PATTERNS OF DISTRIBUTION OF FRONTAL RECESS CELLS AND SUPERIOR ATTACHMENT OF UNCINATE PROCESS IN PATIENTS UNDERGOING PARANASAL COMPUTED TOMOGRAPHY SCAN AT THE KENYATTA NATIONAL HOSPITAL

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2022

DECLARATION

I, the undersigned, hereby declare this dissertation to be purely my original work and has not been presented before for a degree award in any other university. In places where I have used another person's work, I have ensured proper acknowledgement of so with referencing done.

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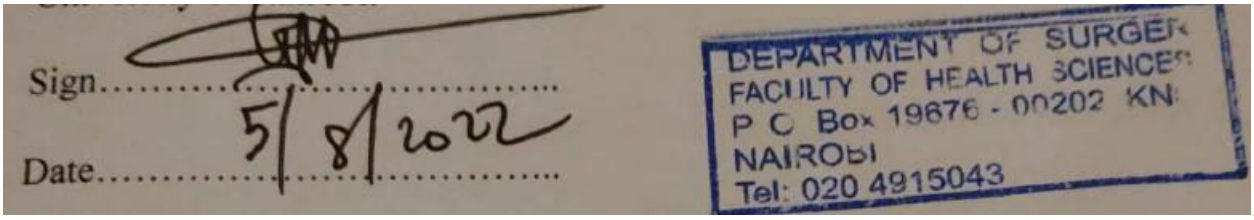


TABLE OF CONTENTS

LIST OF ABBREVIATIONS

ANC - Agger Nasi Cells

CT - Computed Tomography

ESB - Ethmoid Skull Base

ENT - Ear Nose and Throat

ESS - Endoscopic Sinus Surgery

FBC - Frontal Bullar Cells

FC - Frontal Cells

FSDP - Frontal Sinus Drainage Pathway

IFAC - International Frontal Sinus Anatomy Classification

IFSSC - Inter-Frontal Sinus Septal Cells

KNH - Kenyatta National Hospital

MDCT - Multi-Detector Computed Tomography

MPR - Multiplanar Reconstruction

MT - Middle Turbinate

MTCP - Middle turbinate and cribriform plate

RT - Recessus Terminalis

SAC- Supra Agger cell

SAFC- Supra Agger frontal cell

SAUP - Superior Attachment of the Uncinate Process

SBC – Supra-Bullar Cells

SOEC – Supra-orbital Ethmoid Cells

UP - Uncinate Process

LIST OF FIGURES AND TABLES

List of figures

List of Tables

ABSTRACT

Background

Frontal recess cells and superior attachment of uncinate process are key to understanding the drainage of frontal sinus and are important anatomical landmarks during endoscopic sinus surgery. The two have variable anatomical distribution patterns among individuals and are best assessed using a high-resolution computed tomography scan of the nose and paranasal sinus.

Objective

To determine the patterns of distribution of frontal recess cells and superior attachment of uncinate process in patients undergoing paranasal sinuses computed tomographic scan at Kenyatta National Hospital.

Study population: The study involved adult patients 18 years and above undergoing paranasal sinus region imaging.

Study design: This was a descriptive cross-sectional study

Study Setting: The study was conducted at Kenyatta National Hospital Ear, Nose and Throat and Radiology departments.

Methodology

A total of 100 patients undergoing nose and paranasal sinus region CT scan were recruited via convenient sampling method and informed consent obtained. Multiplanar reconstruction CT scan images were obtained and reviewed with a consultant radiologist. The patterns of frontal recess cells and superior attachment of uncinate process was documented.

Results

One hundred CT scans (200 sides) were examined. The mean age was 42years with male: female ratio of 13:7. Out of the 200 sides, 83.5% had an Agger Nasi cell, 16.0% had a Supra Agger Nasi cell, 1.0% had a Supra Agger Frontal cell, 63.0% had a Supra Bulla cell, 6.5% had a Supra Bulla Frontal cell, 1.0% had a Supraorbital Ethmoid cell, and 2.0% had a Frontal Septal cell. In terms of the distribution of superior attachment of the uncinate process type I 44%, type II 6.5%, type III 5%, type IV 5%, type V 17% and type VI 22.5%.

Conclusion

Agger Nasi cell and type I attachment were the most prevalent frontal recess cell and uncinate superior attachment pattern in this population.

1.0 CHAPTER ONE: BACKGROUND

1.1 Introduction

Frontal sinus, one of the four paranasal sinuses, is a paired, anterior sinus situated between the two diploe of frontal bone, deep to the medial part of superciliary arch. It can be viewed as a complex structure having four parts: infundibulum, frontal sinus recess, sinus and frontal ostium. During surgery, these structures and their relationship to the uncinate process are important landmarks. Its anatomy is challenging to surgeons as well as radiologists(1).

Various ethmoidal cells occupy the Frontal sinus recess, affecting the drainage pathway of the frontal sinus. Several classification systems have been proposed in order to understand these cells and better characterize the frontal sinus drainage pathway. Despite the fact that these nomenclatures have boosted our ability to describe the anatomy of Frontal sinus recesses, many of these systems have deficiencies, such as intrinsic discrepancies, subjective inter-observer variations, or even inadequate anatomical details. (2). Through technological advances in endoscopic visualization and high-resolution computed tomography scans, we are now better able to understand the anatomy of the Frontal sinus recess. (3).

Within the past few decades, there has been an increase in the number of frontal sinus surgeries and interest in refining the surgical approaches. In addition, endoscopes, preoperative computed tomography scans, and intraoperative navigation systems are commonly used. Due to its proximity to the brain, orbit, vascular structures such as the anterior ethmoidal artery, and its likelihood of causing iatrogenic complications like sinus stenosis, the frontal sinus has been considered the most challenging and risky sinus to operate. (2). Frontal sinus surgery aims to restore ventilation and drainage. In order to achieve this, ethmoidal disease blocking the Frontal sinus recess needs to be identified and removed. Additionally, failure of endoscopic sinus surgery has been linked to anatomical causes, including persistent Frontal sinus recess obstruction of the Frontal sinus recess. This failure is commonly caused by the anatomical complexity of the Frontal sinus recess (4). In order to ensure the safety of the patient during a complete dissection, it is imperative that the surgeon has a clear understanding of the Frontal sinus recess cells. (5). For safe endoscopic sinus surgery (ESS), one must understand normal anatomical variations (1). Endoscopic intranasal approach has gained favor over the external surgical approaches but sometimes both approaches can be indicated. (6).

1.2 Frontal recess

Frontal sinus recess as a concept is more than a century old. Other terms that have been used before to describe it include nasofrontal duct. The Frontal sinus recess was first described by Killian in 1903, and the pneumatization patterns around the recess were described by Van Alyea later. It is currently known that the Frontal sinus recess plays an important role in endoscopic frontal sinusotomies. (7).

The Frontal sinus recess is basically the area into which the frontal sinus drains. Cells that affect drainage usually occupy this area. It is also described as a complex space resembling an hourglass or an inverted funnel. The apex is located at the frontal ostium. On the medial side of this space is the lateral lamella of the cribriform plate, on the lateral side is the lamina papyracea, on the anterior side, the frontal beak and associated cells, and on the posterior side, the bulla lamella. When it runs in a mesentery off the skull base, the anterior ethmoidal artery is vulnerable to injury if it is situated in the posterior region of the Frontal sinus recess roof. Pneumatization of this space is mostly caused by various anterior ethmoidal cells. Among these cells are agger nasi cells (ANC), frontal cells types 1-4 (FC1-4), supra-orbital ethmoid cells (SOEC), supra-bullar cells (SBC), frontal bullar cells (FBC), and inter-frontal sinus septal cells (IFSSC).). (7). Anatomical conceptualization, surgical planning and intraoperative precision of dissection are essential for preventing complications in this region. (8).

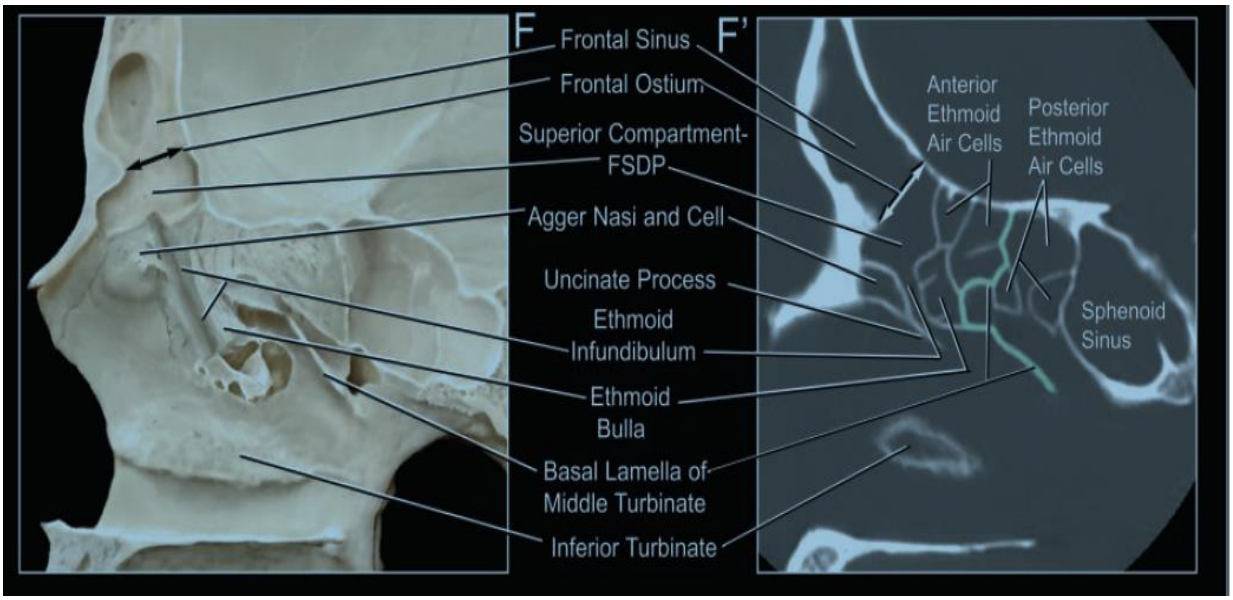


Figure 1: Anatomy of frontal sinus and its drainage pathway: Cadaveric (F) and on CT scan (F'). Courtesy of Daniels,2003(9)

1.3 Classification of frontal recess cells

Over the years, different classification systems have been proposed for Frontal sinus recess cells. Based on cadaveric studies, Van Alyea was the first person to introduce the concept of grouping frontal cells. In line with his findings, frontal cells can be divided into two anatomical types: Frontal sinus recess cells and invading frontal cells. A frontal sinus cell is one that originates in the Frontal sinus recess and extends there, whereas an invading frontal cell is one that invades the

Frontal sinus recess regardless of origin. Subsequently, he sub-classified the two broad groups. Cells in the anterior recess were divided into three groups based on how they expanded: anterior extension of the recess; small cells (small and proportionate but poorly developed and rudimentary); and wide and shallow cells. These invader subgroups included: cells that arose in the Frontal sinus recess and pneumatized into the frontal sinus, inter-sinus cells, infundibular, supra-infundibular, and ethmoid bulla cells (10).

