A MORPHOMETRIC EVALUATION OF NASAL SEPTUM IN RHINOSINUSITIS PATIENTS AND ASSOCIATION WITH ITS SEVERITY

By

DR ABDUL MOKHTI BIN ABDULLAH

Dissertation Submitted In Partial Fulfillment of The Requirements
For The Degree of Master of Medicine
(Otorhinolaryngology – Head And Neck Surgery)

UNIVERSITI SAINS MALAYSIA

2016

In The Name of ALLAH

The Most Beneficient

The Most Merciful

ACKNOWLEDGEMENTS

I would like to address my utmost thanks to my main supervisor, Profesor Dr Baharuddin Bin Abdullah, and my co supervisors Dr Ramiza Ramza Ramli (who is currently The Head of the Department, Department of Otorhinolaryngology – Head and Neck Surgery, School of Medical Sciences, Universiti Sains Malaysia) Dr Norhafiza Binti Mat Lazim lecturer in the Department of Otorhinolaryngology – Head and Neck Surgery, School of Medical Sciences, Universiti Sains Malaysia and Dr Ayzam Bin Ahmad, ENT Surgeon Department of Otorhinolaryngology – Head and Neck Surgery Hospital Sultanah Bahiyah Alor Setar.

I would also like to forward my utmost gratitude to Dr Zul Izhar Mohd Ismail, a senior lecturer in Department of Anatomy, School of Medical Sciences, Universiti Sains Malaysia, Associate Profesor Dr Meera Mohaideen Abdul Karem, a senior lecturer in the Department of Radiology, School of Medical Sciences, Universiti Sains Malaysia, and Mr Kunasekaran Sinnasamy, a senior radiographer in the Department of Radiology Hospital Sultanah Bahiyah Alor Setar, for their great assistance and guidance during the preparation of this precious dissertation. Without their expert advice and gracious comments, this research could not have been possible.

My special thanks to the Department of Radiology, Universiti Sains Malaysia and Hospital Sultanah Bahiyah for allowing me to use the department's instruments and radiology workstation for my work. Without their help, expertise and good assistance this work would have not become a reality.

I would also like to address my utmost thanks to the Associate Profesor Dr Azriani Binti Ab Rahman, a senior lecturer in Department of Community Medicine, School of Medical Sciences, Universiti Sains Malaysia statisticians for helping me in statistical analysis and sample size calculation.

My appreciation to all lecturers and fellow colleagues for providing me with good encouragement and support.

Finally, to my beloved wife and kids, to whow I dedicate this research. Without their love and support, none of this would have been worthwhile. Thank you very much

TABLE OF CONTENTS

CONTENTS **PAGE**

CHAPTER 4

CHAPTER 5

CHAPTER 6

CHAPTER 7

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

CRF - Case report form

CT - Computed tomography

DNS - Deviated nasal septum

HRCT - High resolution computed tomography

HSB - Hospital Sultanah Bahiyah

HUSM - Hospital Universiti Sains Malaysia

MRI - Magnetic Resonance Imaging

OMC - Osteomeatal complex

ORL - Otorhinolaryngology

PNS - Paranasal sinus

QOL - Quality of life

SMR - Submucous resection

VAS - Visual analogue scale

ABSTRAK DALAM BAHASA MELAYU

PENGENALAN

Peranan septum hidung dalam penyakit ‘rhinosinusitis’ masih lagi tidak jelas. Memandangkan septum hidung bengkok di dalam populasi mempunyai insiden yang tinggi, kajian tentang kaitan di antara septum hidung bengkok dengan penyakit ‘rhinosinusitis’ adalah amat menarik. Terdapat data yang tidak menentu di dalam kajian-kajian sebelum ini berkenaan dengan peranan septum hidung bengkok dengan penyakit ‘rhinosinusitis’, jadi kajian berkenaan dengan subjek ini adalah amat bernilai untuk menambah input di dalam subjek ini. Dengan mengetahui kaitan antara septum hidung bengkok dengan penyakit ‘rhinosinusitis’ satu langkah kehadapan dalam merawat penyakit ini diharap dapat dilaksanakan.

OBJEKTIF

Tujuan kajian ini secara umumnya adalah untuk mengkaji tentang bentuk septum hidung di dalam pesakit ‘rhinosinusitis’ dan kaitannya dengan keterukan penyakit ini. Secara khusus adalah untuk melihat kaitan di antara sudut kebengkokan septum hidung dan jenis septum hidung bengkok berdasarkan ‘klasifikasi Mladina’ dengan keterukan penyakit ‘rhinosinusitis’ berdasarkan skor simptom, ‘visual analog scale (VAS) dan skan tomografi berkomputer.

METODOLOGI

Satu kajian telah dilakukan di mana kami telah mengkaji 98 pesakit ‘rhinosinusitis’ tentang tahap keterukan simptom pesakit berdasarkan skor simptom dan ‘visual analog scale’ (VAS) mengkaji imej skan tomografi berkomputer untuk menilai jenis septum hidung bengkok berdasarkan ‘klasifikasi Mladina’, sudut kebengkokan septum hidung dan skor skan tomografi

berkomputer. Imej – imej ini adalah dari sudut pandang axial dan koronal dengan ketebalan potongan 3.0 mm. Data-data telah dianalisa menggunakan ujian ‘One Way ANOVA test’.

KEPUTUSAN

Sudut kebengkokan septum hidung yang telah direkodkan adalah seperti berikut : normal (sudut kurang daripada 5^o) sebanyak 7 kes (7.1%), tahap sedikit (sudut antara 5^o – 10^o) sebanyak 54 kes (55.1%), tahap sederhana (sudut antara 10.1^o – 20^o) sebanyak 37 kes (37.8%) dan tiada kes dalam tahap teruk (sudut lebih daripada 20^o). Manakala jenis kebengkokan septum hidung berdasarkan ‘klasifikasi Mladina’, majoriti adalah jenis 1 dalam 33 kes (32.6%) diikuti oleh jenis 3 sebanyak 27 kes (26.5%), jenis 4 dalam 14 kes (15.3%), jenis 2 dalam 12 kes (12.2%), jenis 6 dalam 8 kes (8.2%), jenis 5 dalam 4 kes (5.1%) dan tiada kes untuk jenis 7. Majoriti pesakit (62.0%) mempunyai tahap sederhana dalam skor simptom, skala analog penglihatan dan skor ct scan. Didapati terdapat kaitan antara sudut kebengkokan septum hidung dengan keterukan penyakit ‘ rhinosinusitis’ berdasarkan skor simptom dan skala analog penglihatan ($p<0.05$). Didapati tiada kaitan antara skor skan tomografi berkomputer dan jenis kebengkokan septum hidung berdasarkan ‘klasifikasi Mladina’ dengan keterukan penyakit ‘rhinosinusitis’ ($p>0.05$).

