NASAL AIRWAY ANALYSIS USING THREE-DIMENSIONAL SOFTWARE AMONG NORMAL SUBJECTS IN HOSPITAL UNIVERSITI SAINS MALAYSIA, KUBANG KERIAN, KELANTAN

By

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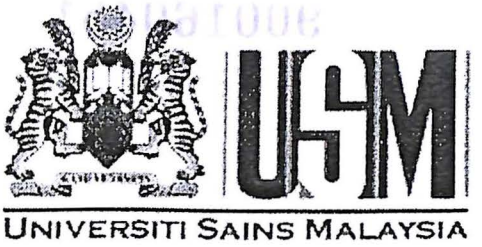

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ABSTRAK DALAM BAHASA MALAYSIA

Pengenalan

Untuk berfungsi dengan baik, patensi hidung berperanan penting untuk membawa masuk dan keluar udara. Patensi hidung boleh di kaji dengan berbagai cara, dari pemeriksaan subjektif contohnya skala permerhatian analog kepada pemeriksaan yang lebih terperinci dan tepat seperti Akustik Rhinometri (AR).AR ialah pemeriksaan yang disyorkan untuk mengkaji geometri hidung. Perisian 3-Dimensi ini dapat menukar data dalam bentuk 2-Dimensi yang akan memberi cara baru bagi mengkaji patensi hidung.

Objektif

Objektif kajian ini ialah untuk menukar data-data 2-Dimensi kawasan keratin rentas minimal (minimal cross-sectional area-MCA) yang diperolehi dari AR kepada data-data 3-Dimensi. Kajian ini juga mengkaji perbezaan MCA antara subjek lelaki dan perempuan.

Keputusan

Dalam kajian ini di dapati MCA1 bagi lelaki adalah 0.49 ± 0.14 cm dan bagi perempuan ialah 0.42 ± 0.16 cm^2. Bagi jumlah isipadu (nasal volume-V1) MCA, lelaki adalah sebanyak 3.46 ± 1.28 dan perempuan sebanyak 2.9 ± 0.98 cm^2. Perisian 3-Dimensi pula menunjukan keputusan yang sama dimana di dapati ada perbezaan bermakna diantara hidung lelaki dewasa dengan perempuan dewasa (p=0.00) dan remaja dan juga lelaki remaja (p=0.004). Perbezaan yang bermakna tidak ada bagi MCA dengan BMI.

Kesimpulan

Hidung lelaki berbeza dari hidung perempuan samada hidung sebelah kiri atau kanan. Keputusan ini juga dapat diperolehi dari AR dan juga perisian 3-Dimensi. Perisian 3-Dimensi menunjukan ada perbezaan antara lelaki dan perempuan. Dengan in dapat disimpulkan bahawa perisian 3-dimensi ini dapat digunakan bersama AR bagi menerbitkan data yang lebih terperinci dan amat berkesan untuk mengdiagnosakan penyakit hidung, rawatan yang dirancangkan dan rawatan susulan.

Abstract

Nasal Airway Analysis Using 3-Dimensional Software Among The Normal Subjects In Hospital Universiti Sains Malaysia, Kelantan.

Introduction.

In order to function well the nasal patency plays a major role to bring in inspired air and release the expired air. The patency of the nasal cavity can be assessed by variety of methods, ranging from simple subjective measurement such as visual analogue scale to more accurate objective measurement such as acoustic rhinometry. Acoustic rhinometry (AR) is the recommended technique for assessment of the nasal geometry. It quantifies subjective symptoms of nasal obstruction into an objective assessment of nasal patency. 3D software is capable in converting the data from AR (2D) into a 3-Dimensional image and this will provide a new prospect in how nasal patency can be measured and evaluated.

Objectives

The objective of this study is to convert the normal values of the Minimal Cross-sectional Area (MCA) and nasal volumes collected using Acoustic Rhinometry and analyze using the 3D software. This study also analyzed the differences between MCA and nasal volumes of male and female collected by the AR and 3D software.