Four types of frontal cells were identified by Bent and Kuhn in 1994. Type I was a single recess cell seen above the agger nasi cell, while Type II was composed of two or more recess cells above the agger nasi cell. Both were best seen in coronal sections of CT scan and could extend up into the frontal sinus. Additionally, they are distinguished from agger nasi cells by their superior location and being inferior to the frontal sinus floor. Type III consisted of a large Frontal sinus recess cell pneumatizing superiorly into the frontal sinus. Type IV is confined wholly within the frontal sinus with its volume varying significantly sometimes appearing like an air bubble within an otherwise opaque frontal sinus or as a cell within a cell. (6)

Lee et al. described frontal sinuses and Frontal sinus recess cells anatomy in 50 adults without known frontal sinus disease using high resolution tri-planar CT images (7). The frontal sinus and recess were functionally defined based on anatomical descriptions and current imaging modalities, from the perspective of a surgical endoscopist. The ten types of cells were described along with the CT scan planes on which they appear best. These cells included Agger nasi cell (ANC), frontal cells - type I-IV (FC I-IV), supraorbital ethmoidal cell (SOEC), Frontal bullar cell (FBC), supra-bullar cell (SBC), Inter-frontal sinus septal cell (IFSSC) and Recessus terminalis (RT) (7). Because of the addition of as yet unrecognized cell types, this system was an improvement over Bent and Kuhn. Despite this, it only gives the nomenclature of the Frontal sinus recess cells without clearly indicating their location at a glance.

Since then, other suggestions have been made on classification. In the European Position Paper on Anatomical Terminology for the Internal Nose and Paranasal Sinuses, cells were classified as anterior, posterior, medial, and lateral (11). Although it gives surgeons a good idea of where a cell is located, it does not provide enough information about the cellular relationships within this region to allow them to plan better (8).

Based on the work of the authors mentioned above, the International Frontal Sinus Anatomy Classification (IFAC), 2016 set forth a new consensus classification system for frontal sinus anatomy. This was in an attempt to have a classification system that took into account the number and position of cells, as well as how that impacted the pattern of frontal drainage. A system such as this will also enhance understanding of the surgical anatomy and methods used in approaching the Frontal sinus recess and its surrounding area. There are three groups of cells in the Frontal sinus recess: anterior, posterior, and medial. Each class has specific cell names and how its defined. There are three types of cells in the anterior region: Agger, supra-agger, and supra-agger frontal cells. Suprabulla cell, suprabulla frontal cell, and supra-orbital ethmoidal cell are the posterior cells, while the medial cell only has the frontal septal cell. In addition, endoscopic sinus surgery is graded on a scale of 0 to 6 according to the extent of the surgery. In grades 0 and 3, the Frontal sinus recess is surgically operated on, rather than the frontal sinus itself, while grades 4 and 6 require bone removal to enlarge the frontal ostium. (8). This is the most current system that is being adopted and the grading system has been recommended for use in graduated form of surgical training and communication amongst surgeons operating in the nose.

TABLE 1. International Frontal Sinus Anatomy Classification (IFAC)

Cell type	Cell name	Definition
Anterior cells - pushes drainage pathway of frontal sinus medially, posteriorly or Postero-medially	Agger nasi cell (ANC)	Cell sitting either anterior to the origin of the middle turbinate or directly above the most anterior insertion of the middle turbinate into the lateral nasal wall.
	Supra-agger cell (SAC)	Anterior-lateral ethmoidal cell, situated above agger nasi cell (not extending into the frontal sinus).
	Supra-agger frontal cell (SAFC)	Anterior-lateral ethmoidal cell extending into the frontal sinus. A small SAFC will only extend into the floor of the frontal sinus, whereas a large SAFC may extend significantly into the frontal sinus and may reach the roof of frontal sinus.
Posterior cells - pushes drainage pathway anteriorly	Supra-bulla cell (SBC)	Cell above the bulla ethmoidalis that does not extend into the frontal sinus.
	Supra-bulla frontal Cell (SBFC)	Cell originating in the supra-bulla region and pneumatizing along the skull base into posterior region of frontal sinus. The skull base forms posterior wall of the cell.
	Supra-orbital ethmoid cell (SOEC)	An anterior ethmoid cell that pneumatizes around, anterior to, or posterior to anterior ethmoidal artery over the orbital roof. It often forms part of the posterior wall of an extensively pneumatized frontal sinus and may only be separated from the frontal sinus by a bony septation
Medial cells- pushes drainage pathway laterally	Frontal septal cell (FSC)	Medially based anterior ethmoid or inferior frontal sinus cell, attached to or located in the inter-frontal sinus septum. It is associated with the medial aspect of frontal sinus outflow tract, pushing drainage pathway laterally and frequently posteriorly.

1.4 Uncinate process

There are four ethmoidal lamellae (superior turbinate basal lamella, middle turbinate basal lamella, uncinate and bulla lamella,) located most anteriorly in the skull. A superior attachment of the uncinate process influences the configuration of the ethmoidal infundibulum and consequently its relation to the Frontal sinus recess. The ethmoidal infundibulum ends blindly superiorly in a pouch known as the terminal recess when the uncinate process turns laterally before inserting into the lamina papyracea. The ethmoidal infundibulum and Frontal sinus recess are separated by this,

which allows the Frontal sinus recess to drain into the middle meatus between the middle turbinate and uncinate process. When the uncinate process is attached to the base of the skull (ethmoid roof) or medially to the middle turbinate, both the Frontal sinus recess and frontal sinus open directly into the ethmoidal infundibulum.

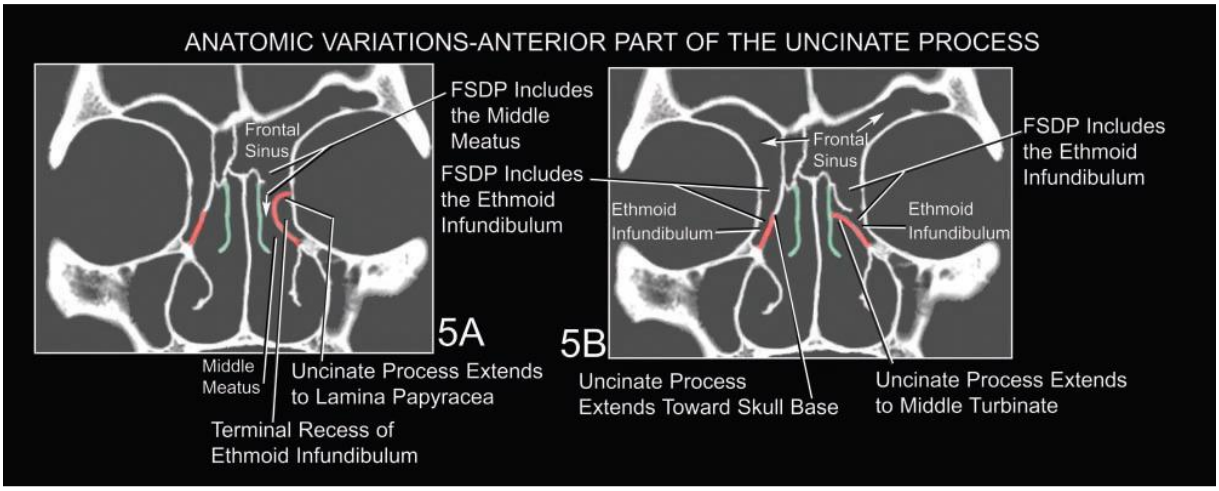


Fig 2: Anatomic variations of SAUP on coronal CT scan sections and its effect on FSDP (5A & B). Courtesy of Daniels,2003(9)

In Frontal sinus recess surgery, the superior attachment of the uncinate process is a vital anatomical landmark. (12). During ESS the uncinate process is the first structure to be removed. Individuals with chronic sinusitis are reported to experience its anomalies the most frequent. (13). It therefore underscores the need for proper dissection in the Frontal sinus recess, adequate exposure of the frontal sinus, as well as the minimization of risks and complications during surgery. Owing to high quality CT scan images, the anatomical variations can be detected pre-operatively.

Understanding the uncinate process and more specifically its superior attachment is therefore important for any surgeon operating in the nose and paranasal sinuses.

1.5 Classification of superior attachment of uncinate process

There are two main classification systems for the superior attachment of the uncinate process (SAUP).

The superior attachment of the uncinate process was first classified in 1991 by Stammberger and Hawke into three patterns: attachment to the lamina papyracea (type I), attachment to the skull base (type II), and attachment to the middle turbinate (type III). However, they did not describe

other extensions or combinations of extensions and their prevalence. In 2001, Landsberg and Friedman categorized the superior attachment into six patterns as shown in table 2 below (12).