KESIMPULAN

Sudut kebengkokan septum hidung memainkan peranan dalam penyakit ‘rhinosinusitis’ memandangkan terdapat kaitan antaranya dengan keterukan penyakit ‘rhinosinusitis’ berdasarkan kajian ini. Ini bermakna semakin teruk sudut kebengkokan septum hidung maka semakin tinggi kebarangkalian pesakit mempunyai masalah ‘rhinosinusitis’ yang teruk.

Sebaliknya didapati tiada kaitan antara jenis kebengkokan septum hidung berdasarkan ‘klasifikasi Mladina’ dengan keterukan penyakit ‘rhinosinusitis’.

ABSTRACT

INTRODUCTION

The role of nasal septum in rhinosinusitis patient still remain unclear. Given the high incidence of deviated nasal septum in the population, the study about their association with rhinosinusitis is interesting. There are conflicting data in literatures regarding the role of DNS in rhinosinusitis, it is worth in studying this subject to give some input in this field of knowledge. By knowing the association between the DNS and rhinosinusitis one step ahead can be advocated in the management of rhinosinusitis.

OBJECTIVES

The aim of the study was to evaluate the morphometry of nasal septum in rhinosinusitis patient and to associated with its severity. To look for association between angulation and type of DNS based on Mladina classification with severity of rhinosinusitis based on symptom score, visual analogue scale (VAS) and CT scan score.

METHODOLOGY

A cross sectional study was done in which we evaluated 98 rhinosinusitis patients for symptoms severity and reviewed their CT scan of paranasal sinus . Their CT scan paranasal sinus obtained was 3.0 mm thicknesses in axial and coronal planes with high resolution technique. Symptoms severity was assessed via symptoms score and visual analogue scale (VAS). Whereas type of DNS according to Mladina classification, degree of septal angle deviation and CT scan score were obtained by reviewed the CT scan. The data were analysed using One Way ANOVA test.

RESULT

The prevalence of angulation and type of DNS were recorded: normal (angulation $< 5^o$) in 7 cases (7.1%) , mild (angulation $5^o – 10^o$) in 54 cases (55.1%), moderate (angulation $10.1^o – 20^o$) in 37 cases (37.8%) and no subject in severe ($> 20^o$) category. In term of Mladina type, majority are type 1 in 33 cases (32.6%) followed by type 3 in 27 cases (26.5%), type 4 in 14 cases (15.3%), type 2 in 12 cases (12.2%), type 6 in 8 case (8.2%), type 5 in 4 cases (5.1%) and type 7 are nil. Majority of the patient (62.0%) had a moderate symptom score, visual analogue scale and ct scan score. There was an association between angulation of DNS with severity of rhinosinusitis based on symptom score, visual analogue scale ($p<0.05$). There were no association between CT scan score and Mladina type of DNS with severity of rhinosinusitis ($p>0.05$).

CONCLUSION

Septal deviation angle of DNS play a role in rhinosinusitis as there was an association between severity of septal deviation angle with severity of rhinosinusitis. The more severe the septal angle deviation the more likelihood the severity of rhinosinusitis. However there were no association between type of DNS based on Mladina classification with severity of rhinosinusitis.

CHAPTER 1

INTRODUCTION

A morphometric evaluation of nasal septum in rhinosinusitis patients and association with its severity

1.0 INTRODUCTION

1.1 ANATOMY OF THE NOSE AND PARANASAL SINUS

The complexities of the nose and paranasal sinus anatomy, as well as their multiple functions make the sinuses an interesting topic to study. There are total of four paired sinuses which include the frontal, ethmoid, maxillary and sphenoid sinuses (Figure 1.1 & 1.2). They are divided into anterior and posterior groups of sinuses depending upon their common draining areas and functions. Anterior group of the sinuses comprised of maxillary, frontal and anterior ethmoidal air cells. While posterior group of the sinuses comprised of sphenoid sinus and posterior ethmoidal air cells. These sinuses are essentially mucosa-lined airspaces within the bones of the face and skull. The anterior group of sinuses drain into the middle meatus while posterior ethmoid sinus drain into the superior meatus and sphenoid sinus drain into the sphenoethmoidal recess.

1.2 OSTEOMEATAL COMPLEX (OMC)

The terminology of OMC or osteomeatal unit was first described by H. Nauman in 1965 (Xavier P, 2003). It is a functional term for anterior group of sinuses drainage system and is defined as region situated lateral to anterior 2/3 of middle turbinate (Figure 1.3). This includes agger nasi, uncinate process, bulla ethmoidalis, remaining anterior ethmoidal cells, hiatus semilunaris, osteum of maxillary sinus and frontal recess.