Methodology

This is a cross sectional study of healthy volunteer adult subjects ranging between the age of 18 years old to 70 years old, comprising of 75 males and 75 females Otorhinolaryngology Head and Neck clinic, Hospital Universiti Sains Malaysia (HUSM), Kubang Kerian, Kelantan. A written consent was taken from the candidates after the aim and methodology as well as the procedure was explained to the candidates. A primary assessment with thorough history, systematic ear, nose and throat (ENT) examination, including rigid nasoendoscope was included and performed to each subjects. Later the subjects were examined using the AR scan. The AR scan that was be used was the RhinoScan SRE2100 (RhinoMetric, Denmark). The Acoustic rhinometry was performed following the standard procedure as described in the literature. The

data was analyzed using paired T-test with p-value less than 0.05 was considered to be significant.

Results

In this study, the mean MCA1 for males were 0.49 ± 0.14 cm^2 and females 0.42 ± 0.16 cm^2. For the nasal volume of MCA, V1 for males were 3.46 ± 1.28 and for females were 2.9 ± 0.98 cm^2. In 3D analysis the results also showed that the adult male nasal airway is significantly different from female teenagers (p=0.00), female adult (p=0.00) and male teenager (p=0.004) on both the left and right nostril. There is also no significant correlation between MCA and BMI.

Conclusion

The male nasal airways differ from the female nasal airways on both the left and right nostrils. These results were produced by the Acoustic rhinometry software and also by the 3D software. The 3D software showed that the male adult nose differs from the female (adult and teenager) and even the male teenager. The male nasal airway is narrower at the anterior nasal valve and wider distal to nasal valve. Acoustic rhinometry is a valuable method of assessing geometry of nasal cavity. 3-Dimensional software can be used with AR in enhancing the data and making it more useful in diagnosis, treatment planning and ongoing post treatment or surgery.

1. INTRODUCTION

The nose is an important organ in the human respiratory system. It plays several important physiological functions which include smell, humidification of air for breathing and for defensive functions which include filtering particles in the inspired air and first line immunological defense via the mucous coated membranes that contain Ig A (Alan, Mackay, Bull, 1997).

In order to function well the nasal patency plays a major role to bring in expired air and release the expired air. The patency of the nasal cavity can be assessed by variety of methods, ranging from simple subjective measurement such as visual analogue scale to more accurate objective measurement such as acoustic rhinometry.

1.1. Anatomy of Nose

The nasal cavities consist of two fossae that extend from the anterior nares to the posterior nares or choanae. The anterior nares are the external or proper nostrils or the area of mucocutaneous junction of the nose with the nasal vestibule anterior to it. The posterior nares are the openings of the nasal cavities into the mouth or pharynx. The nasal cavities are lined mostly by respiratory type ciliated columnar epithelium, the olfactory epithelium at the roof of the nasal cavities and

sometimes the squamous epithelium encroaches from the vestibules to the anterior part of the inferior and the middle turbinates. The turbinates are located at the lateral wall of the cavities which consist of the superior, middle and inferior turbinates. Each turbinates overhangs their respective meatus or channels.

The turbinates function as filtration, heating and as a humidifier of respiratory air. The nasal cavities are divided into left and right nostril by the septum. Anteriorly it is consist of cartilaginous and posteriorly it is bony. The cartilaginous is bendable and elastic in nature; this will help the septum to return to its previous position when minimal trauma exerted upon it. The respiratory epithelium which covers the erectile tissue (or Lamina propria) of the turbinates plays a major role in the body's first line of immunological defense. The respiratory epithelium is partially composed of mucus producing goblet cells (Alan, Mackay, Bull, 1997).