Table 2: Types of SAUP according to Landsberg and Friedmann

Type	Description	Frontal sinus drainage
Type I	Insertion into the lamina papyracea (LP).	Medial to infundibulum into middle meatus
Type II	Insertion into the posterior wall of agger nasi cell (ANC).	Medial to infundibulum into middle meatus
Type III	Insertion into the lamina papyracea and junction of the middle turbinate with the cribriform plate (MTCP)	Medial to infundibulum into middle meatus
Type IV	Insertion in to junction of the middle turbinate with the cribriform plate	Into the infundibulum
Type V	Insertion into the ethmoid skull base (ESB)	Into the infundibulum
Type VI	Insertion into the middle turbinate (MT).	Into the infundibulum

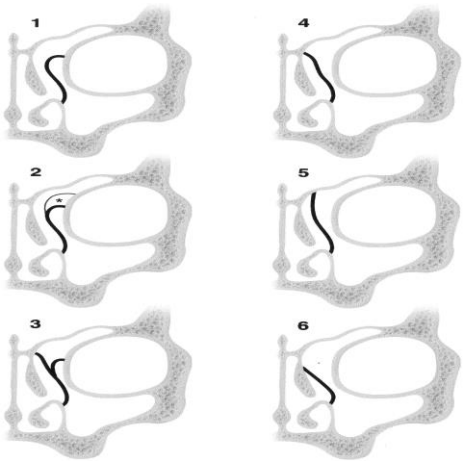


Figure 3: SAUP drawings according to Landsberg and Friedman. (Courtesy of Landsberg and Friedman)(12).

1.6 Imaging for the nose and paranasal sinus

The initial preferred imaging modality for the nose and paranasal sinuses is a CT- scan. This will help delineate the normal anatomy as well as depict pathologies when present. For maximum exploitation of this modality, a tri-planar view with several reconstruction options are available from the axial cuts; recommended is less than 2mm reconstruction slices. A computer work station installed with appropriate multiplanar viewer improves reliability (1,4–6).

Generally, the indications for sino-nasal CT scanning include: evaluation for sino-nasal infectious or inflammatory diseases, sino-nasal tumors, trauma and cerebrospinal fluid leaks. For this anatomical study, paranasal reconstruction images were used.

2.0 CHAPTER TWO: LITERATURE REVIEW

2.1 Patterns of Frontal recess cells

There are several studies on Frontal sinus recess cells distribution based on earlier classification systems (Lee et al and Bent & Kuhn and its modification) (1,3,5,7,14) with limited number based on the IFAC system . This can be justified by IFAC being relatively new, first introduced in 2016 (8). Despite this, similarities in description of cells across the systems exist due to the fact that IFAC consensus classification system was based on the work done by earlier authors(8).

Studies reviewed utilized high resolution CT scan images of nose and paranasal sinuses, maxillofacial or orbit with appropriate viewer that had capabilities of reconstruction in multiplanar or 3D formats (1–3,5,7,14). The protocols used varied but basically ranged from axial images of 0.6mm to 2mm maximum with tri-planar reconstructions. The male to female ratio also varied with some studies having male preponderance(3), others female preponderance(3,5,7,14). There was equal sex distribution (1:1) in one Egyptian study by Shama in 2017(1), this was a comparative study matched for age and sex. Mean age ranged from 44.9 to 51.9 years with the widest range being 18-79 years(1,3,5,7,14).

Studies reviewed that used Lee et al classification criteria reported varied proportions of distribution of each category of Frontal sinus recess cell. The ranges are as follows: FC1 (20%-37.8%), FC2 (6.3%-20.7%), FC3 (4.3%-25.5%), FC4 (0%-13.8%), ANC (86.6%- 95.7%), SOEC (2.6%- 64.6%), FBC (6.1%-24.5%), SBC (11%-39.5%), IFSSC (7.3%-22.2%). RT was not reported in some studies (15), however it ranged from 22% to 66.7%(1,3,5,7,14). Study population also varied. (7) Lee et al. analyzed the anatomy of the Frontal sinus recess in patients without frontal sinusitis. In a retrospective review by Lien et al, 2010, the anatomy of the Frontal sinus recess and its association with frontal sinusitis among Taiwanese adults was compared to that of other Asian adult populations particularly Koreans and Chinese. There was an increase in frontal sinusitis among patients with SOECs, FBCs, and RTs (5). A similar study by Kubota et al, 2015 evaluated the Frontal sinus recess anatomy among Japanese subjects and its association with frontal sinusitis. The results also showed that Japanese adults in the study had similar distribution patterns of Frontal sinus recess cells in comparison to other East Asian populations, namely the Chinese, Koreas, and Taiwanese. Only FBC levels were associated with the development of frontal sinusitis in this study (15). In 2006, Cho et al. compared frontal pneumatization patterns between Koreans and Caucasians and concluded that pneumatization patterns differed among Koreans and Caucasians (3).

An Egyptian case control study by Shama in 2017 on frontal sinus outflow tract using a multi-detector CT (MDCT) scan took 100 individuals and divided them into two groups. The first group (group A) of 50 patients complaining of symptoms attributable to frontal sinusitis as case and a second group (group B) of also 50 patients without symptoms of frontal sinusitis with matched age and sex acted as control group. Their MDCT scans were performed for other indications including headaches, bleeding, trauma, orbital or hearing problems. The study design differed from other studies mentioned as well as the frontal cells distribution. Frontal sinusitis pattern differed in each group with highs being record in type I in group A and type III in group B. It also emphasized the deficiencies of original cell classification system by Bent and Kuhn by adding other categories of cells: type 0- could not be identified, combined type and could not be assed type(1). House et al in 2017 correlated frontal sinus recess anatomy with gender, ethnicity, and pathology. The advantage of this study lied in the large sample size (602 CT scans). This study concluded that FC3 and FC4 have significant association with development of frontal sinusitis. Frontal sinus disease was more likely to affect males than females. They further demonstrated a lack of differences in disease patterns among Caucasians and African Americans(14).

Studies that have used the IFAC criteria have shown variations in pattern of distribution of Frontal sinus recess cells(2,16,17). Sjorgren et al in 2017 studied paranasal CT scans of 95 patients (190sides) above 18 years of age and found pneumatization patterns as follows: ANC- 88.9%, SAC- 29.5%, SAFC- 22.1%, SBC- 55.8%, SBFC- 18.9%, SOEC-11.6% and FSC- 13.2%. Surgically relevant finding was the strong association between SOEC and a low lying anterior ethmoidal artery(16). Another similar study by Choby et al in 2018 reported a slightly different distribution pattern of ANC- 96.5%, SAC- 30%, SAFC- 20%, SBC- 72%, SBFC- 5.5%, SOEC-28.5% and FSC- 30%. One advantage of Choby's study is that it also reported the interclass correlation coefficient (ICC) which showed excellent reliability of all IFAC cells except for SBFC. This supported the effectiveness of IFAC system as far as inter-rater or intra-rater reliability is concerned(2). Sommer et al, 2019 evaluated paranasal CT scans of 249 patients aged between 14 years and 95 years with CRS complains. This study also found varied distribution pattern as ANC-95.2%, SAC- 49.0%, SAFC- 24.9%, SBC- 88.8%, SBFC- 26.5%, SOEC-9.2% and FSC-27.7%(17).

Other reliability studies for the IFAC system include Villarreal 2018 study that measured inter-rater, intra-rater and interclass correlation coefficient among a group of experienced rhinologists. It showed a substantial to almost perfect agreement between and among raters with SBC having the least score- it was reported by some raters as SBFC(18). Another similar study by Assir et al 2020 with the study population being senior residents showed an overall rate of correct classification of the IFAC cells to be initially at 34.4% and in two weeks improved to 43.8%, the ICC was significant for most questions(19). No validity studies are available due to the difficulty in determining the gold standard reference for frontal cells.

2.2 Patterns of superior attachment of uncinate process

Studies that have used Landsberg and Friedman classification system for SAUP have shown varied results(12,20,21). In 2001, Landsberg and Friedman studied one hundred forty-four (288 sides) CT scans for CRS patients planned for ESS after failed medical therapy. They did not report the protocol used for CT scanning; however, tri-planar viewing was applied. Identification of the SAUP was done systematically by initially marking the uncinate process on coronal section then careful scrolling back and forth along the axial plane. This was successful in 173 (60%) of the 288 sides but in 115 (40%) sides they could not identify the SAUP (52 sides (18%) due to mucosal disease, 43 sides (15%) due to previous ESS) and in 20 sides (7%) due to unclear anatomy). Six patterns of superior attachment of the uncinate process were described: lamina papyracea (52%), posteromedial wall of ANC (18.5%), both lamina papyracea and junction of the middle turbinate with the cribriform plate (17.5%), meeting point of the middle turbinate with cribriform plate (7%), ethmoid roof (3.6%), and to the middle turbinate (1.4%). Bilateral similarity of attachment was found in 93% of the scans(12).

Similarly, Turgut et al in 2015 retrospectively evaluated CT scans of same patient population in a different setting using 5mm axial with 1mm sagittal and coronal reconstructions CT scan protocol. This study had a higher number of patients (243; 486sides) and sex ratio was 146:97 (male: female) with mean age of 35.2 ± 4.2 years, range 20-66 years. SAUP was identified 74% (361/486 sides) while the contrary happened in 26% (125/486 sides) due to unclear anatomy. The rate of identification of SAUP was higher than in the Landsberg and Friedman study (74% vs 60%). The frequency of combined type 1 & 2 was at 63% (226 sides), type 3 3% (11 sides), type 4 12% (42 sides), type 5 14% (52 sides) and type 6 8% (30 sides). The combination of type 1 and 2 attachment mode makes it ambiguous to compare this group with other studies. In terms of the relationship between the frontal outflow tract and frontal sinusitis, there was a statistically significant relation in the medially located outflow tract. It was also a common form of outflow compared to lateral one(20).

Kumar et al, 2015 retrospectively evaluated, one hundred patients' CT scans. The CT protocol used was a 3-mm thickness (also different from earlier studies) combination of axial, coronal and sagittal. The mean age was 32.7 years (range 11-75 years) with sex ratio of 54:46 (male: female). SAUP was evaluated in 200 sides. Type 1 19%, type 2 36%, type 3 5%, type 4 2%, type 5 8% and type 6 20%. In 11%, the superior end showed no attachment to surrounding structures(21).