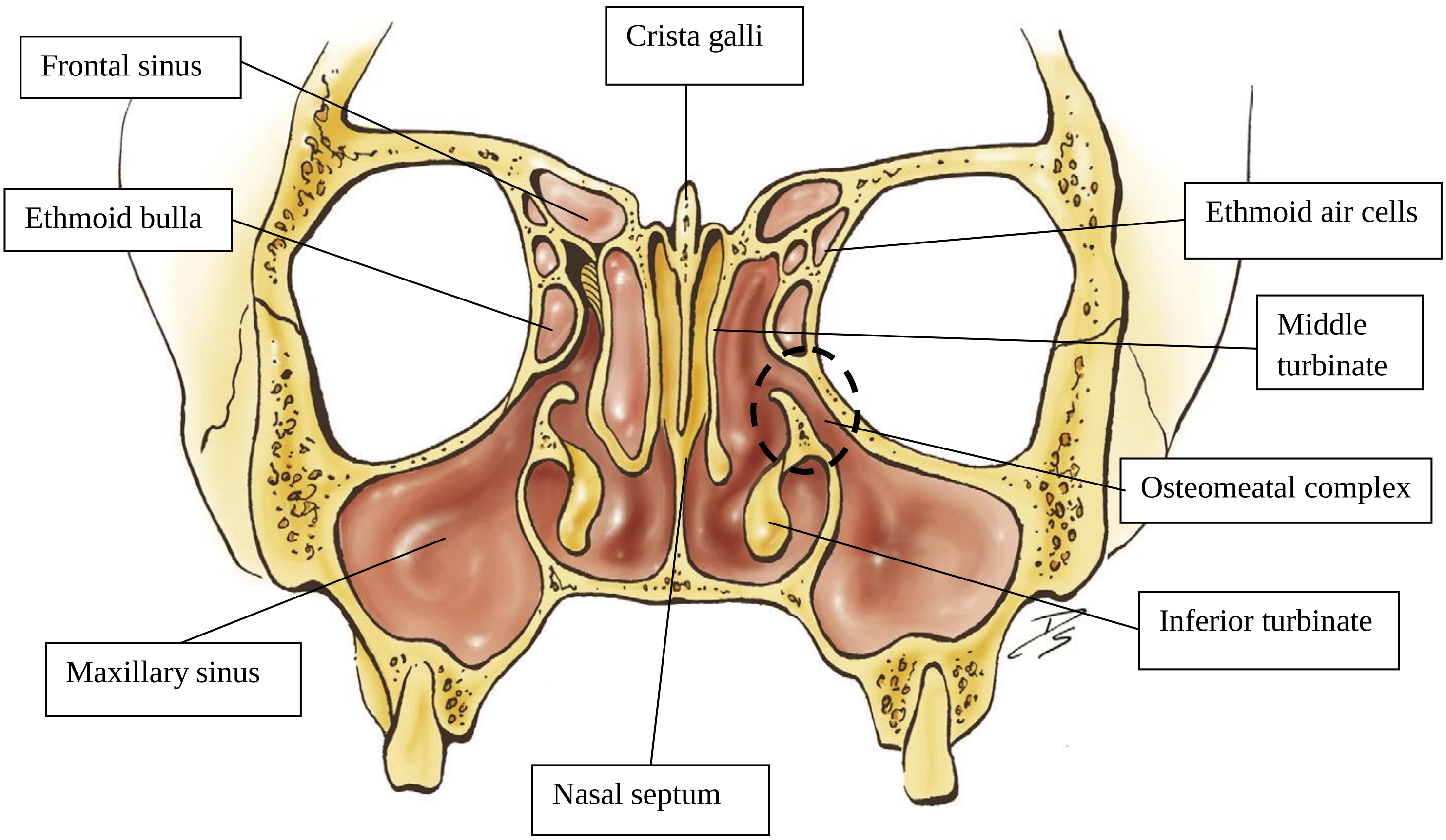

Figure 1.1 : Illustrated picture of adult paranasal sinus in coronal view (adopted from James NP *et al* 2013)

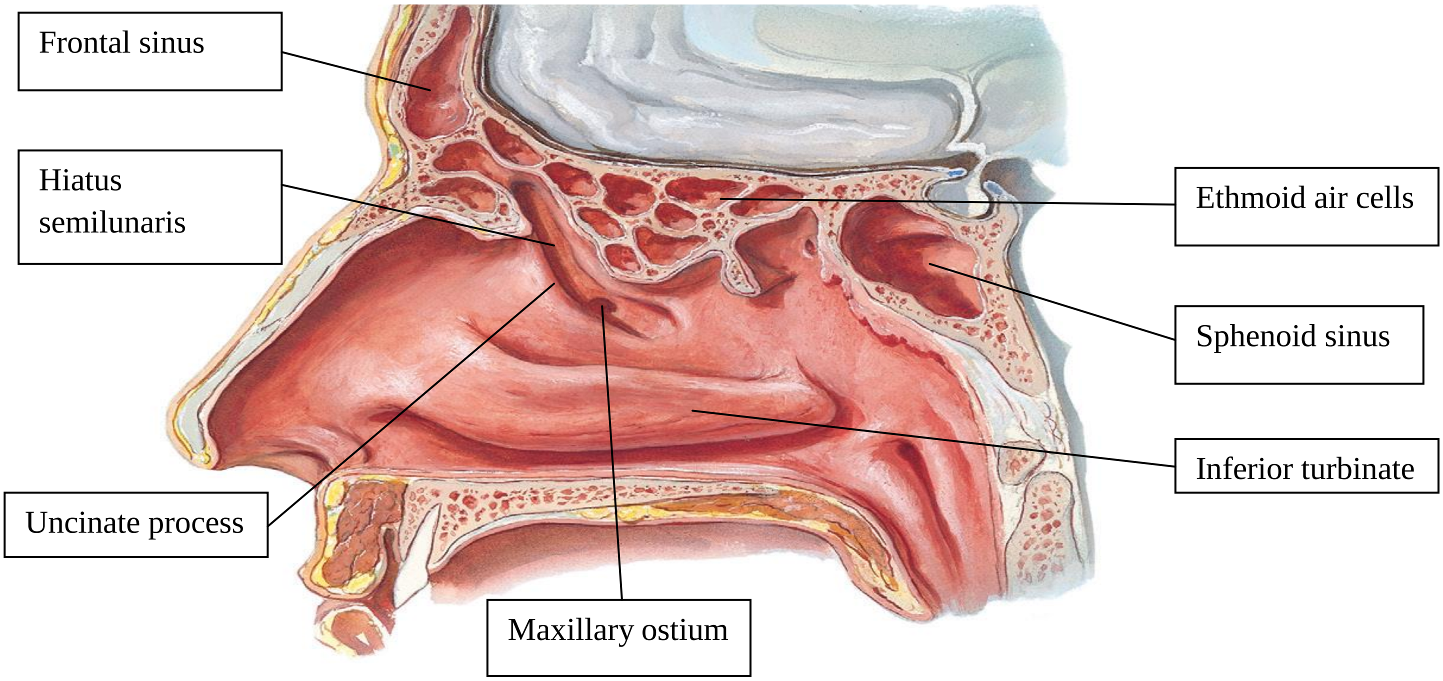

Figure 1.2 : Illustrated picture of lateral wall of nasal cavity in adult in sagital view (adopted from Norton NS *et al* 2012)