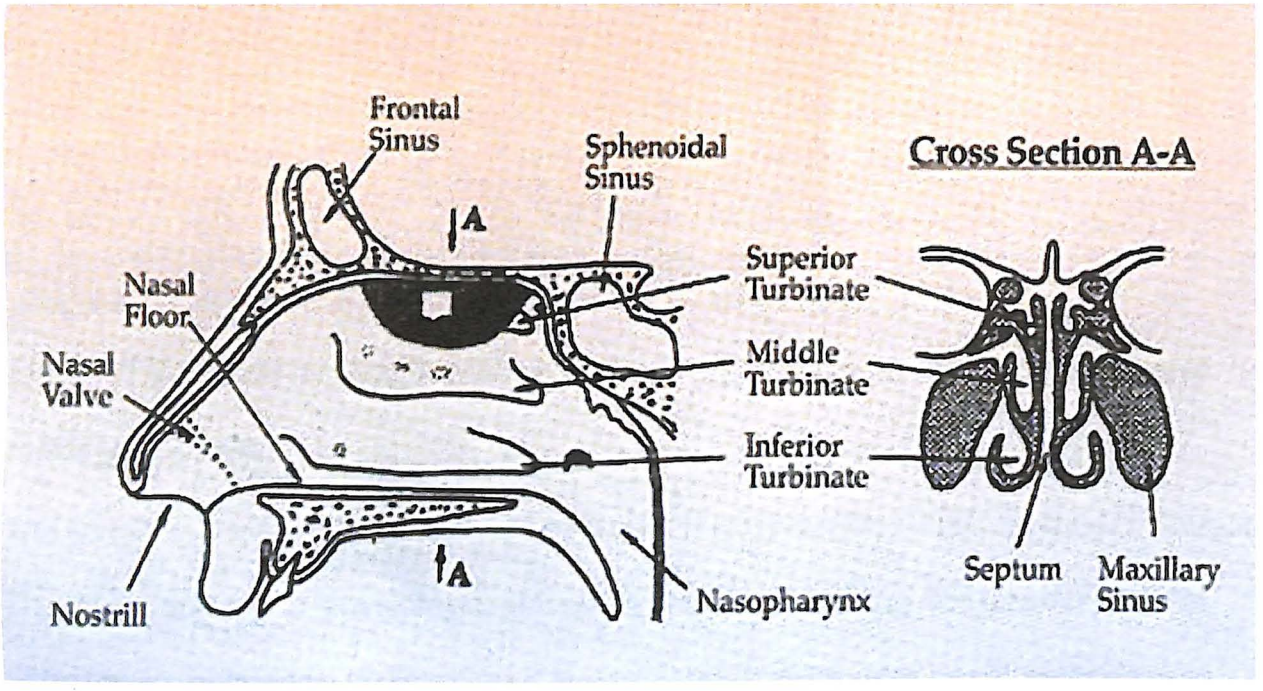

Figure 1.1: A cross section of the nose showing the nasal valve.

The respiratory epithelium also serves as a means of access for the lymphatic system which protects the body from being infected by viruses or bacteria. The turbinates also increase the surface area of the inside of the nose, and by directing and deflecting airflow across the maximum mucosal surface of the inner nose, they are able to propel the inspired air.