2.3 Study Justification

Frontal sinus recess cells and superior attachment of the uncinate process are crucial anatomical structures that affect frontal sinus drainage pathway (FSDP) and are key landmarks in frontal sinus surgery. Several variations exist in their anatomical patterns further complicating frontal sinus surgery. A local study of paranasal sinus anatomy and variants only reported Agger Nassi cell, one of the cells in IFAC system. It then proposed that further research is needed on the specific

paranasal sinus anatomy(22). Local data on the FSDP, FRC and SAUP is lacking. This study has elucidated Frontal sinus recess cells and SAUP and its effect on the frontal sinus drainage pathway.

2.4 Research question

What are the patterns of distribution of frontal recess cells and superior attachment of uncinate process on CT-Scan in patients undergoing paranasal CT-scan at KNH?

2.5 Objectives

2.5.1 Broad objective

To determine the patterns of distribution of frontal recess cells and superior attachment of uncinate process in patients undergoing paranasal CT-scan at KNH

2.5.2 Specific objectives

1. To describe the demographic features of patients undergoing paranasal CT-scans at KNH
2. To classify the pattern of distribution of frontal recess cells according to IFAC in patients undergoing paranasal CT-scan at KNH
3. To describe the pattern of superior attachment of uncinate process using the Landsberg and Friedman classification system in patients undergoing paranasal CT-scans at KNH

3.0 RESEARCH METHODOLOGY

3.1 Study design

This was a descriptive cross-sectional study

3.2 Study setting

This study was conducted at the KNH ENT and Radiology departments

3.3 Study population

The study population included patients scheduled for head and neck CT scan with nose and paranasal sinus multi-planar reconstruction (MPR) at KNH Radiology department.

3.3.1 Inclusion criteria

All patients, 18years and above, who had been scheduled for head and neck CT scan with nose and paranasal sinus multi-planar reconstruction at KNH during the study period and consented to the study.

3.3.2 Exclusion criteria

1. Patients with destructive paranasal disease obliterating sino-nasal anatomy, specifically FSDP
2. Patients who have undergone prior sinus surgery
3. Patients who have consented but whose CT-scans have significant artifacts which interferes with interpretation of the paranasal anatomy
4. Patients with congenital anomalies affecting the FSDP

3.4 Sample size determination

The sample size was calculated using WHO formula extracted from WHO's Sample size determination of prevalence in health studies. (23)

The sample size formula that was used was:

$n=Z^2p(1-p)/d2$

Where:

n= minimum sample size required

Z= normal standard deviation at 95% confidence level=1.96

p= the anticipated population proportion estimated at the “safest choice” of 50% prevalence for uncertified/ unknown prevalence thus p= 0.5

d= standard margin of absolute precision or error at 10% given to be 0.1

Therefore: $n=1.96^2\times0.5(1-0.5)/0.1^2$

$n=0.96/0.01$

$n=96.04$

There were 96 participants plus 5% (n= 4.8) to cater for possible exit from study hence totaling 100 participants.

3.5 Sampling method

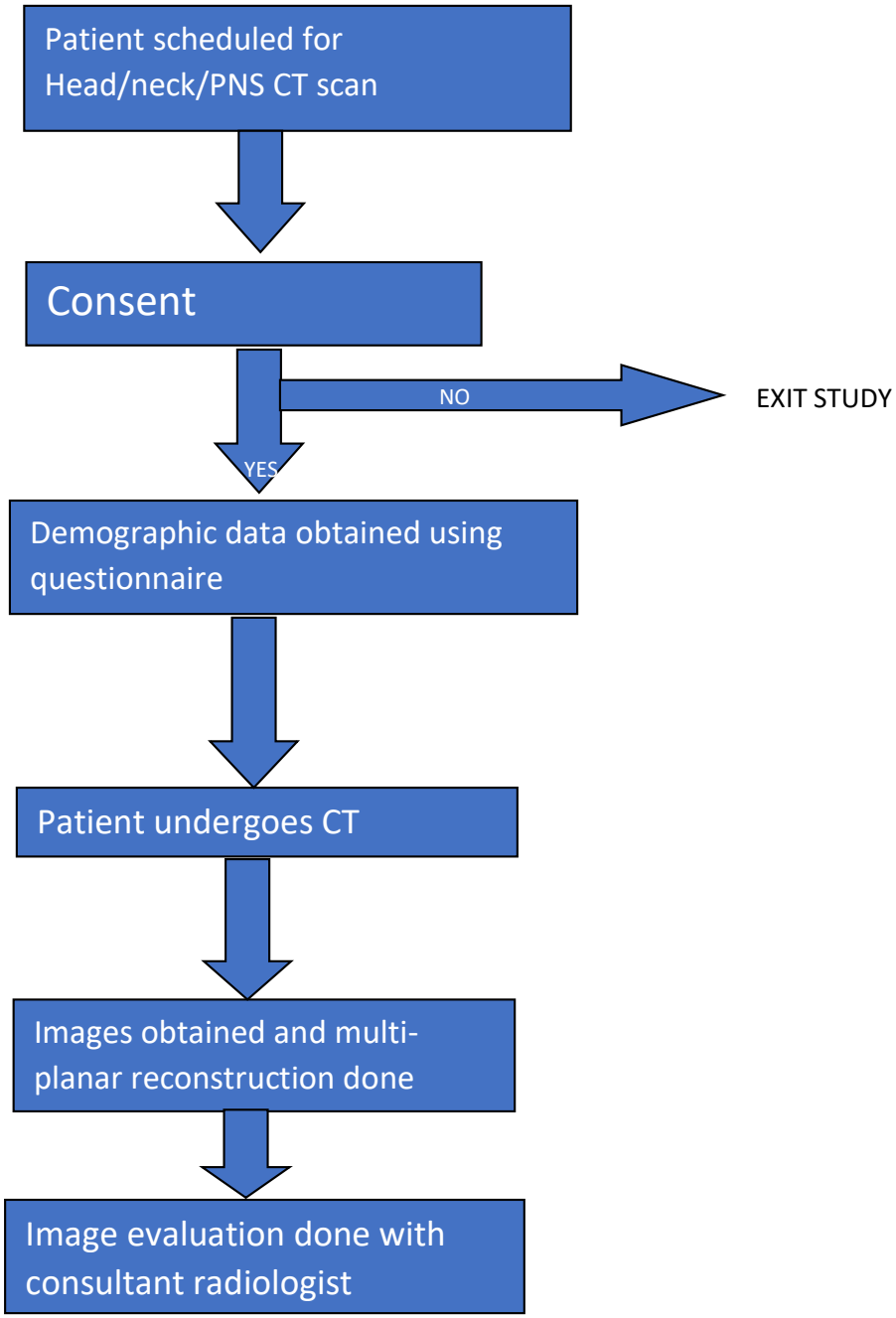
Patients who met the inclusion criteria were recruited using the Convenient sampling method until the desired sample size was achieved.

3.6 Study procedure and equipment

Patients were recruited at the KNH ENT clinic or in the radiology department's reception area before undergoing head and neck CT scans with multi-planar reconstruction of the nose and paranasal sinuses, an independently requested service. The principal investigator explained to all eligible patients and had provided informed consent about the use of their CT scans and their demographic data. After obtaining consent, demographic data of the patients were entered into the data collection sheet (appendix II). All CT scans done were saved in a DVD disk which the researcher and a radiologist reviewed at a work station in the department of radiology.

The Computed tomography scan machine employed at KNH was Neusoft 64 Slice CT, Model: NeuViz 64In, SN: N64IN170152E manufactured by Neusoft Medical Systems taking standard axial scans by helical technique (140kV, 250mA, rotation time of 0.75 seconds, routine section thickness of 1mm with 1mm reconstructions) with an inbuilt viewer. Head and neck CT scans used similar protocol as pure paranasal sinus CT scans with axial cuts of 1mm and possibility of MPR reconstructions of 1mm.

Figure 4: Study procedure flow chart



3.7 Data management

Upon assessment of the nose and paranasal sinus MPR CT scans, the findings were recorded on the data collection sheet (Appendix II). A lockable drawer was used to store all forms and signed consents in the Department of Surgery (ENT Section). A password-protected computer contained the electronic copy of the data. Radiology consultant and supervisors were the only ones who had access to the data.

3.8 Data analysis

In this study, results were presented in text, graphs, charts, and tables. Univariate analysis was used for descriptive analysis. A mean and median were calculated for age. For the analysis of gender and age distribution, multivariate cross tabulations were used.

Multivariate cross tabulations used to examine the class distribution according to gender and age group and their statistical significance calculated using Fisher's exact test where significance was given by a p value of <0.05. The data analysis was performed using IBM SPSS statistical software (Version22) and Microsoft excel (version 2016).

3.9 Quality control

The principal researcher reviewed all CT in coordination with the same consultant radiologist. All the images were evaluated using the same viewer. Machine was up to date in terms of service and calibration.

3.10 Ethical consideration

The ethics committees at KNH and UoN approved the study prior to its execution. Permission from KNH administration was obtained. The study was voluntary and participants gave verbal and written consent. Patients were not subjected to additional procedures other than the ones usually done during any other head/neck/ nose and paranasal CT scanning. There were no additional expenses incurred or any unique risk by participating in this study. Neither refusal nor participation in the study resulted in victimization or preferential treatment. On the study data collection sheet, no names were recorded and all patient information was kept confidential.

In order to ensure safety of study participants, the KNH-UON ERC- guidelines on conducting research during the Covid-19 pandemic were used. (KNH-UoN/ERC/FORM/RGCOV-19). Hospital specific protocols regarding patient contact while being handled in specific departments was adhered to for the level of risk. This includes appropriate personal protective equipment,

hygiene measures: sanitization, hand washing; and social distance where applicable and appropriate for the level of risk.

KNH-UON ERC- guidelines on conduct of research during the covid-19 pandemic was used to ensure safety of study participants and the researcher (KNH-UoN/ERC/FORM/RGCOV-19). Hospital specific protocols regarding patient contact while being handled in specific departments was adhered to for the level of risk. This includes appropriate personal protective equipment, hygiene measures: sanitization, hand washing; and social distance where applicable and appropriate for the level of risk.