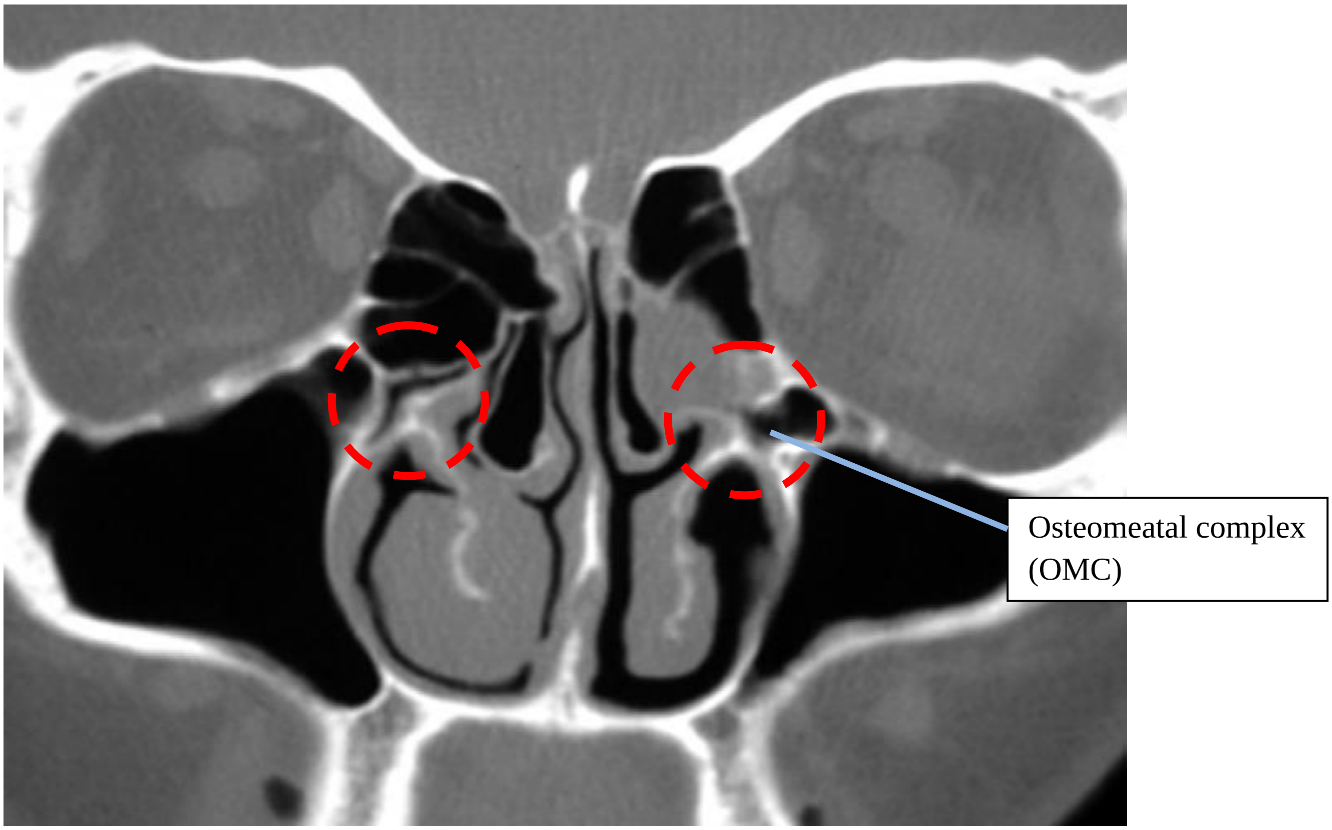

Figure 1.3 : CT scan PNS (coronal view) showing osteomeatal complex and paranasal sinus (adopted from James NP *et al* 2013)

1.3 RHINOSINUSITIS

Rhinosinusitis is a significant and increasing health problem which results in a large financial burden on the society. It was estimated that, there are over a billion cases of viral and bacterial rhinosinusitis annually (Benninger *et al,* 2008). Rhinosinusitis are diagnosed more frequently than all of the other respiratory diseases in adults. It is fairly well accepted that rhinosinusitis is one of the most common reasons for an individual seeking medical care and results in high direct medical costs. Furthermore it was associated with losses in time away from work or school with the associated decrease in productivity. There are also the costs related to decreased productivity of individuals who less effective because of their illness (Benninger *et al*, 2008).

By definition, rhinosinusitis is a group of disorders characterized by inflammation of the mucosa of the nose and paranasal sinuses (Benninger *et al,* 2008). Clinical definition of rhinosinusitis as proposed Rhinosinusitis Task Force criteria by Fokkens et al (2012) is defined as:

Inflammation of the nose and the paranasal sinuses characterized by:

1. Two or more symptoms, one of which should be either:

   Nasal blockage / obstruction / congestion or nasal discharge (anterior / posterior nasal drip) :

   ± facial pain / pressure,

   ± reduction or loss of smell

   and either :

2. Endoscopic signs of : nasal polyps and / or mucopurulent discharge primarily from middle meatus and / or oedema / mucosal obstruction primarily in middle meatus,

and / or:

3. Computed tomography (CT) scan changes: mucosal changes within osteomeatal complex (OMC) and / or sinuses.

Furthermore, a widely accepted classification of rhinosinusitis is based on the duration of symptoms as developed by the Rhinosinusitis Task Force of the American Academy of Otolaryngology – Head and Neck Surgery (Table 1.1) (Benninger *et al*, 2008). These criteria are based in large part on temporal time frames. The distinctions between acute rhinosinusitis (ARS), recurrent acute rhinosinusitis (RARS), subacute rhinosinusitis (SRS), chronic rhinosinusitis (CRS) and acute exacerbation of chronic rhino sinusitis (AECRS) are based on the temporal differences in the presentation and, in some cases, on the clinical presentation. There are also differences in the histopathology and the bacteriology of acute and chronic rhinosinusitis. Consensus has been reached to define these three distinct but related clinical entities based on duration of symptoms and defining clinical factors that would suggest rhinosinusitis.

1.4 AETIOLOGY OF RHINOSINUSITIS

There are various causative factors that play a role in the development of rhinosinusitis including both host and environmental factors. These include microorganisms, allergic and non-allergic immunologic inflammation (Tan *et al*, 2010; Tomassen *et al*, 2011). Whereas, non-infectious and non-immunologic causes have also been described. Examples include exposure to tobacco smoke and noxious chemicals, iatrogenic factors such as surgery, medications, nasal packing or nasogastric tube placement (Benninger *et al*, 2008).

Morphologically, there are certain anatomical variations such as deviated nasal septum (DNS), uncinate process deviation, paradoxical turbinate, concha bullosa and paraseptal structural abnormalities that have been suggested to predispose to obstruction of the osteomeatal unit and the development of chronic rhinosinusitis (Benninger *et al,* 2008, Calhoun *et al,* 1991, Yousem *et al,* 1991). Another study by Danese *et al* (1997) has shown that anatomical factors such as ipsilateral septal ridges or spurs, unusual ipsilateral deflections of uncinate process, and contralateral septal watch glass like deviation are significantly associated to the presence of sinusitis.

There are pathological changes of rhinosinusitis such as edema, loss of submucosal glands, ulceration, loss of cilia, fibroplasia, bone remodeling and later changes of goblet cell formation. From physical findings in rhinosinusitis, externally there may be erythema and swelling over the maxillary, ocular, orbital and frontal area. By anterior rhinoscopy, there may be hyperemia, edema, crust, pus or polyps in the nasal cavity. By nasal endoscopy, there may be discolouration of the turbinates, pus in the region of the osteomeatal complex and polyp formation.

