Sudan University of Science and Technology

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Study of Upper Airway Tract of Normal and Snoring patients using Computed Tomography

دراسة الجهاز التنفسي العلوي للأشخاص الطبيعيين ومرضي الشخير باستخدام جهاز الاشعة المقطعية المحوسب

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Dedication

Dedicated to

My father

The spirit of my mother and sister

My small family husband and kids

My brothers ,sister and, Colleagues

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I would like to dedicate my sincerest gratitude for the people who have continuously supported me throughout the process of making this thesis possible.

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Abbreviations

OSAS	Obstructive sleep apnea syndrome
MDCT	Multidetectors computed tomography
CT	Computed tomography
UA	Upper airway
OSA	Obstructive sleep apnea
CSAs	Cross sectional areas
OSAHS	Obstructive sleep apnea hypopnea syndrome
MRI	Magnetic resonance imaging
BMI	Body mass index
EDS	Excessive daytime sleepiness
NCPAP	Nasal continuous positive airway pressure
SNA	Angle between sells ,nasion and anterior nasal spine
SNB	Angle between sella , nasion and supramentai
ANB	Angle between anterior nasal spine ,nasion and supramentai
S	Sella
N	Nasion
ANS	Anterior nasal spine
PNS	Posterior nasal spine
SDB	Sleep disorder breathing
Ksa	Kingdom of Saudi Arabia
Kvp	Kilo electron volt peak
mA	milli Ampere

PNS-U	Distance—from the posterior nasal spine to the tip of the uvula
SP-max	Maximum thickness of the soft palate
RS	Retroglosal
RP	Retrplatal
NC	Neck Circumference
UAL	Upper airway length

Abstract

Snoring is a respiratory sound which originates during sleep, and so can be nocturnal or diurnal. Snoring may result in serious health and social problems.

The main objectives of this study were to characterize of upper airway tract in snoring and non-snoring patients and establish normative data of upper airway in Saudi adult population who are living in Jazan-South Saudi Arabia

Two hundred Asian patients undergoing Computed tomography (CT) scanning for head and neck were included and were divided into two groups (snoring group [n = 127] and non-snoring group [n = 73]) (mean age: 44.8 ± 15.9 years and 26.2 ± 7.0). Total 8 parameters were measured on sagittal reconstructed CT images for each subject. The differences in neck circumference (NC), linear distance between mandibular plane and hyoid bone (Mp-H), upper airway length (UAL), the maximum thickness of the soft palate (SP max), soft palate length (PNS-U), linear distance between anterior and posterior nasal spine (ANS-PNS),retroglosal width (RS), retroplatal width (RP) Results showed that the NC, UAL, and SP max were significantly higher in snoring group; however RP was found to be significantly lower. Inferior positioning of hyoid bone gives longer measurement for MP-H. In snoring group UAL was found to be significantly different at $p \leq 0.000$ between the two genders. All the measured variables showed no significant differences in respect to age. Upper airway (UA) CT quantitative features play an important role in the characterization of the anatomy and are compared between snoring patients and non-snoring subjects.

In order to obtain normative data of upper airway in Saudi adult population who are living in Jazan-South Saudi Arabia to be considered as local reference; another group of patients were selected. 64 healthy subjects, 43(67.2%) were males and 21 (32.8%) were females with (mean age: 25.69±6.6). All were with normal skeletal profile with no history of sleep-related disorders or trauma. The cephalometric parameters assessed were; (ANB)the angle between the nasion (N)–sella(S) line and the line from deepest point of maxilla(A) , (SNB) the angle between the nasion (N)–sella(S) line and the line from deepest point of mandible (B) and(ANB) angle indicates an antero-posterior relationship between the mandible and maxilla . (NC) and other upper air way measurement including (MP-H), (UAL), (SP max), (PNS –U), (ANS- PNS), (RS), (RP) were measured and evaluated in both genders. No significant gender dimorphisms results were observed in most of the parameters with the exception of the (SP max), and (NC). A local reference of upper air way values for Saudi –Jazan population was recognized. New equations to predict the (ANS- PNS), (MP-H) and (NC) for Saudi population of known age were established. Saudi in Jazan have distinct cephalometric and upper air way tract features, for which specific norms should be used as a reference in treating orthodontic patients and sleep disorder breathing. Norms for the airway in the Saudi-Jazan population have been established in this study.