3.11 Study limitations

The limitations identified at the proposal stage were mitigated by using standard imaging protocols.

3.12 Study results dissemination

In addition to publication in peer-reviewed journals, the results of the study will be presented at scientific meetings to the medical fraternity. Hard copies of this research will be store in the UoN library, department of surgery and ENT department. An electronic copy of the research will be available at the University of Nairobi e-repository

4.0 RESULTS

4.1 Demographic data

Distribution of patients according to gender and age.

The mean age and sex distribution of the patients in the study are as shown in the table below.

Table 3: Demographic characteristics

Variable	n (%)
Age in years	
Mean (SD)	42.0 (17.5)
Min-max	18.0-89.0
Sex	
Male	65 (65.0)
Female	35 (35.0)

4.2 Patterns of frontal recess cells according to international frontal sinus anatomy classification (IFAC)

Out of the 200sides examined, Agger nasi cells were found in majority of the CT scans, contributing 83.5%. The right had 81% and the left 86%. SBC was second most common cell encountered at 63% with right side having 59% and left 67%. SOEC and SAFC were the least common cells at 1% each with right side having 0% and left 2% for SOEC and 2% vs 0% right vs left for the SAFC respectively. The other distribution is as shown in the table and figures below.

Table 4: Patterns of frontal recess cells

Cell type (n=200 sides)		Cell name (n=200 sides)	
Category	**Frequency (%)**	**Category**	**Frequency (%)**
Anterior cells	168 (84.0)	Agger nasi cell (ANC)	167 (83.5)
		Supra-agger cell (SAC)	32 (16.0)
		Supra-agger frontal cell (SAFC)	2 (1.0)
Posterior cells	132 (66.0)	Supra-bulla cell (SBC)	126 (63.0)
		Supra-bulla frontal cell (SBFC)	13 (6.5)
		Supra-orbital ethmoid cell (SOEC)	2 (1.0)
Medial cells	4 (2.0)	Frontal septal cell (FSC)	4 (2.0)

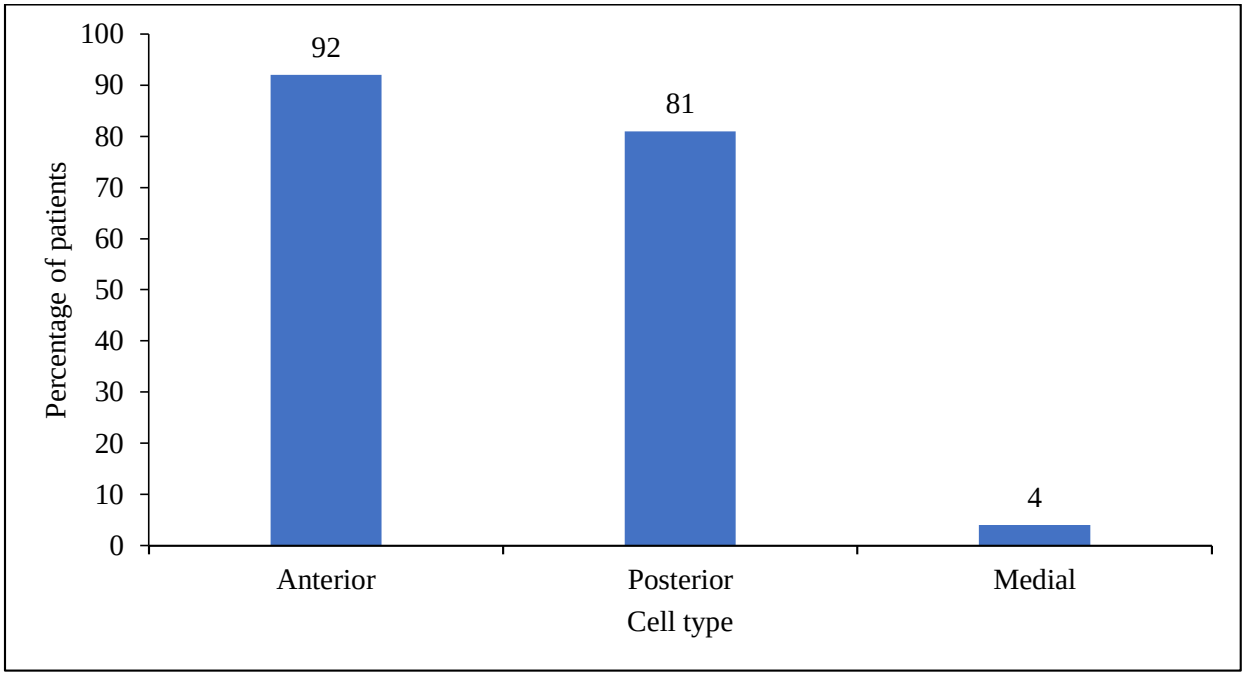


Figure 5: Class distribution of frontal cells

Table 5: Laterality of Frontal recess cells

Cell	Laterality (n=100 patients)		
	Bilateral	**Unilateral**	**None**
Agger nasi cell (ANC)	75 (75.0)	17 (17.0)	8 (8.0)
Supra-agger cell (SAC)	7 (7.0)	18 (18.0)	75 (75.0)
Supra-agger frontal cell (SAFC)	0	2 (2.0)	98 (98.0)
Supra-bulla cell (SBC)	47 (47.0)	32 (32.0)	21 (21.0)
Supra-bulla frontal cell (SBFC)	3 (3.0)	7 (7.0)	90 (90.0)
Supra-orbital ethmoid cell (SOEC)	0	2 (2.0)	98 (98.0)
Frontal septal cell (FSC)	0	4 (4.0)	96 (96.0)

4.3 Landsberg and Friedman classification and Drainage patterns of the superior attachment of the uncinate process (SAUP)

Out of the 200sides examined, the most common attachment pattern was type I (attachment to the lamina papyrecia) at 44% with the right having 40% and left 48%. This was followed by type VI (attachment to the middle turbinate) at 22.5% with right having 25% and left 20%. Type III and IV had the least distribution, both at 5%. In terms of frontal sinus drainage, drainage into the middle meatus occurred in 55.5% while into the infundibulum was at 44.5%.

Table 6: Patterns of superior attachment of uncinate process & frontal sinus drainage pattern

Type (n=200 sides)		**Frontal sinus drainage (n=200 sides)**	
Category	**Frequency (%)**	**Category**	**Frequency (%)**
Type I	88 (44.0)	Into middle meatus	111 (55.5)
Type II	13 (6.5)		
Type III	10 (5.0)		
Type IV	10 (5.0)	Into the infundibulum	89 (44.5)
Type V	34 (17.0)		
Type VI	45 (22.5)		

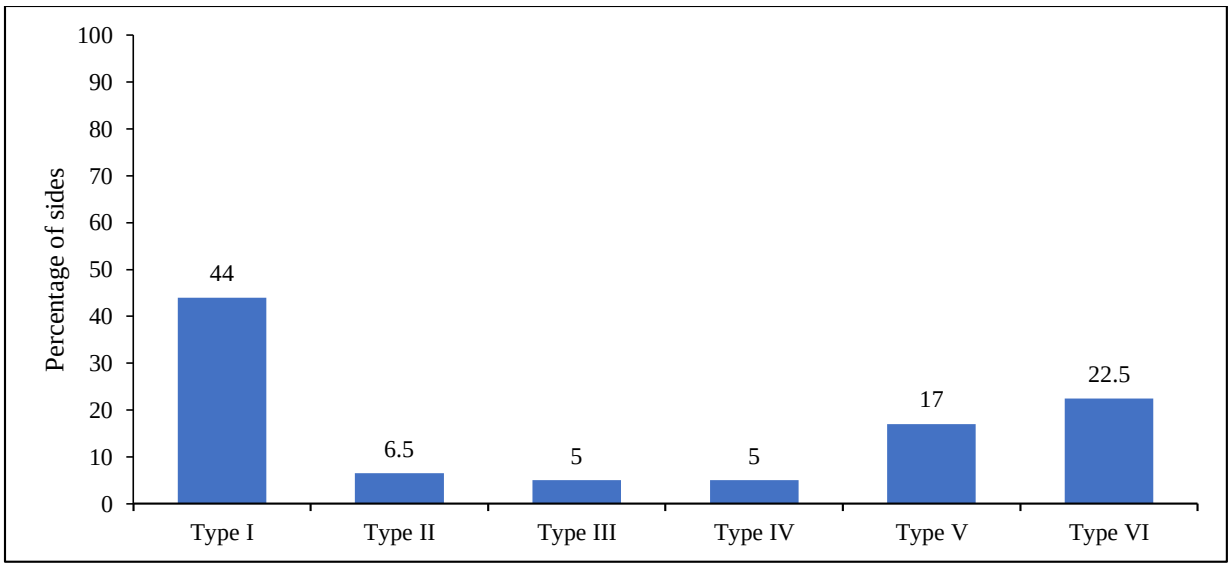


Figure 6: Pattern of distribution of SAUP

Table 7: Association between frontal recess cells and frontal sinus drainage pattern based on SAUP

Cells	Drainage		P value
	Middle meatus	Infundibulum	
Anterior cells	96 (86.5)	72 (80.9)	0.284
Posterior cells	72 (64.9)	60 (67.4)	0.705
Medial cells	3 (2.7)	1 (1.1)	0.630
Agger nasi cell (ANC)	96 (86.5)	71 (79.8)	0.204
Supra-agger cell (SAC)	17 (15.3)	15 (16.9)	0.768
Supra-agger frontal cell (SAFC)	2 (1.8)	0	0.504
Supra-bulla cell (SBC)	66 (59.5)	60 (67.4)	0.247
Supra-bulla frontal cell (SBFC)	8 (7.2)	5 (5.6)	0.650
Supra-orbital ethmoid cell (SOEC)	2 (1.8)	0	0.504
Frontal septal cell (FSC)	3 (2.7)	1 (1.1)	0.630

There was no statistically significant association between any of the frontal recess cells with the frontal outflow tract pattern based on SAUP.

