is the commonest site of chronic sinusitis with **PV : 0.10**, near to (Olackan – 2013) detected mucosal abnormalities higher in maxillary and ethimoid, agree with (Rege etal 2012) studied occurrence of maxillary CT in asymptomatic patients and result that abnormalities were diagnosed in 68.2% of cases also agree with (R. Zojaji MD.et al. in 2008) found the higher frequency of choronic sinusitis abnormalities in maxillary and ethmoid sinuses.

5.2 Conclusion

CT is modality of choice in imaging of paranasal sinuses for evaluating the chronic diseases, associated complication.

This study was concluded that the pathological lesions is common in rang of age (30_44), bilateral lesions with higher percentage, the disease of chronic sinusitis is common and the common site is maxillary sinuses, the chronic sinusitis affected female more than male.

5.3 Recommendations:

Multidetector computed tomography must be performed for diagnosis of PNS disease because it is more effective and superior than plain X-ray.

The early diagnosis and early treatment of paranasal sinuses reduce the complication.

Future study should compare between the magnetic resonance imaging and the Multidetector computed tomography for diagnosing the paranasal sinuses disease.

Future study should use large sample size for more accurate result.

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https://www.therespiratorysystem.com/paranasal-sinuses/
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https://radiopaedia.org/articles/acute-sinusitis?lang=us
https://www.therespiratorysystem.com/paranasal-sinuses-
https://radiopaedia.org/articles/pott-puffy-tumour?lang=us
https://www.frontiersin.org/files/Articles/395284/fneur-09-00745-HTML/image_m/fneur-09-00745-g001.jpg
https://radiopaedia.org/cases/allergic-fungal-sinusitis?lang=us
https://radiopaedia.org/cases/maxillary-sinus-mycetoma-in-chronic-fungal-sinusitis
https://radiopaedia.org/articles/ acute-invasive-fungal sinusitis?lang=us
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https://radiopaedia.org/articles/sinonasal-polypsis?lang=us
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https://radiopaedia.org/articles/fibrous-dysplasia?lang=us
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https://radiopaedia.org/articles/sinonasl-adenocarcinoma?lang=us
https://radiopaedia.org/articles/sinonasal-undefrentiated-carcinoma?lang=us
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Appendix (A)

Sudan University of Science and Technology

College of Graduate Studies

Data Collecting Sheet:

Patient NO	Gender	Age	Lesion	Side of Lesion		Site of Lesion			
				Unilateral	Bilateral	Maxillary	Sphenoid	Ethimoid	Frontal

Appendix (B)

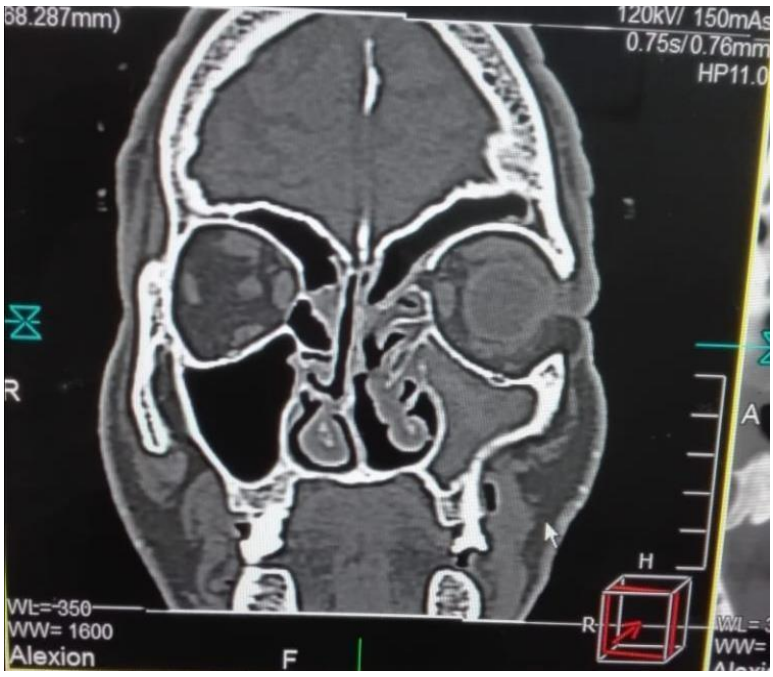

IMAGE 1: shows 35 years old female coronal CT with chronic sinusitis in lt maxillary sinuse