ملخص البحث

الشخير هو الصوت الذي يخرج من الجهاز التنفسي أثناء النوم، يمكن أن يكون ليلي أو نهاري. قد يؤدي الشخير الي مشاكل صحيه واجتماعيه خطيرة الهدف الرئيسي من هذه الدراسة وصف الجهاز التنفسي العلوي للمرضي الذين يشخرون والذين لا يشخرون اثناء النوم بالإضافة لتأسيس مرجعيه في وصف الجهاز التنفسي العلوي للسكان البالغين السعوديين الذين يعيشون في جازان-جنوب المملكة العربية السعودية.

وصف الجهاز التنفسي العلوي للمرضي الشخير مقارنه مع من لا يشخرون اعتمد علي الطريقة الكميه للعوامل التشريحية لمجري الهواء العلوي باستخدام التصوير المقطعي المحوسب شملت الدراسة مائتي مريض اجري لهم فحص للراس والرقبة عن طريق الأشعة المقطعية وقد قسمت إلى مجموعتين (مجموعة من يشخرون [عدد = 127] ومجموعة من لا يشخرون ، [عدد = 73]) (متوسط العمر: 44.8 ± 15.9 سنة و 26.2 ± 7.0). تم قياس ثمانية عوامل للصور المقطعية في الوضع الجانبي والتي اشتملت علي قياس محيط الرقبة (NC) و قياس المسافة بين الفك السفلي والعظم الامي (MP-H)، قياس طول مجري الهواء العلوي (UAL) ، الحد الأقصى لسمك اللهاة (SP Max)، طول اللهاة (PNS-U) ، طول الفك العلوي (PNS-ANS)، عرض المسافة خلف اللهاة (RS)،عرض المسافة خلف اللسان (RP) واظهرت النتائج ان هناك اختلافات مقدره بين المجموعتين حيث ان قياس محيط الرقبة (NC) وطول مجري التنفس العلوي (UAL) وسمك اللهاة (SP max) اعلي بكثير في مجموعه الشخير وان المسافة خلف اللهاة (RP) اقل في مجموعة الشخير . موقع العظم الامي MP-H يعطي قياس أطول. في مجموعة الشخير ، طول مجري التنفس العلوي UAL مختلفة بشكل ملحوظ بين الجنسين . وأظهرت جميع المتغيرات قياس فروق ذات دلالة إحصائية فيما يتعلق العمر. التصوير المقطعي المحوسب للجهاز التنفسي العلوي يلعب دورا هاما في توصيف التشريح والمقارنة بين المرضي الذين يشخرون ومن لا يشخرون. للحصول على البيانات المعيارية من مجرى الهواء العلوي في عدد السكان السعوديين البالغين الذين يعيشون في جازان-جنوب المملكة العربية السعودية لا اعتبار المرجعية المحلية. شملت الدراسة 64 شخصا سليما، 43 (67.2٪) من الذكور و 21 (32.8٪) من الإناث (متوسط العمر: 25.69 ± 6.6). عوامل قياسات الرأس تم تقييمها علي النحو التالي . SNA زاويه تشير لعلاقة الفك العلوي بقاعدة الراس ، SNB زاويه تشير لعلاقة الفك السفلي بقاعدة الراس

ANB, زاويه تشير لعلاقة الفك العلوي بالسفلي (NC) وغيرها من قياس مجري الهواء العلوي بما في ذلك (MP-H)، (UAL)، (SP MAX)، (ANS- U)، (ANS- PNS), (RS))، (RP) تم قياسها وتقييمها في كلا الجنسين. لوحظت النتائج انه ليس هنالك اختلاف مقدر بين الجنسين في معظم العوامل باستثناء (SP Max) و (NC). انشئت معادلات للتنبؤ بمعرفة العمر بالنسبة ل (PNS -ANS)، (MP-H) و (NC) للشعب السعودي في جازان .
الاستنتاجات: السعوديون في منطقة جازان تم تميز العوامل الطبيعية لمجري الجهاز التنفسي العلوي وقياسات الراس نامل في استخدامها كمرجع في علاج تقويم الاسنان كما نامل ان تكون مفيدة كمرجع لتقيم حالات متلازمة توقف التنفس اثناء النوم بالنسبة للسعوديين في منطقة جازان.