1.5 ROLE OF COMPUTER TOMOGRAPHY SCAN (CT SCAN) IN RHINOSINUSITIS

For radiological evaluation of rhinosinusitis patient, computed tomography (CT) of paranasal sinus is considered the gold standard. Although CT scans cannot distinguish between inflammation and infection, they do seem to correlate fairly well with the extent of disease. Findings consistent with rhinosinusitis include isolated or diffuse mucosal thickening, bone changes or air fluid levels.

Table 1.1. Classification of rhinosinusitis based on duration of symptoms. (Benninger *et al*, 2008)

Classification	**Duration**
Acute rhinosinusitis (ARS)	7 days to < 4 weeks
Subacute	4 - 12 weeks
Recurrent acute	> 4 episodes of ARS
Chronic rhinosinusitis (CRS)	> 12 weeks
Acute exacerbation of chronic rhinosinusitis	Sudden worsening of CRS with return to baseline after treatment

CT scan imaging allows a detailed study of the nasal cavity and paranasal sinuses. It also providing an applied anatomical view of the region and the anatomical variants that are very often found (Pérez-Piñas *et al,* 2000). Moreover, the role of CT scan in rhinosinusitis is mostly for evaluation of suspected or impending complications. The primary serious complications of bacterial rhinosinusitis are local extensions of the infection into the intracranial cavity or orbit and metastatic spread to the central nervous system with subsequent brain abscess, meningitis and cavernous sinus thrombosis. Furthermore, CT scans have been very helpful in assessing a response of treatment in rhinosinusitis. Meanwhile magnetic resonance imagings (MRI) have been limited in their application in rhinosinusitis, primarily because they may be too sensitive for routine clinical use and the lack of bony detail needed for surgical intervention.

1.6 ASSESSMENT OF SEVERITY OF RHINOSINUSITIS BASED ON CT SCAN

In order to evaluate the severity of rhinosinusitis based on CT scan, the Lund–Mackay staging system was recommended by the task force of the American Academy of Otorhinolaryngology and Head and Neck Surgery (Appendix A) (Lund and Kennedy, 1997). This staging system has been designed with the simplest form in order to minimize individual variation in the interpretation of the degrees of opacification (Lund and Mackay, 1993). In this staging system, axial and coronal view of CT PNS scan in bone window setting is evaluated for the opacity of each paranasal sinuses (frontal, anterior ethmoid, posterior ethmoid, maxillary and sphenoid) and whether presence of OMC obstruction. It is numerically graded based on the opacity of the sinuses. A score of ‘0’ means no opacification, a score of ‘1’ means partial opacification and a score of ‘2’ represents full opacification. For osteomeatal complex (OMC), it is scored as ‘0’ for no obstruction and scored as ‘2’ for presence of obstruction [Figure 3.3(a) &

3.3(b)]. Then it is categorized into mild disease : total score ≤ 8, moderate disease: 9 -16 and severe disease: 17 – 24. It has been shown that this staging system correlates well with other markers of chronic rhinosinusitis severity, the nature of surgery offered, and its outcome (Hopkins *et al*, 2007). This system has been widely used by several researchers for their studies related to CT investigations in sinus diseases (Harar *et al*, 2004, Mohebbi *et al*, 2012, Moghadasi *et al*, 2008).

Successful management of rhinosinusitis is achieved in majority of patients via medical or surgical treatment. Occasionally in some cases symptoms spontaneously resolved. Treatment of rhinosinusitis is aimed to alleviate symptoms and signs, improve quality of life and prevent disease progression or recurrence. Medical treatment is the initial treatment of choice before opting for surgery in patients who do not improve. Many medical treatment have been employed or recommended. Evidence for their efficacy is rarely strong, partly because of the poor quality trials in unselected group of patients. Rhinosinusitis involves multifactorial etiology. The disease does not respond by simply making an empiric antibiotic selection. The quest and identification of factors predisposing to rhinosinusitis is key to guide appropriate management.

The most common indication for sinus surgery is failing medical therapy for rhinosinusitis. Approximately 200 000 U.S adults undergo sinus surgery per year. In Hospital USM, according to unpublished data study done by Rushdan *et al* (2001), a total of 45 cases of FESS was done from January 1997 to December 1999. It was believed this number is increasing tremendously by year.

Most of the patients who are subjected for functional endoscopic sinus surgery (FESS) must have preoperative CT scan evaluation. In Hospital USM and Hospital Sultanah Bahiyah (HSB), preoperative CT scan is the routine examination before FESS for identification of disease extention and pre-operative anatomical maping for possible anatomical variations. Sometimes, some uncommon anatomical variations other than mentioned previously may be encountered and these conditions would increase the risk of complications especially when the surgeon lacks of experience.

1.7 NASAL SEPTUM

Nasal septum formed a medial wall of nasal cavity. Embryologically, the nasal septum is thought to develop as a fold growing downward between the paired nasal cavities until it reaches the palatal shelves. Its growth is thought to be in an inferior direction from the nasofrontal prominence (Neskey and Casiano, 2009). The septum was believed to grow as a free process that projected from the craniofacial complex. Then it continues to grow and fuses with the palatal shelves to form the secondary palate. The anterior portion of the septum is continuous with the nasomedial processes and combines to form the primary palate. The cartilaginous nasal capsule surrounds the cavity and is continuous with the nasal septum. The capsule further develops to form the lateral nasal wall until its completion at 24 weeks gestation (Neskey and Casiano, 2009).

Anatomically it consists of bone and cartilage (Figure 1.4). The triangular vomer, articulating above with the sphenoid body form the posterior border of the septum. Inferiorly it is slotted into the grooved ridge on the hard palate and extends beyond the incisive canal. The vomer is grooved on each side by the nasopalatine nerves. The perpendicular plate of the ethmoid articulates with the upper margin of the vomer but not throughout its length. The septal cartilage, the unossified part of the ethmoid’s perpendicular plate, forms the anterosuperior part of the septum. Inferiorly it is slotted into a bony groove at its vomerine and maxillary articulations. The nasal septum is frequently deviated from the midline and small bony spurs may project from the septal surface into the nasal cavity. The anteroinferior corner of the septum is mobile, being formed by the medial crura of the paired major alar cartilages.