5.0. Discussion, conclusion and Recommendations

5.1. Discussion

The anatomy of the Frontal sinus recess affects the pattern of drainage of the frontal sinus. Frontal sinus recess cells and the SAUP are key anatomical structures that contribute to the drainage pattern of frontal sinus, both of which vary in patterns of distribution depending on population under study. Several classifications have been used in describing the patterns of distribution of Frontal sinus recess cells as well as SAUP. In this study we evaluated the patterns using the IFAC criteria for Frontal sinus recess cells and Landsberge and Friedman for the SAUP.

In terms of the demographic characteristics, the mean age was 42 years with a range of 18-89 years and a male: female ratio of 13:7. The lower age limit of 18 years had been predetermined in the inclusion criteria since at that age the frontal sinus anatomy is expected to have fully developed. The average age and sex distribution is similar to other studies reviewed (1,3,5,7,14) and the range corrects for any age related variability in anatomy if any. The mean age was comparable to the other studies which ranged from 44.9 to 51.9 years with the widest range being 18-79 years(1,3,5,7,14). In studies reviewed, the male to female ratio varied with some studies having male preponderance, similar to this current study, and others female preponderance(3,5,7,14). There was equal sex distribution (1:1) in one Egyptian study (1), this was a comparative study matched for age and sex. The variant sex ratios may reflect the varied population from which the subjects were drawn from for CT scanning. Some used reconstruction images from head, neck, maxillofacial and others were purely nose and paranasal sinus CT scans. This current study used paranasal sinus reconstruction images from head CT scans, nose and paranasal sinus and few high resolution temporal bone CT scans. The CT scanning protocols used in the setting was 1mm axial cuts with possibility of multiplanar reconstruction (MPR). This did not affect the ability to visualize cells or attachment type since recommended cuts is less than 2mm.

The most common pattern of distribution of Frontal sinus recess cells was the Aggar Nasi at 83.5% (200sides) followed by the supra bulla cell at 63%. This is similar to the pattern seen by Choby et al, Sommer et al, Sjorgen et al in terms of the top two common frontal cell types. In comparison with other studies that have used the IFAC criteria, there have been variations in terms of proportions in pattern of distribution of Frontal sinus recess cells (2,16,17) as depicted in table 8 below. The study samples ranged from 95 patients in Sjorgren et al study to 249 patients in Sommer et al study. In Sommer's study, patients had CRS complains hence able to draw a clinical correlation.

Table 8: Comparison of pattern of distribution of Frontal sinus recess cells

Author	**Frontal sinus recess cell pattern of distribution in %**						
	ANC	**SAC**	**SAFC**	**SBC**	**SBFC**	**SOEC**	**FCS**
Sjorgen et al [16]	88.9	29.5	22.1	55.8	18.9	11.6	13.2
Choby et al [2]	96.5	30.0	20.0	72.0	5.5	28.5	30.0
Sommer et al [17]	95.2	49.0	24.9	88.8	26.5	9.2	27.7
Sargo et al	83.5	16.0	1.0	63.0	6.5	1.0	2.0

This current study concurs with patterns observed in all the above studies in terms of the most common and second most common cell type (ANC and SBC respectively) as well as a local study done by Maalim that showed ANC to be the most common cell in his study population (22). Cells that pneumatize into the frontal sinus (SAC, SAFC, SBFC, SOEC and FCS) represented smaller percentages relative to other studies reviewed. This may be a unique pattern in the population under study and one may postulate that there may be lower incidence of isolated frontal sinus disease in this population due to theoretically reduced chance of narrowing of frontal sinus drainage pathway by such cells.

The superior attachment of the uncinate process also showed a wide variability in comparison with other studies. The most common pattern of attachment seen was type I at 44% followed by type VI at 22.5%. Other patterns and comparisons are as depicted in table 9 below.

Table 9: Comparison of patterns of distribution of SAUP

Author	SAUP pattern of distribution in %					
	Type I	**Type II**	**Type III**	**Type IV**	**Type V**	**Type VI**
Landsberge & Friedman[12]	52	18.5	17.5	7.0	3.6	1.4
Turgut et al[20]	63.0		3.0	12.0	14.0	8.0
Kumar et al[21]	19.0	36.0	5.0	2.0	8.0	20.0
Sargo et al	44.0	6.5	5.0	5.0	17.0	22.5

Compared to patterns seen in Landsberg and Friedman study whose population was patients with CRS, most common attachment type was to the lamina papyracea, type I (52%), similar to our study. Other patterns were variably distributed with the least being type VI, unlike in our study (type VI was the second most common). Bilateral similarity of attachment was found in 93% of the scans (12). In Turgut et al study, combination of type I and II attachment mode makes it difficult to compare this group with other studies. In terms of the relationship between the frontal outflow tract and frontal sinusitis, Turgut et al found a statistically significant relationship in the medially located outflow tract and frontal sinusitis. It was also a common form of outflow compared to lateral one (20), similar to our study where in terms of frontal sinus drainage, drainage into the middle meatus (medial group) occurred in 55.5% while into the infundibulum (lateral group) was at 44.5%. Our study was anatomical; we did not look into the incidence of frontal sinusitis versus pattern of drainage. Lastly, Kumar et al study had a contrasting pattern to our study with type II being the most common. In 11%, the superior end showed no attachment to surrounding structures (21). One advantage of our study is that we were able to demonstrate SAUP in all the scans unlike Landsberge and Friedman, Kumar et al and Turgut et al who were unable to demonstrate SAUP in 40%, 11% and 26% of their population (12,21,20).

5.2 Conclusion

In our study population, the most common pattern of Frontal sinus recess cells was the Aggar nasi cell while type I form of superior attachment of the uncinate process and medial drainage into infundibulum being predominant.

5.3. Recommendations

The surgeon should thoroughly study the patterns of both the frontal recess cells and superior attachment of the uncinate process on CT scans in order to determine the pattern of frontal sinus

drainage pathway, plan appropriate surgery for the frontal recess and subsequently carry out complete clearance of cells during frontal sinus surgery. These patterns should also be part of imaging reporting protocol for paranasal sinus CT scans by the radiologist.

Timelines

Year	2020												2021							
Month Activity	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	March,2022
Concept development																				
Proposal Writing																				
Proposal presentation																				
Ethics Approval																				
Data Collection																				
Data Analysis																				
Presentation of Results																				

Budget

ITEM	UNIT PRICE	COST (KSH)
Flash disk and Hard drive	9 000	9 000
Statistician	30 000	30 000
Printing	10 per page	5 000
Binding	500	5 000
Photocopying services	3	10 000
Publishing fee	45 000	45 000
TOTAL		104 000

The budget was funded through a grant by the KNH research and funding committee to a tune of Ksh. 80,100.

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APPENDICES

Appendix I: Consent Form

PATTERNS OF DISTRIBUTION OF FRONTAL RECESS CELLS AND SUPERIOR ATTACHMENT OF UNCINATE PROCESS IN PATIENTS UNDERGOING PARANASAL COMPUTER TOMOGRAPHY AT THE KENYATTA NATIONAL HOSPITAL

English version

This Informed Consent form is for Patients who are undergoing nose and paranasal sinus computed tomography (CT) at Kenyatta National Hospital (KNH).

Principal Investigator: Dr. Kennedy Kipkoech Sargo

Institution: School of Medicine, Department of Surgery (Otolaryngology, Head and Neck) University of Nairobi

Supervisors: 1) Professor Isaac Macharia – Professor and Consultant Otorhinolaryngologist

2) Dr. Sophie Gitonga - Consultant Otorhinolaryngologist

3) Dr. Wangari Felista- Consultant radiologist

This form has three parts:

I. Information sheet

II. Consent statement

III. Research statement

Part I: Information sheet

My name is Dr Kennedy Kipkoech Sargo, I am a postgraduate student at the Department of Surgery (ENT) in The School of Medicine, University of Nairobi. I am the principal researcher, carrying out a study to determine the " PATTERNS OF DISTRIBUTION OF FRONTAL RECESS CELLS AND SUPERIOR ATTACHMENT OF UNCINATE PROCESS IN PATIENTS UNDERGOING PARANASAL COMPUTER TOMOGRAPHY AT THE KENYATTA NATIONAL HOSPITAL ". This will be determined by evaluation of the nose and paranasal CT scans that you will undergo as independently requested by your primary clinician. I am inviting

you to participate in my study at your free will. You will be given the opportunity to ask questions before you accept and you may talk to anyone you are comfortable with about the research before making your decision. You may seek any further clarification from me or my supervisors through the contacts given below.

Study background

There are several variations in the patterns of frontal sinus drainage pathway. This is mainly affected by two factors: the frontal recess cell and superior attachment of the uncinate process. These anatomical variations impact on frontal sinus disease occurrence and are useful in surgical planning.

Broad objective

The study aims to describe the anatomical variations and their prevalence in our set up by using scans taken of the nose and paranasal sinus.

Voluntariness and role of participation

Your participation is voluntary and no coercion or inducement will be experienced. If you agree to participate, your main role in this study is to consent to the use of the scans of the nose and paranasal sinus. These scans will be examined for the structural differences also known as anatomical variants. You will also be asked to provide some minimal information about you/ your patient.

Confidentiality

Your name will not appear in data collection sheet. You will only be identified by a number and only the principal researcher and supervisors can relate the number to you. This information will not be shared with anyone outside the study unless authorized by the Kenyatta National Hospital/University of Nairobi - Ethics and Research Committee (KNH/UoN-ERC).

Costs and compensation

There will be no extra cost incurred for participating in this study. The scans you will undergo are independently requested by your primary clinician at his/her discretion and not by the researcher. No inducement or compensation will be provided.

Benefits of the study

The results of this research will be beneficial as they may help reduce risks during sinus surgeries by describing the variant anatomy in our local setup as well as explain disease processes of the nose and paranasal sinus.

Risks

You will not be exposed to any unique risks if you consent to participate. The main requirement will be nose and paranasal scan that you will undergo as requested independently by your clinician.

Right to withdraw

You will not be denied medical care in case you refuse to participate in or withdraw from the study. You may stop participating at any time with no consequences whatsoever.