Contents

Chapter One

Introduction

Snoring sounds are mainly composed of both the vibrational sounds of the upper airway soft tissues (soft palate, uvula, tongue base, epiglottis, and tonsils) and the noise passing through the narrowed airway

Snoring in ancient times was known as a sign of good sleep, but recently discovered that was a one of the symptoms which indicate sleep disordered breathing such as sleep apnea syndrome. Breathing in sleep normally by nasal but when nasal obstructed ,breathing become by oral then habitual loud snoring was happen . Since oral breathing tends to make the upper airway more collapsible, loud snoring caused by oral breathing found in many sleep apnea/hypopnea patients (Tsuyoshi . 2014)

muscle relaxation, and Oral snoring is a typical symptom of OSAS. Open mouth during sleep moves the lower jaw downward and the tongue base tends to obstruct the airway. This cause is different from the enlargement of the upper airway soft tissues.

Patients with snoring and OSAS are also at increased risk for coronary artery disease, stroke, hypertension diabetes mellitus, and involvement in traffic accidents . recently focused on serious one which is traffic accidents, as serious problem which are caused by the daytime heavy sleepiness of the drivers. Such sleepiness is one of the most serious problems , because snoring patients do not have a good sleep due to an unconscious awakening caused by apneas during sleep. traffic accidents caused by moderate or severe sleep apnea is more times higher than that caused by normal drivers .Loud snoring, often becomes problem for the family of patients at home. Non of their families can even in social problem (Tsuyoshi . 2014)

Varity technique used to evaluate patient with snoring and OSAS one of them MDCT, common structures of upper airway and craniofacial structures will be demonstrated by using MDCT included, , soft plate, hard plate, uvula, epiglottis, parapharyngeal fat and muscle ,volume of retroplatal ,retroglosal volume, maxilla, mandible and hyoid bone .CT is attainable, fast, provides excellent detail of the airway and surrounding tissues, and is the good of upper airway imaging. Intravenous contrast is generally recommended unless a clear contraindication, and the addition of intravenous contrast enhances visualization of the vasculature and other soft tissue components. (Eugene and Renaud . 2010)

MDCT scanners have very fast scan times, which allow visualization of the entire airway and limits motion artifact. By other hand MDCT scanners allow for isotropic voxels, and these data can be displayed in different planes without loss of resolution. Three-dimensional post-processing of the raw CT data provides a different diagnostic viewpoint . The frequent use of CT due to the ease of access and rapidity of results also raises concern for increased cumulative radiation exposure. This issue is perhaps of greatest concern in the pediatric population and in women of childbearing age(Eugene and Renaud . 2010)

1.2 Problem of study

Snoring and Sleep apnea affects the breathe during sleeping. In untreated snoring or sleep apnea, breathing should interrupted or becomes very shallow during sleep. These stopping breathing can occur up to hundreds of times a night, then lead to , daytime sleepiness, slow reflexes, poor concentration, personality changes, impotence in men, morning headaches ,and an increased risk of accidents. also lead to serious health problems over time, including diabetes, high blood pressure, heart disease, stroke, and weight gain.

Diagnostic studies have been used to assess upper airway anatomy in patients with snoring to reveal potential differences in upper airway anatomy and also to improve patient management and treatment. And then decreasing morbidity and mortality

1.3 Objectives of the study

1.3.1 General objective

- Characteristics of upper airway tract in snoring and non snoring patients
- Establishing reference of normative data of upper airway tract and craniofacial structures of Saudi population who living in Jazan

1.3.2 Specific objectives

- To evaluate the upper airway differences in patients with snoring and non snoring
- Identify the factors that can cause snoring and the areas of the airway that are the most likely to collapse
- Determine the craniofacial structures contributing to snoring
- Identify the key structures associated with snoring
- Determine the level of narrowing
- Find correlation between significant anatomical differences
- To define the normative airway of Saudi population in Jazan region three-dimensional imaging