1.8 DEVIATED NASAL SEPTUM (DNS)

DNS is defined as deviation of the bony or cartilaginous septum to one or both sides of nasal cavity. DNS are common and occur in nearly 77% to 90% of the general population worldwide (Figure 1.5) (Gray LP, 1978).The development of DNS can arise both early and late in development and often arises from a combination of etiological sources. Failure of development at any embryological stage can lead to a DNS. Both genetic and environmental causes can lead to defects. Following normal development, one of the first causes of DNS in the newborn is trauma at childbirth. Prolonged pressure during the intrauterine phase leads to deviation (Pirsig WG, 1992). Other causes include genetic influences, mechanical injuries, congenital malformations, infections or neoplasia. Reduced ossification of the sphenoidal process of the septal cartilage lead to greater overall septal length and increased nasal septal deviation (Kim *et al*, 2011). Early analysis of adult population variation of nasal septal deviation focused on skulls. One of the first studies on 2,152 adult skulls of varied races found 23% straight, 67% kinked and 10% deviated (Mackenzie and Morell, 1880). A separate study analyzed 2,112 adult skulls of five ethnic origins found 37% of nasal septum were deviated, 42% kinked and 21% straight (Gray LP, 1978). The septal deviation also found to be correlated with dental malocclusion. Comparison of deviation rates between twins in the same study had a poor correlation, suggesting a minimal impact of heredity.

1.9 DNS CLASSIFICATIONS

There are several proposed classifications for deviated nasal septum (Ingo B *et al,* 2007; Buyukertan *et al,* 2002; Guyuron *et al,* 1999; Mladina *et al,* 1987; Mladina *et al,* 2008; Rao *et al,* 2005). However, some of these classifications have somehow been modified according to the population being studied in different regions of the world. Therefore, currently, there is no standardized classification that has been agreed upon for routine clinical assessment. The earlier classification and widely used classification method was proposed by (Mladina *et al,* 1987). He has proposed seven types of DNS. In this study, he has identified three types of DNS with vertical crest, one type with bilateral deformity, two types with horizontal deformity and another type with atypical deformity (Table 1.2, Figure 1.6).

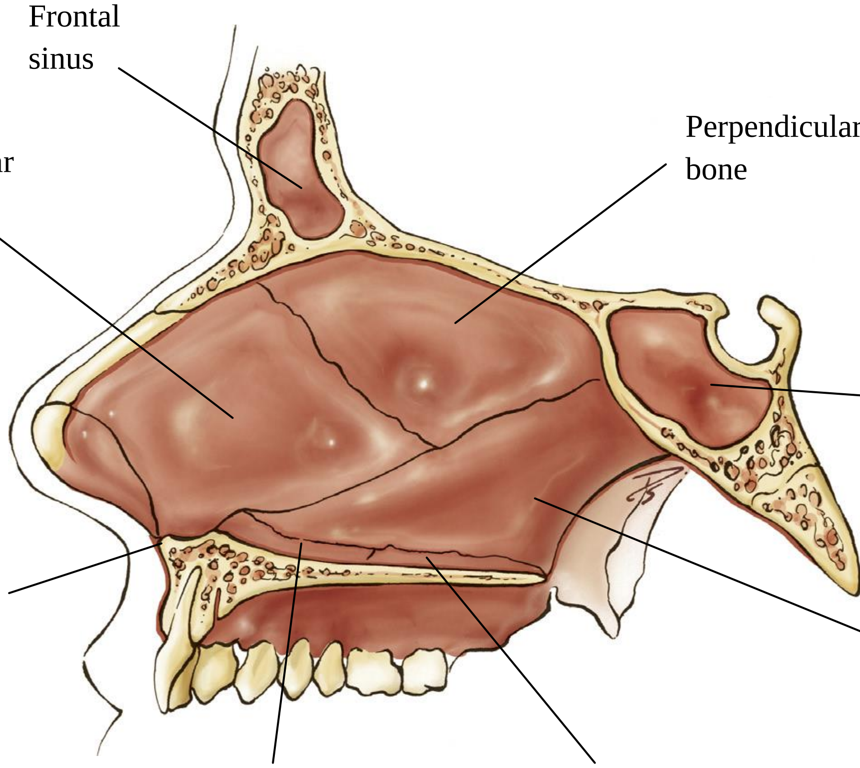

Figure 1.4 : Illustrated picture of nasal septum in adult in sagital view.(Adopted from James NP *et al*, 2013)

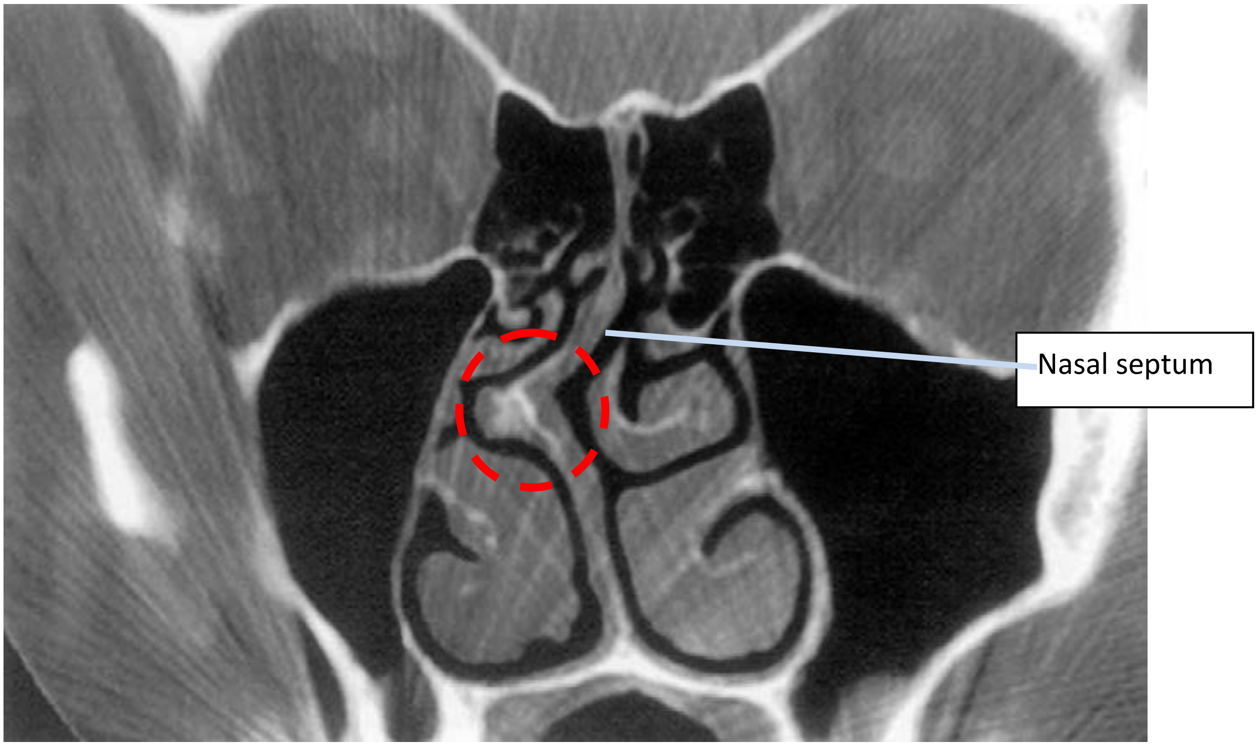

Figure 1.5: CT scan PNS (coronal view) showing a deviated nasal septum. (Adopted from James NP *et al*, 2013)