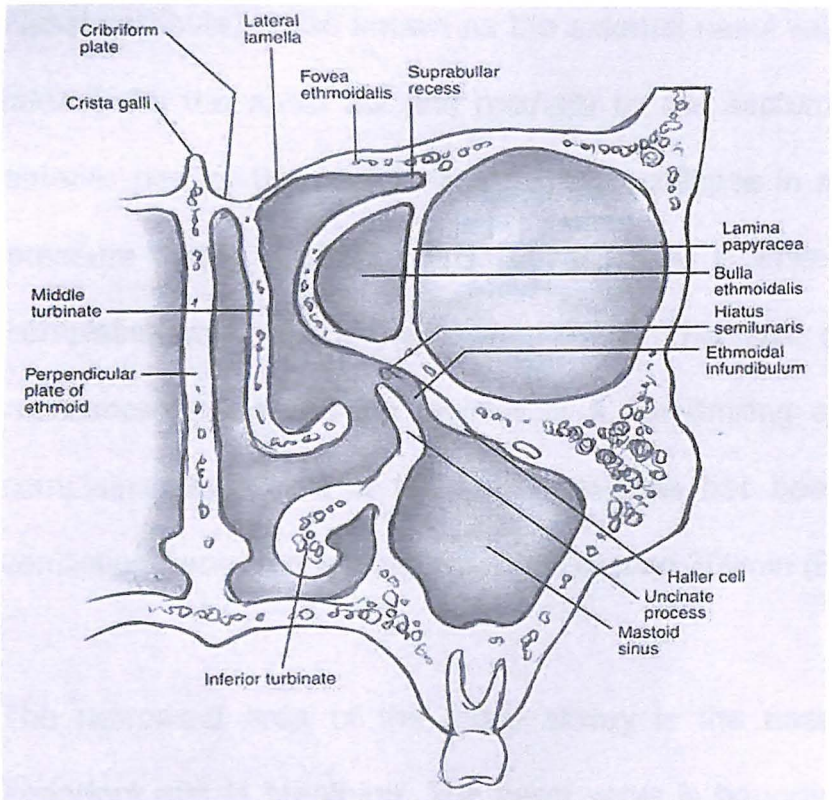

Figure 1.2: Cross section of the left nostril in relation to the ethmoidal and maxillary sinuses.

The nose acts as a physiologic airway resistor, accounting for around 50% of total airway resistance (Sulsenti and Palma, 1996). Adequate nasal resistance is important for correct functioning of the nose and also in ensuring the normal pulmonary physiology.

The nasal resistance can be divided into three components:

1) Nasal vestibule
2) Nasal valve
3) Turbinated nasal passage

Nasal vestibule is also known as the external nasal valve. This area is bounded laterally by the nasal ala and medially by the septum. The nasal ala and the anterior part of the septum are liable to collapse in response to the negative pressure during inspiration. The nasal airflow is limited by the collapse of the complaint walls of the nasal vestibules. This first component of the nasal resistance act as Starling resistor or a flow-limiting segment. Collapse of the complaint lateral wall of the nasal vestibule has been shown to occur when ventilation through one nostril reaches around 30l/min (Brigger, 1970).

The narrowest area of the nasal airway is the nasal valve which plays an important role in breathing. The nasal valve is bounded laterally by the inferior turbinate, superiorly by the caudal end of the upper lateral cartilage, inferiorly by the nasal floor and medially by the septum (Howard and Rohrich, 2002). The nasal valve is situated about 2 cm from the anterior nares which lies at the anterior end of the inferior turbinate within the first few millimeters of the bony nasal cavity (Haight and Cole, 1983). Minimal changes at this area (mean cross-section) can produce significant nasal resistance examples in mucosal swelling, structural abnormality (deviated nasal septum) or combination of both.

Pathological nasal resistance is determined by alterations in the shape and volume of the nasal cavities that singly or in association disrupt nasal aerodynamics, a condition that will present mainly in the form of obstructive disorders (Sulsenti and Palma, 1996).

Nasal valve become narrower when negative inspiratory pressures are generated during breathing. These pressure airway resistance and slowing the velocity of the air-stream. Pathological abnormalities such as deviated nasal septum or mucosal swelling will predisposed the nasal valve to close prematurely thus resulting in symptoms of nasal blockage. Even minor changes in the shape of the cross-sectional area of the nasal valve may produce clinical symptoms of nasal obstruction.

1.2. Physiology of Nose

Nose it is a natural pathway for breathing whereas mouth breathing is acquired through learning. It also permits breathing and mastication to act simultaneously. During quit breathing, the inspired air passes through the middle part of the nose between the turbinates and the nasal septum, rarely through the inferior and the superior part of the meatus therefore weak odour will not be detected during quiet breathing. During expiration, air flows the same course but the entire air

flow will undergo turbulence at the nasal valve and limen nasi that will ventilate the sinuses through the ostia (Alan, Mackay, Bull, 1997).

Nasal cycle occurs every two and half to four hours for each nose. It is a normal rhythmic cyclical congestion and decongestion, thus function to control the air current through the nasal chambers.

Smell is very important function of nose, it correlate well with sense of taste, when nose is blocked food will almost always taste bland and unpalatable. Smell is perceived in the olfactory region at the roof of the nose where the olfactory receptors cells are located.