IMAGE 2: shows 43 years old female axial CT image with polyps in ethmoid and maxillary

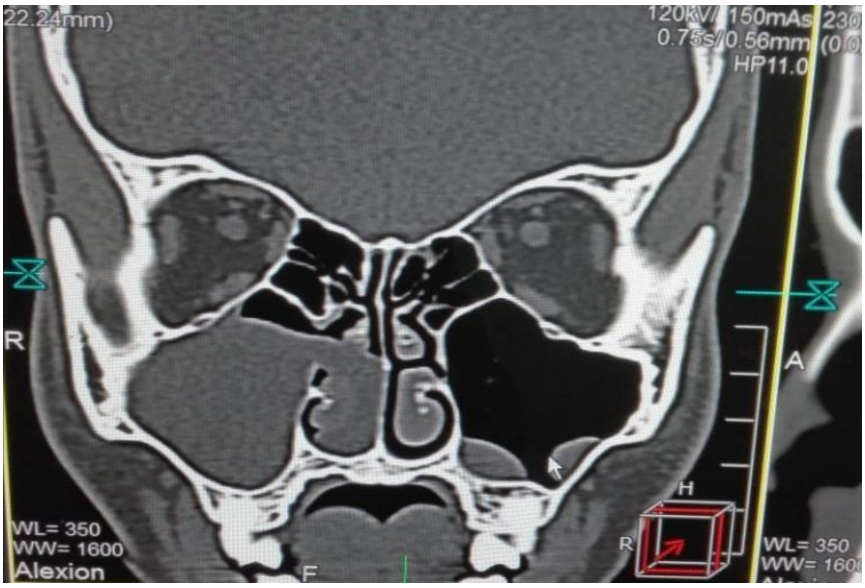

Image 3: shows 30 years old female coronal CT with polyp in rt and lt maxillary and rt ethmoid

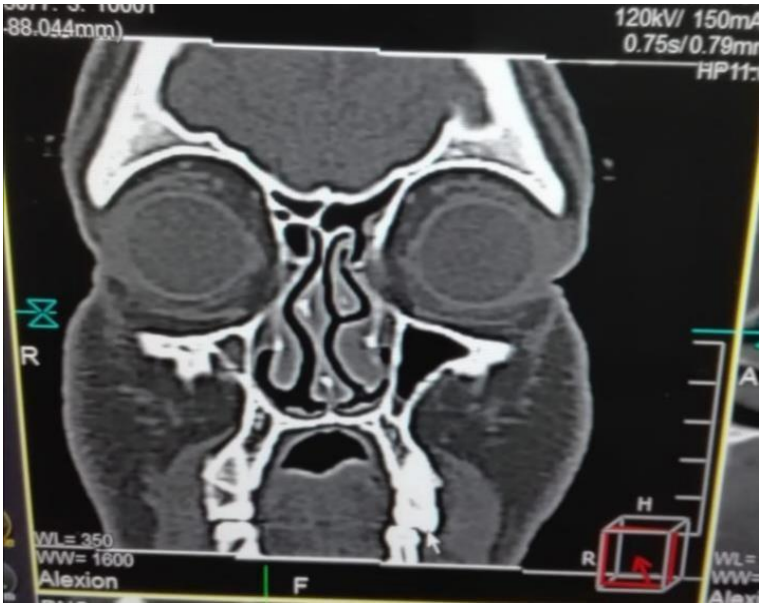

Image 4: shows 40 years old male coronal CT image with acute sinusitis in lt ethmoid