Table 1.2: Type of deviated nasal septum according to Mladina's classification (Mladina *et al* , 1987; Mladina *et al.*, 2008)

Type	Description
Type 1	Mild anterior unilateral crest at nasal valve area
Type 2	Severe anterior unilateral crest at nasal valve area
Type 3	One unilateral crest at the level of the head of the middle nasal concha
Type 4	Two crests - one at the level of the head of the middle nasal concha, and the other on the opposite side in the valve area
Type 5	A unilateral ridge on the base of the septum, while on the other side the septum is straight
Type 6	A unilateral sulcus running through the caudal-ventral part of the septum, while on the other side there is a ridge and accompanying asymmetry of the nasal cavity
Type 7	A mix of types from 1 to 6

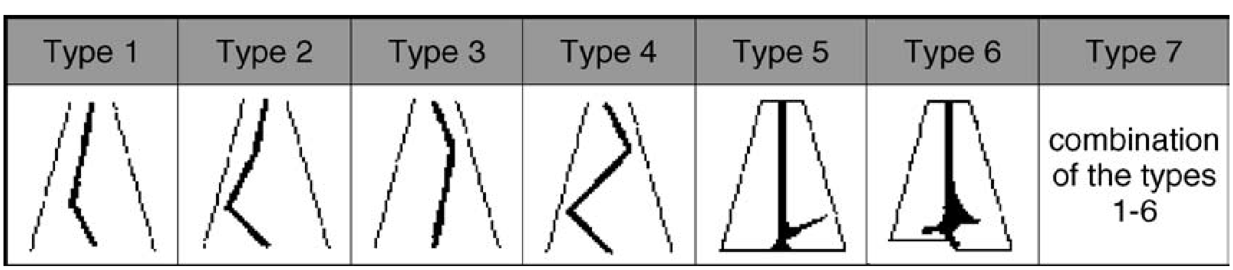

Figure 1.3: Illustration of the types of DNS based on Mladina's classification (Mladina 1987; Mladina *et al*, 2008)

1.10 ASSOCIATION BETWEEN DNS AND RHINOSINUSITIS

From a study, they found there are possible reasons for the association between DNS and chronic rhinosinusitis. The first suggested mechanism is due to mechanical obstruction of the OMC by Stammberger and Posawetz (1990). They demonstrated that the source of obstruction is either from an anatomical deformity or hypertrophy of the nasal mucosa. This would further lead to accumulation and stagnation of secretions and predisposition to infection.

Secondly, the association could be due to aerodynamic factor. It has been suggested that DNS leads to an increased velocity of nasal airflow (Blaugrund *et al*, 1989). This would result in mucosal drying and disrupt the physiological function of mucociliary clearance. This is supported by the work of Ginzel and Illum (1980) who found a delayed saccharin clearance time in patients with septal deflection. The third theory was proposed by Bachert (1987), who demonstrated alterations of maxillary sinus pressure and ventilation with septal deviations in the region of the OMC. He found diminished antral pressures in association with posterior septal deviations.

Moreover, a systematic analysis review by Orlandi (2010) has demonstrated that there is significant association of DNS and rhinosinusitis. Meanwhile, Elahi and Frenkiel (1997) evaluated 122 patients with sinus disease and found an increasing angles of septal deviation are associated with bilateral sinus disease and contralateral middle turbinate abnormalities.

1.11 LITERATURE REVIEW

1.11.1 RHINOSINUSITIS

Rhinosinusitis is a significant health problem which seems to mirror the increasing frequency of allergic rhinitis which results in a large financial burden on society. According to Fokkens *et al* (2012), The 2007 Rhinosinusitis Task Force criteria were widely accepted for diagnosing chronic rhinosinusitis. From the criteria, it requires both subjective and objective evidences. Firstly, for symptoms criteria, it requires ≥ 2 symptoms for ≥ 12 weeks of mucopurulent drainage (anterior, posterior, or both), nasal obstruction (congestion), facial pain or pressure or fullness or decrease sense of smell.

Secondly, it requires objective evidence of inflammation, purulent (not clear) mucus or edema in the middle meatus or ethmoid region, polyps in nasal cavity or the middle meatus from the nasal endoscopy and /or radiographic imaging showing inflammation of the paranasal sinus.

A pathophysiologic explanation of rhinosinusitis remains elusive. Allergy, viruses, bacteria, superantigens, osteitis, bio-films, immunologic dysregulation, and gastroesophageal reflux have all been proposed as etiologic factors, and evidence exists to support each of these claims (Benninger et al, 2003, Meltzer et al, 2004). The search for a single all-inclusive etiology has yet to reveal one and has led some to postulate that multiple factors may cause chronic rhinosinusitis. Indeed, some have postulated chronic rhinosinusitis may instead be a syndrome of inflammation and impaired mucociliary clearance, a final common pathway with multiple initial etiologies. Anatomic abnormalities were once sought as a significant factor in the pathogenesis of rhinosinusitis. The use of computed tomography (CT) in the evaluation of rhinosinusitis together with the nasal endoscopy contributes further to improvement in its diagnosis and treatment. These nearly simultaneous advents led to a search for anatomic abnormalities that could explain rhinosinusitis on the basis of OMC obstruction or other anatomic variants that impair mucociliary clearance. Numerous researchers examined CT scans for the presence of pneumatized uncinate processes and middle turbinates (including the presence of a concha bullosa), paradoxically curved middle turbinates, infraorbital (Haller) cells, sphenoethmoidal (Onodi) cells, enlarged agger nasi cells, and other variants.

1.11.2 NASAL SEPTUM & DEVIATED NASAL SEPTUM (DNS)

According to Moore KL (1994), it has been suggested that the nasal septum is usually a midline structure until the age of seventh and it deviates mostly to the right side thereafter. Some authors consider the nasal septum as a figure representing the displacement of maxilla during growth and development (Enlow DH, 1992). Deviation of the nasal septum may take the form of a "C" or "S" or may look like a large spur (Donald PJ, 1994). Meanwhile, Cottle MH (1958) classified the deviations of the septum into four different groups: subluxation, large spurs, caudal deflection and tension septum. Whereas Gray LP (1978) described two main septal deformities which is anterior cartilage deviation and combined septal deformity. An anterior cartilage deviation was defined as asymmetry of the external bony pyramid and dislocation of the cartilage off the anterior nasal spine. Combined septal deformity involves vomer, perpendicular plate of ethmoid and quadrilateral cartilage having some level of kinking or spur deformity.