Filtration or purification of air that passes through the nose during breathing help prevents harmful particles to enter the lungs. The nasal vibrissae at the entrance will filter bigger particle (up to 3μm) whereas the finer particles such as pollen, dust or even bacteria (0.5μm to 3μm) will adhere to the mucus that overlay the mucous surface of the nose (Alan, Mackay, Bull, 1997).

Nose as an air-condition unit, helps us to inspired air that is suitable for the lungs. It will adjust the temperature and the humidity of the air before air is passed down to the lungs. This is achieved by the large surface of the nasal mucosa and the mucous membrane especially at the middle and inferior turbinates of the nose. This region is highly vascular and making it able to increase and decrease the size of turbinates thus making it an efficient "radiator" to warm up cold air. Inspired air that may be at 20 degrees Celsius or even subzero can be heated up close to body temperature by this "radiator" mechanism. Similarly, hot air is cooled to the body temperature. Nasal mucosa also can adjust the relative

humidity of the inspired air to 75% or more. The inspired air is saturated by water produced by the nasal mucous membrane which is rich with mucous and serous secreting glands. Humidification is important to prevent infection of the respiratory tract. If the moisture at 50% relative humidity the ciliary function cease in about eight to ten minutes, thus predisposing to infection (Niels, Ronald, 1998). Humidification also is needed in order for gas exchange to be optimized.

The nose also protects the lungs from infection by its enzymes and immunoglobulin in the nasal secretions. Such enzyme is called the muramidase (Lysoenzyme) which kills virus and bacteria. Immunoglobulin IgA, IgE and inteferons provide immunity against upper respiratory tract infections (Sanford, 2006).

Mucociliary mechanisms of the nose via its mucous blanket which consist the superficial mucous layer with the deep serous layer help to carry the unwanted trapped particle towards the nasopharynx.

Table 1.3: Major Functions of Nose.

Major Function Of Nose	
1.	Airway for breathing
2.	Olfactory
3.	Filtering unwanted particles
4.	Protection
5.	Humidification

The ability to quantify nasal airway patency is useful in both clinical diagnostic procedure and in pharmacological research related to nasal airway. Various methods can be used to assess nasal airways ranging from a simple visual analog to more accurate objective measurement such as acoustic rhinometer (Lund, 1989).

For nose to function optimally, patency of the airway is very important. Nasal patency is a very complex phenomenon that is determined by different characteristics of nasal cavity. Measuring nasal patency is different than measuring nasal airway or nasal resistance. Assessment of nasal patency is measuring the cross-sectional areas of nasal cavity or the volumes of a part or the whole of a cavity. According to Scadding et al (1994), significant negative correlation between minimum nasal cross sectional area using acoustic rhinometry and nasal airway resistance using anterior rhinomanometry, which he believes that acoustic rhinometry is more accurate in quantifying the real nasal condition.

Methods used to objectively measure nasal patency and resistances include rhinomanometry and acoustic rhinometry. These two methods provide complementary and importantly objective information concerning the nasal airway (Wang, Pang, Yeoh, 1999).

Rhinomanometry in general provide information regarding the nasal airway current and resistance. It does not provide a topical description of the interior of the nasal passage. Rhinomanometry failed to relate the symptom of nasal blockage and determined the causal of nasal airflow disturbance (Suzina S. A.H et al 2000).

1.3. Acoustic Rhinometer

Was first introduced by Hilberg et al (1989) as an objective method for examining the nasal cavity. It measures the minimum cross sectional area (MCA) as a function of distance from nostril. The technique is based on the principle that a sound pulse propagating in the nasal cavity is reflected by local changes in acoustic impendence (Tarhan, 2005). An audible sound pulse (150 – 10,000 Hz) is created in a tube and travel along it where it passes a microphone and enters the nasal cavity via a nosepiece. Changes of MCA is reflected, recorded and calculated. The measurements are displayed as a curve where the cross-sectional area (cm^2) is represented in X-axis and the distance from nostril (cm) represented in Y-axis.

The results are then analyzed by the in built software to provide a graphic display of the cross-sectional area and the nasal volumes. Two notches are seen on the graph in the proximal five cm of the baseline are assumed to relate with the location of the structural component of the nasal valve while the anterior part of