Ethical issues

All the information that you give us will be used for this research study only. Only the researcher and the supervisors are privy to your raw information. Confidentiality will be maintained as no names will appear in the data collection sheet. All hard copy data will be stored safely in a lockable cabinet in the Department of Surgery, UoN. All soft copy data will be password protected.

This proposal will be reviewed and approved by the KNH/UoN-ERC. It will be submitted to them through the Chairman of the Department of Surgery at the School of Medicine of the University after approval by my university supervisors.

Part II: Consent Statement

I……give my/ my patient's (if guardian) consent …… to take part in the study conducted by Dr Kennedy Kipkoech Sargo, the nature of which has been explained to me. I have been informed and have understood that my participation is entirely voluntary and I understand that I am free to withdraw my consent at any time if I so wish and that my withdrawal will not compromise the care given to me/my patient.

…… …….

Signature (indicate if guardian) Thumb Print

Date……

Day/Month/Year

Study Number…….

CT scan Number……..

Statement by the witness (where applicable)

I have witnessed the accurate reading of the consent form to the participant, and the individual has had the opportunity to ask questions. I confirm that the individual has given consent freely.

Name of witness……

Signature of witness/ Thumb Print ……..

Date……..

Day/Month/Year

Please feel free to seek additional information through the contacts given below;

Secretary, KNH/UoN-ERC

P.O. Box 20723 KNH, Nairobi 00202

Tel 020726300-9

E-mail: uonknh_erc@uonbi.ac.ke

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P.O. Box 19676 KNH, Nairobi 00202

Mobile phone 0723646313

E-mail; kennsargo@gmail.com

Part III: Researcher's Statement

I, the undersigned, have fully explained the relevant details of this research study to the aforementioned participant. The participant has understood what the research study entails and has willingly given consent. I confirm that no coercion or inducement for participation was undertaken.

Name ……..

Signature ……Date…….

IDHINI KWA KISWAHILI

FOMU YA IDHINI

Fomu hili lina sehemu tatu

I. Maelezo ya Mtafiti Mkuu

II. Fomu ya Idhini

III. Kiapo cha Mtafiti

(i) Sehemu ya kwanza –Maelezo ya Mtafiti Mkuu.

Mimi ni Dkt. Kennedy Kipkoech Sargo, kutoka chuo kikuu cha Nairobi, Shule ya Utabibu, Idara ya upasuaji, sehemu ya ENT. Ninafanya utafiti wa kubainisha "PATTERNS OF DISTRIBUTION OF FRONTAL RECESS CELLS AND SUPERIOR ATTACHMENT OF UNCINATE PROCESS IN PATIENTS UNDERGOING PARANASAL COMPUTER TOMOGRAPHY AT THE KENYATTA NATIONAL HOSPITAL", kubainasha maumbile tofauti katika mifupa za mapua kulingana na picha spesheli aina ya CT scani.

Utafiti huu unaangalia umbo la mfupa wa pua na kudhibitisha tofauti zinazopatikana katika mfupa huu bila tofauti hizi kuwa magonjwa haswa. Tofauti hizi mara nyingi hufanya upasuaji wa mfupa

huu wa pua kuwa mgumu zaidi. Kujua tofauti hizi kutasaidia katika kupanga upasuaji wa mfupa huu na kupunguza madhara ya upasuaji ambayo yanaweza kuletwa na tofauti hizi. Ningependa kukuchagua / kuchagua mgonjwa wako katika utafiti huu. Kukubali kwako ni kwa hiari yako na sio kwa kulazimishwa. Kukataa kwako hakutadhuru matibabu unayopata/ mgojwa wako anafaa kupata, hautakatazwa matibabu kwasababu ya kukataa kujiunga na utafiti huu. Kujiunga na utafiti huu hakutakudhuru au kudhuru mgojwa wako kwa njia yoyote kwani kile kinachohitajika ni picha ya CT scan ya mfupa wa pua ambao umefanywa au utafanywa kulingana na maagizo ya daktari wako. Habari zozote zitakazokusanywa kutoka kwako zitashughulikiwa kwa usiri na hazitasambazwa kwa yeyote ila tu kwa ruhusa kutoka kwa kamiti kuu ya utafiti ya chuo kikuu cha Nairobi na hospitali kuu ya Kenyatta (KNH/UON ERC).

(ii) Sehemu ya pili– Idhini ya mgonjwa

Mimi(Jina)……..……
….... kwa hiari yangu, nimekubali kushiriki katika utafiti huu ambao unafanywa na Daktari Kennedy Kipkoech Sargo. Nimeelezewa manufaa na madhara ya utafiti huu kwa undani na nimeyaelewa.

Jina la Mgonjwa/mchungaji wa mgonjwa ……

Sahihi/ Kidole Gumba- ……...

Tarehe……..

Siku/Mwezi/Mwaka

Nambari ya utafiti……..

Nambari ya picha(CT scan)……

Jina la Shahidi……

Sahihi……..…….
Tarehe…….

(Siku/Mwezi/Mwaka)

Unaweza kupata uchambuzi wa utafiti huu na maelezo zaidi kutoka kwa:

Katibu wa utafiti, Hospitali kuu ya Kenyatta na Chuo kikuu cha Nairobi (KNH/UON ERC).

Sanduku la Posta 20723 00202.

KNH, Nairobi, Kenya

Nambari ya simu: 020726300-9.

Profesa Isaac Macharia

Sanduku la Posta 19676- 00202

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Dkt. Wangare Felista

Sanduku la Posta 19676-00202

Nairobi, Kenya

Nambari ya simu: 0202726300

Mtafiti Mkuu: Dkt Kennedy Kipkoech Sargo

Sanduku la Posta 19676-00202

Nairobi, Kenya

Nambari ya simu ya rununu: 0723646313

Barua pepe: kennsargo@gmail.com

(iii) Sehemu ya tatu – Kiapo cha mtafiti

Naapa ya kwamba nimeelezea mgonjwa manufaa na madhara yote yanayohusu kusajiliwa katika utafiti huu. Mgonjwa ameelewa yote yanayohitajika na yanayohusu utafiti huu na usajili wake. Idhini yake imepewa kwa hiari yake bila kulazimishwa au kuahidiwa pesa, zawadi au matibabu ya ziada.

Jina la mtafiti/ Msimamizi……

Sahihi…… Tarehe……

(Siku/Mwezi/Mwaka)

Appendix II: Data Collection Sheet

STUDY NUMBER …… CT scan No……

BIODATA

Initials: ……..

Age (Years)…….. Sex: Male/ Female

Indications for CT Scan ……..

Radiological diagnosis ……

1. Checklist for variations in patterns of frontal recess cells according to International Frontal Sinus Anatomy Classification (IFAC)

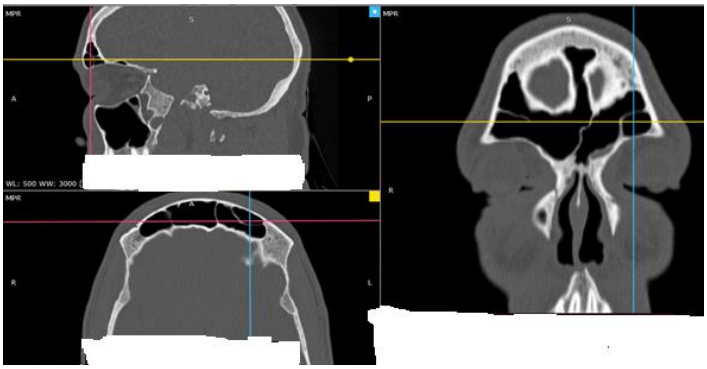
Cell type	Cell Name	Side and Finding				Remarks
		Right		Left		
		Present	Absent	Present	Absent	
Anterior cells (push the drainage pathway of the frontal sinus medial, posterior or posteromedially)	Agger nasi cell (ANC)					
	Supra agger cell (SAC)					
	Supra agger frontal cell (SAFC)					
Posterior cells (push the drainage pathway anteriorly)	Supra bulla cell (SBC)					
	Supra bulla frontal Cell (SBFC)					
	Supraorbital ethmoid cell (SOEC)					
Medial cells (push the drainage pathway laterally)	Frontal septal cell (FSC)					
Others (describe clearly)						

1. Checklist for variations in patterns of superior attachment of uncinate process (SAUP) according to Landsberg and Friedman classification

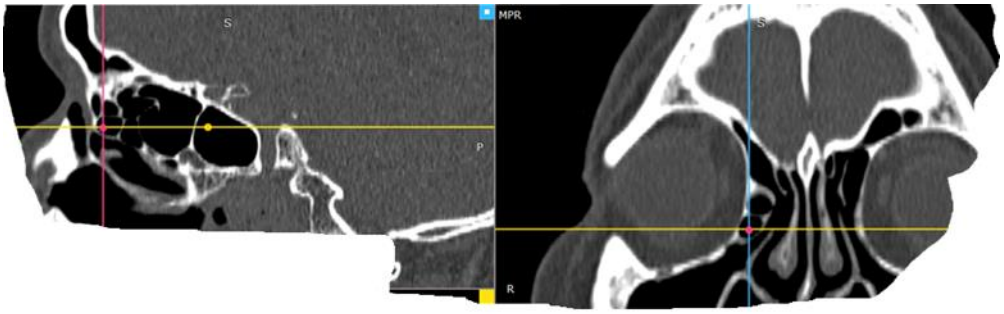
Type of Uncinate process attachment	Side and finding	Remarks

	Right		Left		
	Present	Absent	Present	Absent	
Type 1 (Insertion into lamina papyrecea)					
Type 2 (Insertion into the posterior wall of agger nasi cell)					
Type 3 (Insertion into the lamina papyracea and junction of the middle turbinate with the cribriform plate (MTCP)					
Type 4 (Insertion in to junction of the middle turbinate with the cribriform plate)					
Type 5 (Insertion into the ethmoid skull base (ESB)					
Type 6 (Insertion into the middle turbinate (MT).					
Others (describe clearly)					