Chapter Two

Chapter Two

Literature Review

2.1 Upper airway anatomy

The upper airway is a complex structure composed of soft tissue and more than 24 muscles that work in a dynamic biomechanical relationship to perform many different physiologic functions including respiration, deglutition, and vocalization. (Schwab et al ,1998) The upper airway is divided into three sub-regions based on sagittal imaging nomenclature Figure (1): the nasopharynx – a region between the hard palate and nasal turbinates , the oropharynx – a region that is subdivided: retropalatal – the level of the hard palate to the caudal margin of the soft palate; retroglossal – the caudal margin of the soft palate to the epiglottis base; and the hypopharynx – a region from the base of the tongue to the cervical esophagus.(Listro et al.2003)

The pharyngeal airway lies posterior to the nasal cavity, oral cavity, and larynx and begins its inferior descent posterior to the nasal turbinates towards the esophagus. The upper airway is bounded superiorly by the basilar portion of the occipital bone and body of the sphenoid; anteriorly by the nasal turbinates, soft palate, tongue, and epiglottis; posteriorly by the superior middle and inferior pharyngeal constrictor muscles; and laterally by soft tissue and several muscles, the palatine tonsils, and the pharyngeal fat pads(Schwab et al ,1998)

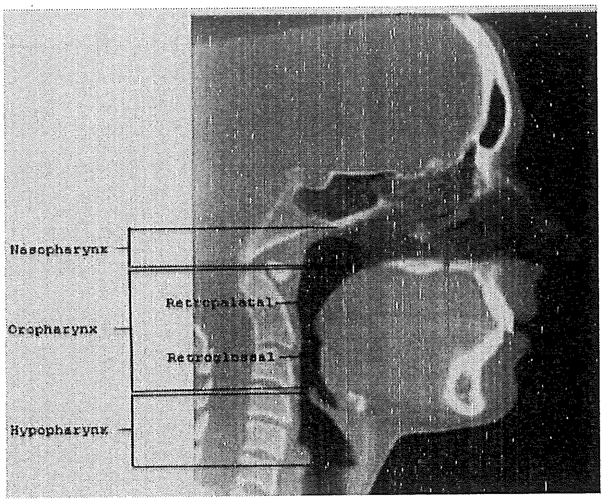

Figure 2 .1 : Pharyngeal Airway Anatomy (Patrick G, 2013)

2.2 Upper Airway Anatomy and Sleep

Human neonates have the remarkable ability to breathe, suck ,and swallow simultaneously owing to the anatomical configuration of the upper airway at birth. Additionally, neonates are obligate nose breathers. During the first month of life, the neonatal upper airway grows and matures toward adult upper airway proportions; the infant's ability to breathe, suck, and swallow simultaneously wanes. Throughout infancy, adolescence, and adulthood, humans remain obligate nose breathers during sleep, which is often the source of significant problems for individuals with sleep disorders.((Mallampati et al. 1985))

The upper airways comprise three primary anatomical regions: the nose, pharynx, and larynx., normal pharyngeal muscle tone prevents the base of the tongue from falling backward in the oral cavity and obstructing the oropharyngeal airway figure (.2). Sleep or unconscious states result in a loss of pharyngeal muscle tone and the relaxation of the soft tissue that constitutes the oropharynx and the tongue, under the influence of gravity, the relaxed tongue falls into the oropharynx, partially or totally occluding the airway. Partial occlusions result in low-pitched snoring sounds,

whereas complete occlusion results in apnea , characterized by ventilator efforts without airflow. Several other soft tissue anatomical structures in the oropharynx may contribute to partial or total obstruction.
(Mallampati et al. 1985)

Obligate nose breathing during sleep causes problems when the nose is obstructed. Many individuals experience difficulty sleeping when nose breathing is limited because of nasal congestion that accompanies a cold or allergy. At the onset of sleep when obligate nose breathing begins, restricted nasal air passages usually cause sleepless or restless nights. Anatomical abnormalities such as a deviated septum create a permanent limitation of airflow through one or both of the nares. Poor quality of sleep is often a major complaint of individuals with nasal septum abnormalities. The assessment of a potential sleep disorder should always begin with inspection of each naris for patency and unrestricted air flow. If allergies are an issue, medications that diminish nasal swelling or secretions to reduce airflow restriction should be considered. If anatomical obstruction is the primary cause of air flow limitations, corrective surgery may be the best remedy for the sleep disorder. If the nose is occluded during sleep, secondary mouth breathing becomes necessary. Regardless of nose or mouth breathing, the oropharyngeal airway must remain patent to allow ventilation. Within the oral cavity, five specific structures can obstruct airflow. Mallampati was the first to categorize the amount of "open space" in the oropharynx by the visualization of five structures: the tongue, the soft palate, the hard palate, the uvula, and the tonsils. (Mallampati et al. 1985)