Mladina *et al* (1987) proposed a user-friendly classification of septal deviation in six basic types. He also described a seventh type, named Passali deformity. They were divided into two main groups which is vertical deformities (Types 1, 2, 3 and 4), and horizontal ones (Types 5 and 6). This classification was well accepted by rhinologists worldwide.

Twelve years later, Guyuron B and Scull H (1999) published a classification which consist of six types. Tilt, antero-posterior C, antero-posterior S, cephalo-caudal S, cephalo-caudal C, and wide spurs. In fact, both Mladina's and Guyuron's classifications describe almost the same deformities but in different terminology. Four years later, Buyukertan *et al* (2003) classified septal deviation by separating the nasal septum into 10 segments with an intention to better localize the deformity. In addition, Ingo B and Helmut B (2007) also published a new classification of septal deviations which was much similar with Mladina classification.

DNS also bear importance with respect to endoscopic sinus surgery and septoplasty operations (Elahi M and Frenkiel S, 1997). Particularly, a DNS may hamper the accessibility to the region where the opening of the maxillary sinus is located during such interventions. Besides this, they also found that an increased incidence and severity of bilateral chronic sinus disease was present with increasing deviations of the septum ($p<0.05$). In addition, Guyuron B and Scull H (1999) found that deviations represent the most frequent pathological condition in the nasal septum and submucosal resection (SMR) is the most frequently applied modality for the treatment of septal deviations. They also added that detailed knowledge about the anatomy of the deviation guides the surgeon during operations and lack of it may result in treatment failure.

1.11.3 DNS AETIOLOGY

The cause of DNS usually due to direct trauma and this is frequently associated with damage to other part of the nose such as fracture of the nasal bone (Cummings 1993). The birth molding theory by Gray LP (1978) claimed that in many patients with septal deviation, there is no obvious history of trauma but abnormal intrauterine posture may result in compression forces acting on the nose and upper jaw like in persistent occipotoposterior presentation. It can result in displacement of septum and the nose can be exposed to further torsion forces during parturition. According to the theory, compression across the maxilla during parturition may cause combined septal deformity, whereas direct trauma may cause anterior cartilage deformity of the quadrilateral septal cartilage.

Genetic factors also thought to play a role in DNS. According to Grymer (1998), which examined 41 pairs of identical twins suggested that anterior lesions were due to an external cause (trauma) whereas the posterior lesions due to genetic factors. Meanwhile Takahashi R (1988), was demonstrated that there were racial distribution of nasal septal deformities which indicate that genetic factor may play a role. DNS is highly common condition in certain population worldwide and have also shown that there is a population based distribution of nasal septal deformities. It is reported to be present in the range between 21% and 65% in different populations (Subaric and Mladina 2002, Rehman *et al*, 2012, Wee *et al*, 2012).

1.11.4 DNS AND ANATOMICAL VARIANT

DNS is also found to be among the commonest anatomical variant of the nasal structure. According to Azila et al (2008) in their study in Hospital USM found that the main anatomical variations encountered in their study are pneumatize agger nasi cells (83%), DNS (50%), Haller's cell (51%) and concha bullosa (36.7%). Whereas, it has been found in an international study that about 89% of the subjects investigated showed the presence of septal deformity of a particular type (Mladina *et al*, 2008). Analysis of populations has found increased incidence of septal deviation in Caucasians compared to African individuals (Mooney and Siegel, 1986).

Another population study in Southern Europe, according to Perez Pinas *et al* (2000), there are high percentage (67%) of anatomical variability in the nasal cavity and paranasal sinuses such as DNS (most frequent), concha bullosa, bony spurs of the nasal septum and Onodi air cells. The suggested explanation for population variation is the timing of the fusion of the premaxillary-maxillary suture. This has been suggested to occur around the age of two, restricting the amount of time cartilaginous septal growth plays a role in facial development and nasal septal deviation. The remaining growth of the nasal septum occurs only in the perpendicular plate of the ethmoid (Van Loosen *et al,* 1996).

The knowledge of anatomical variability, especially the types of septal deformity is essential because it determines the pre-operative planning in endoscopic sinus surgery and septoplasty operations. According to Cho and Jang (2013), it has been shown that the successful outcome rate of rhinoplasty for correcting the deviation is significantly affected by the types of deviated nasal septum.

1.11.5 ASSOCIATION BETWEEN DNS AND RHINOSINUSITIS

DNS was among those anomalies examined in multiple studies, and conflicting results were described. Some reports described a correlation between DNS and the presence of rhinosinusitis, whereas about an equal number found no such correlation. Most of these studies were rather small or examined this association indirectly, such as those investigating the role of a concha bullosa in rhinosinusitis. With the more recent appreciation that the pathogenesis of rhinosinusitis is likely multifactorial, it is appropriate to re-examine possible anatomic etiologies.

A systematic analysis review by Orlandi (2010) has demonstrated that there was significant association of DNS with rhinosinusitis. In a study of 100 patients evaluated for nasal septal morphology, there has been found that patients with more severe DNS and more horizontally-oriented uncinate processes had a higher frequency of sinus opacification. The degree of sinusitis was not significantly different ipsilateral and contralateral to the side of the septal deviation. They concluded that DNS affected both the ipsilateral and contralateral sinuses without drawing any inferences as to the possible nature of the relationship (Yousem *et al*, 1991).

Meanwhile, Elahi and Frenkiel (1997) evaluated 122 patients with sinus disease and found a correlation between DNS and bilateral sinus disease and contralateral middle turbinate abnormalities and ethmoid bulla prominence. In a later similar study, with perhaps the same patient group, they evaluated the sinus CT images of 150 patients with sinusitis and compared that to a control group of 150 patients. As before, they found an increasing severity of bilateral sinus disease with increasing DNS. There was a statistically significant increase in sinus opacification in the ethmoid, maxillary and frontal sinuses with increasing DNS. In addition, there was a correlation with OMC obstruction and DNS. They found a significant increase in middle turbinate and lateral nasal wall abnormalities contralateral to the direction of the septal deviation, which resulted in OMC obstruction and hence accounted for the symmetry of sinus disease. Hatipoglu *et al* (2008) found that the incidence of sinusitis in severe DNS is higher when compared with mild and moderate groups.

Moreover, there are study regarding the sinus CT scans of patients with sinusitis (n=100) and a control group of patients with orbital pathology (n=82). Septal deformity was found in 40% of the rhinosinusitis disease group versus 19.5% of the control group. They also