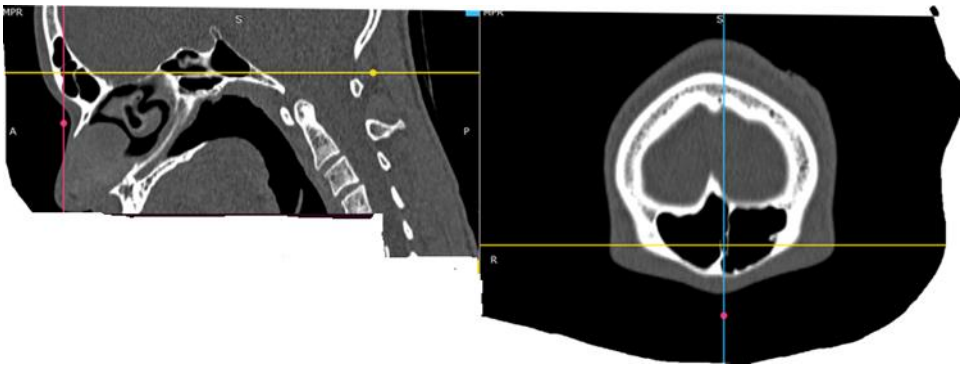
Appendix III: Sample images for frontal recess cells



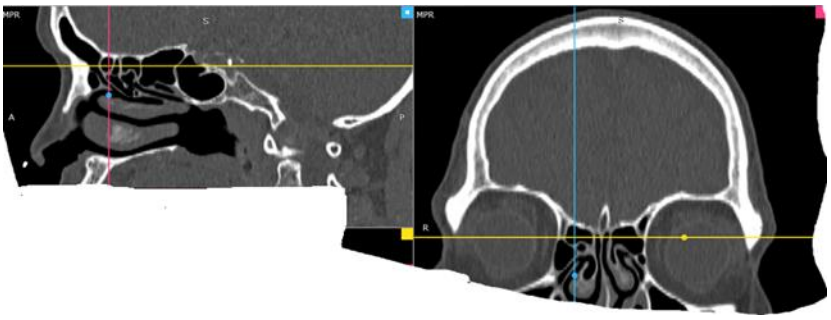
SOEC (Image ID 18)



AN (Image ID 49)

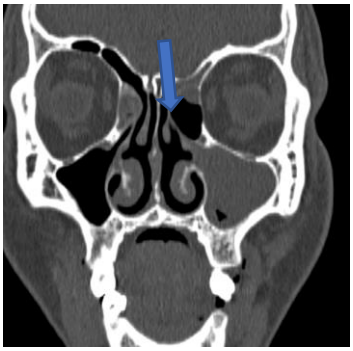


IFSSC (Image ID 74)

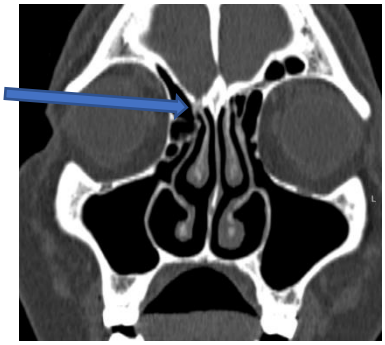


SBC (Image ID 51)

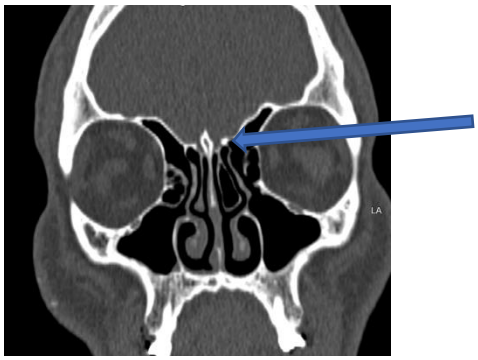
Appendix IV: Sample images for types of superior attachment of uncinate process



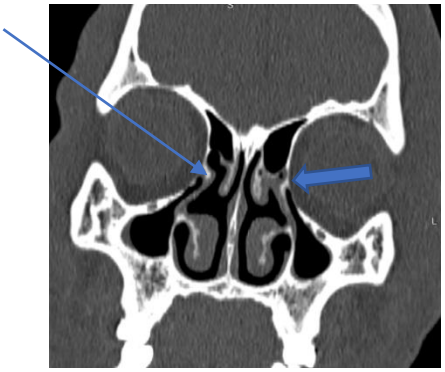
Types I & VI (ID 42)



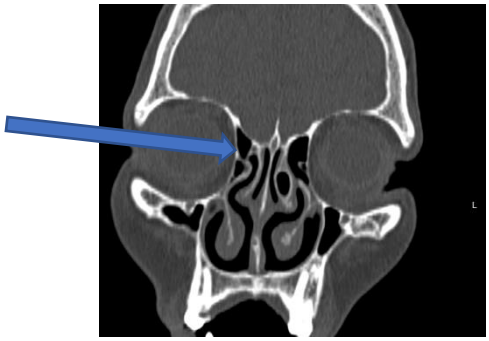
Type IV (ID 49)



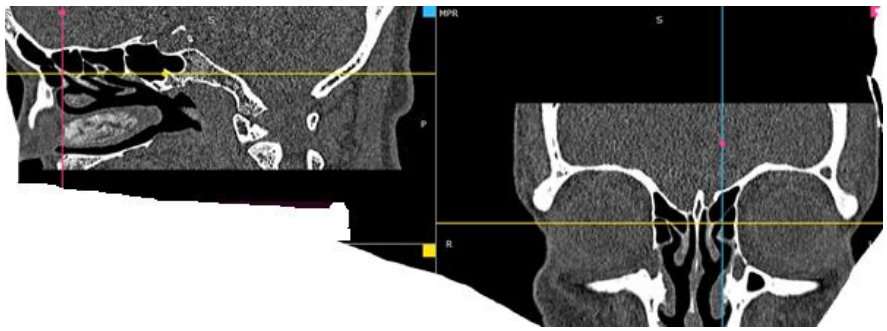
Type V (ID 87)



Type I (ID 85)

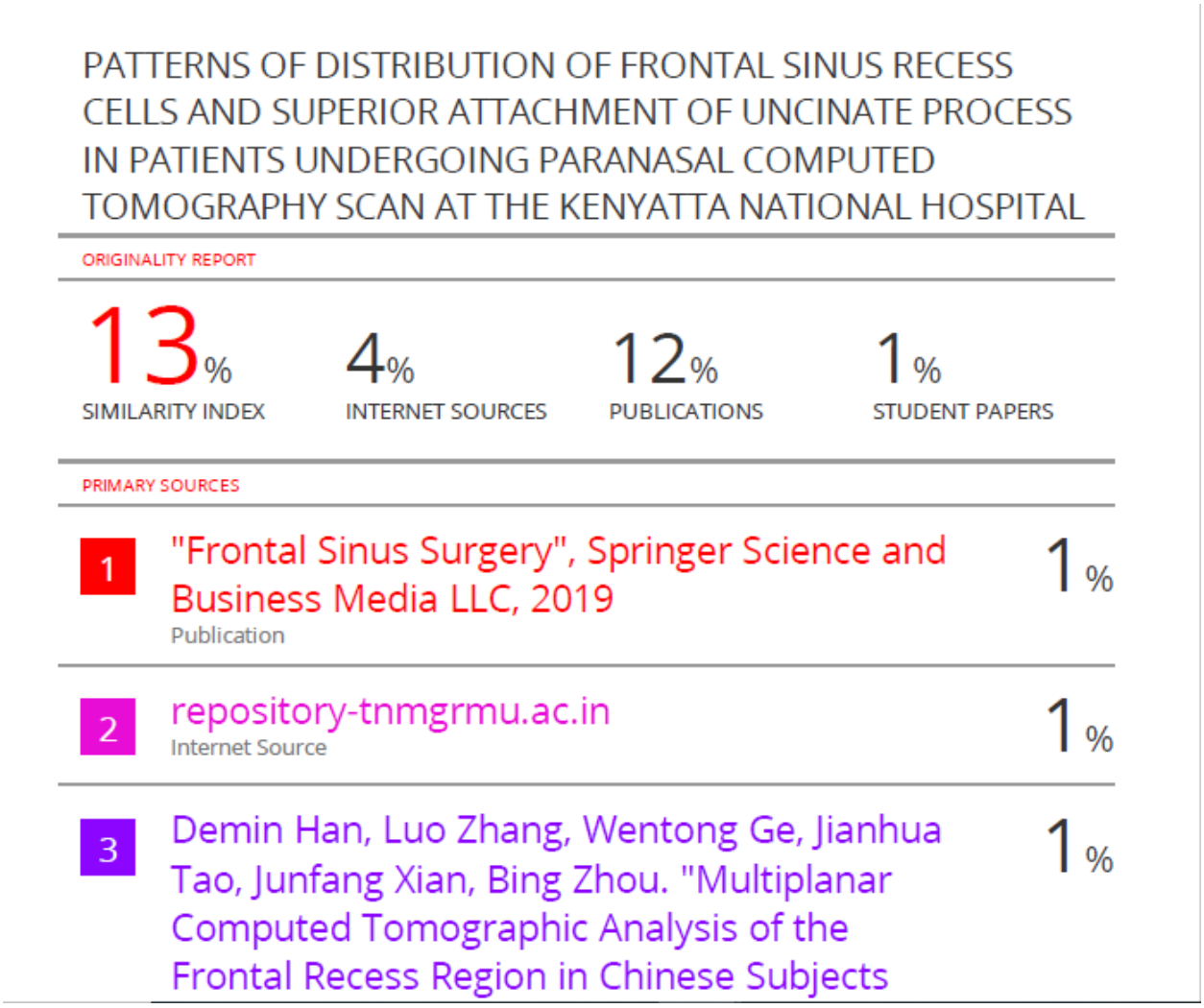


Type III (ID 53)



Type II (ID 99)

Appendix V: Plagiarism report



PATTERNS OF DISTRIBUTION OF FRONTAL SINUS RECESS CELLS AND SUPERIOR ATTACHMENT OF UNCINATE PROCESS IN PATIENTS UNDERGOING PARANASAL COMPUTED TOMOGRAPHY SCAN AT THE KENYATTA NATIONAL HOSPITAL

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