Originally used to classify the difficulty level of oral endotracheal intubation, the Mallampati score Figure (3) is determined by direct visualization of the oropharynx through the open mouth. There are four categories of decreasing airway space A Class I score is considered normal ,in which all five anatomical structures are visible. In Class II, all five structures can be identified, but only the upper portions of the tonsils and uvula are visible. Class III allows only the tongue, the soft and hard plate, and the base of the uvula to be seen. Class IV allows visualization of only the hard palate and tongue. The higher the Mallampati classification number, the more anatomical crowding with less oropharyngeal room for airflow .Sleep research has shown a positive correlation between a high Mallampati score and the risk for obstructive sleep disorders when nasal obstruction is present. (Listro et al .2003)

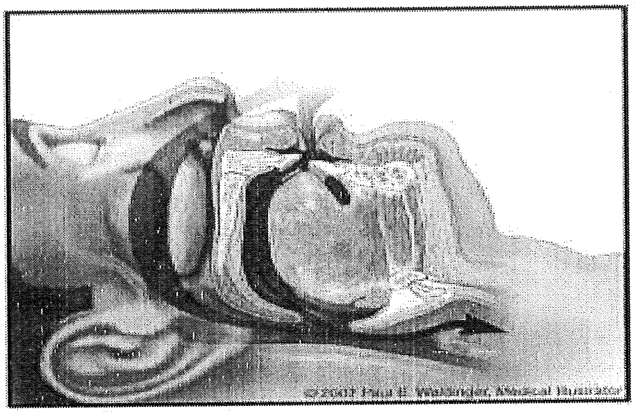

Figure 2.2: Normal airway: no obstruction in the upper
(Tsuyoshi. 2014)

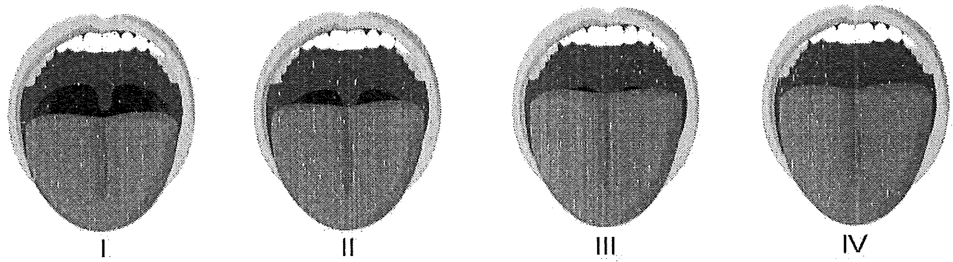

Figure 2.3: Modified Mallampati Grade; Class I (soft palate, uvula, faces, pillars visible), Class II (soft palate, uvula, faces visible), Class III (soft palate, base of uvula visible), Class IV (only hard palate visible
(Tsuyoshi. 2014)

2.3 Physiology of the Nose , Nasal Cavity and pharynx

The nose and its internal nasal cavity provides a passageway for the air to pass through to the lungs, warms and moistens (humidifies) the inhaled air, filters and cleans the inhaled air from any foreign particles, resonates sounds for speech, and houses the olfactory receptors for smell (J. Tu et al. 2013)

The pharynx serves to provide a passageway for both the digestive system and respiratory system since food and air pass through it. The food or air is directed down the correct passageway, either the esophagus or the trachea, by being controlled by the epiglottis. The epiglottis is a flap of elastic cartilage tissue that acts as a lid to cover the trachea when food is swallowed in order to prevent objects entering the larynx During swallowing, the soft palate and its uvula point upwards closing the nasopharynx so that neither air nor food can pass through it thus breathing is momentarily stopped. The connection opens and closes to equalize the air pressure in the middle ear to that of the atmosphere for the conduction of sound. The surface of the nasopharynx is covered by pseudo-stratified columnar epithelium. This is the same epithelium found in the nasal cavity and similarly the same mechanism of mucous secretion from goblet cells in the epithelium to filter, warm and humidify the inhaled air occurs here. In the oropharynx and laryngopharynx the surface is lined with non-keratinizing stratified squamous epithelium which is needed as it is exposed to food moving through the passageway (J. Tu et al.2013)

2.4 Snoring

Snoring is a respiratory sound (or noise) which originates during sleep, and so can be nocturnal or diurnal. It is a typical inspiratory sound, even though a small expiratory component can be heard or recorded with different spectral features. We must distinguish it from all the other sounds (noises) which can be heard, recorded and analyzed during sleep (F. Dalmasso . 1996)

Snoring is known to affect over 60% of adult men and 44% of women over the age of 40 in the world .The noise of snoring can disrupt sleep for the snorer, the bed partner and other members of the household, and more importantly, it is the earliest and most consistent sign of upper airway (UA) dysfunction leading to sleep apnea/hypopnea syndrome (Thorpy .1990)

Snoring is a common symptom of airway obstruction, which is included in the spectrum of sleep-related breathing disorders. The manifestation may occur alone(primary snoring) or in association with other signs and symptoms such as rhinorrhea, hyponasal speech, cough, hypopnea, and sleep apnea. In the latter condition, which is better known as obstructive sleep apnea syndrome (OSAS), patients present nighttime and daily behavioral signs and symptoms that can result, in extreme cases, in serious cardiovascular impairment. In a pediatric age, the most frequent cause of snoring is adenoid hypertrophy. This disorder is probably the most frequent disease occurring in children and, when associated with palatine tonsil hypertrophy, leads to OSAS.(Eugene et al .2010)

2.5 Obstructive Sleep Apnea

Sleep apnea is defined as cessation of airflow to the lungs during sleep for 10 s or more. (J.Lucas et al.1988; R.L. Wilkin.1985). There are mainly two causes of sleep apnea, mechanical and neurological. Mechanical cause is the upper airway collapse, and the resulting apnea is called as obstructive sleep apnea (OSA). Neurological cause is the lack of neural input from the central nervous system to the diaphragm ,and the resulting apnea is known as central sleep apnea (R.L. Wilkin.1985). OSA is the mostly encountered form of the sleep apnea. Common symptoms of OSA are fatigue, reduction in cognitive functions, daytime sleepiness, heart problems, and systemic hypertension (R.L. Wilkin.1985; R. J. Martin.1990). It is usually associated with loud, heavy snoring (R.L. Wilkin.1985). In OSA, the upper airways are obstructed during sleep, resulting in the decrease of oxygen flow to the lungs. Patients suffering from OSA often wake up frequently. When there is a full closure of airways, the problem is termed "apnea" Figure (4) and when there is a partial closure, it is known as "hypopnea Figure(5).OSA is a serious public health concern throughout the world. An estimated 9% of the women and 24% of the men of 30-60 years are reported to have more than five apnea or hypo pnea per hour of sleep and daytime hyper somnolence (excessive sleepiness),which constitute the minimal diagnostic criteria for the sleep apnea syndrome(T.Young et al .1993).

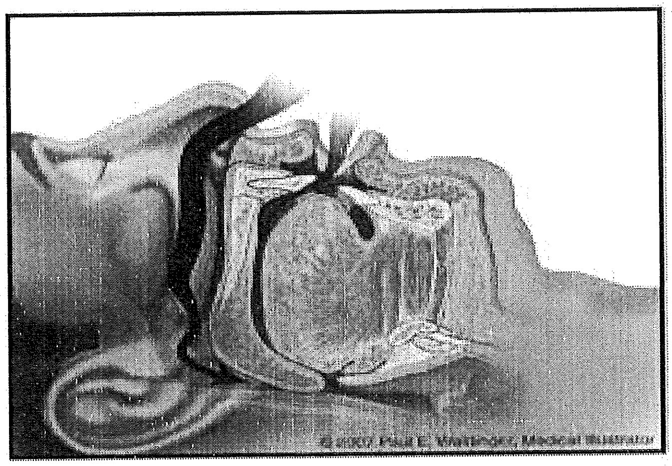

Figure 2.4: Obstructive sleep apnea; the flow of air is blocked through the upper airways (Tsuyoshi. 2014)

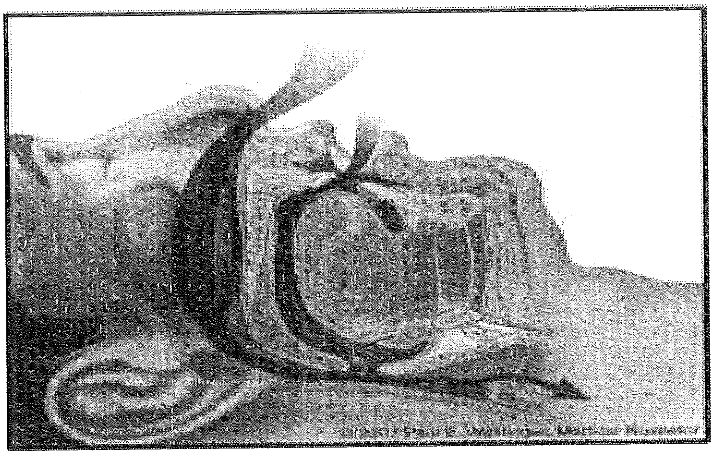

Figure 2.5 : Hypopnea; partial obstruction of the upper airway. (Tsuyoshi. 2014)

2.6 Factors that influence collapsibility of the upper airway

2.6 .1 Anatomic narrowing of the upper airway

Suratt et al. found, using CT scanning, that the CSAs of the retropalatal region were significantly smaller in OSAHS patients than in control subjects (Suratt et al. 1983). Bradley et al. demonstrated that snorers with and without OSAHS have smaller pharyngeal CSAs than non-snorers. (Bradley et al. 1986).Rodenstein et al., using MRI, did not find any difference between healthy subjects, snorers, and OSAHS patients in most anatomical measurements. (Rodenstein et al. 1990) These studies, using different methods, describe opposite results regarding differences in anatomic narrowing between the upper airways of OSAHS patients and snorers/control subjects. These inconsistencies result may indicate that anatomic narrowing concerning to snorers and OSAHS in some, but not in all, patients, another point these studies examining the upper airway size during wakefulness do not examine during sleeping which leads to increasing muscular relaxation

2.6.2 Sleep position

Unlike the supine position the lateral position may prevent the tongue from occluding the airway (Gastaut H et al. 1966). The shape and length of the trachea change when lying on the side (Thut DC et al.1993) and this could cause an increase in the tension of the mucosa of the upper airway which would additionally protect against airway collapse (Van de Graaff WB. 1988) these studies shows the influence of sleep position of upper airway collapse

2.6.3 Gender

. The necks of men are thicker than the necks of women matched for BMI (Martin SE, et al .1997). This could lead to increased mass loading in men when they lie down and, consequently, increase upper airway narrowing during sleep. Popovic et al. demonstrated that female hormones (possibly progesterone) influence the upper airway dilator muscle activity during wakefulness. (Popovic et al .1998).In a study by Cistulli et al. testosterone administration had an adverse influence on the sleep disordered breathing .an influence on neuromuscular control of upper airway patency during sleep (Cistulli et al .1994).

2.6.4 Age

In a study by Jennum and Sjol an elevated snoring were associated with age (Jennum P, Sjol A.1992).. The pharyngeal lumen in normal awake men becomes greater with increasing age (Burger et al. 1992), These studies explain the influence of age of the upper airway narrowing

2.6.5 Obesity

Obesity is a risk factor for OSAHS and snoring (Young T et al. 1993). The association with obesity may be caused by increased fat deposition adjacent to the pharyngeal airway (Shelton et al .(1993)) These studies shows the relation between obesity and snoring .obesity which is leads to increasing fat deposition around pharyngeal lumen then narrowing upper airway

2.6.6 Alcohol

Alcohol increases the upper airway resistance during sleep and the apnoea index in asymptomatic snorers as demonstrated by (Mitle et al.1989.These study explain increasing upper airway resistance in alcoholic patients

2.6.7 Smoking

Current smokers compared with never smokers had a significantly greater occurrence of snoring and of sleep-disordered breathing in an epidemiological study including 811 adults enrolled in the University of Wisconsin Sleep Cohort Study (Wetter et al. 1994) . From these study shows that smoking t may contribute to the development to snoring.**2.7**

2.7 Effects of upper airway narrowing

2.7.1 Hypertension

Hu et al. studied the association between snoring and hypertension were found. Snoring, especially regular snoring, was associated with a statistically significantly increased risk of hypertension independent of age, BMI, waist circumference, and other lifestyle factors. In addition, snoring was associated with significantly higher systolic and diastolic blood pressure levels (Lindberg et al .1998). These study shows hypertension is one of snoring risks

2.7.2 Mortality

Lindberg et al. published a prospective population based study based on a sample of 3,100 men, aged 30-69, followed for a period of 10 years. Snoring without EDS did not carry an increased risk of mortality, but the combination of snoring and EDS was associated with a significant increase in mortality in men below 60 (Lindberg et al .1998). These published explain snoring with Excessive daytime sleepiness increasing risk of mortality

2.7.3 Coronary disease and stroke

Hu et al. examined prospectively the association between snoring and the incidence of cardiovascular disease in women without previously diagnosed cardiovascular disease or cancer at baseline. They followed 71,779 female nurses aged 40 - 65 for 8 years. Snoring was associated with an increased risk of stroke and coronary disease independent of age, smoking, BMI, and other cardiovascular risk factors (Hu et al .2000).These study describe association between snoring and increased risk of cardiovascular disease ,stroke, coronary disease in women

2.7.4 Diabetes mellitus

Al-Delaimy et al. examined prospectively the association between snoring and the diabetes mellitus in women.. Regular snorers were at higher risk than occasional snorers of developing diabetes, (Al-Delaimy et al .2002). In another prospective study by Elmasry et al. 2,668 men aged 30-69 years. The study suggested additive effects of obesity and snoring on the risk of developing diabetes (Elmasry et al . 2000). These studies explain snoring might increase the risk of diabetes.

2.7.5 Road traffic accidents

There is a relatively strong evidence of a link between OSAHS and daytime sleepiness and road traffic accidents as demonstrated by Wright et al in their systematic review (Wright et al. 1997). Findley et al. recently found that OSAHS patients using NCPAP have a lower crash rate while being treated than before treatment. Untreated OSAHS patients continue to have a high crash rate. The crash rates were confirmed with traffic records (Findley et al .2000). From these studies shows snoring and OSA increasing road traffic accidents because snoring and OSA causes fragmentation of sleep , reduced blood oxygen and excessive daytime somnolence and then reduce drive efficiency

2.8 Radiology Investigations

Many studies have a try to investigate the site of narrowing of the upper air way with the help of CT and cephalometry in patients with snoring. helpful effects on treatment and surgical intervention. some considerations must be taken when assessment the patient. One should realize that the findings obtained during wakefulness cannot always predict the site of collapse, partly because the additional effect of muscle relaxation during sleep can result in an increased collapsibility.. In general clinical practice, the restricted availability, the associated costs and the associated ionized radiation.

2.8.1 Lateral cephalometry

Is a simple non –invasive, easily available, relatively inexpensive and well-standardized technique involving radiographs of the head and neck with focus on bony and soft tissue structures. Over the years, lateral cephalometric radiography has become one of the standard diagnostic tools to evaluate skeletal and soft tissue abnormalities contributing to obstruction, and have been the most common imaging method in evaluating the patients with OSAS. The cephalometric images are used to study measurements of many set points, planes or distances within the head and neck region. . radiograph of the head and neck with special focus on several bony and soft tissue landmarks are involved in this traditional method. The parameters that are aimed to be measured include the distance between these set points and the angles between the lines connecting the landmarks Figure (6). The relationships of the cranium to the maxilla and the mandible are assessed by measuring angles between the sella, nasion, and anterior nasal spine (SNA angle) for the maxilla; and the sella, nasion, and supramentale (SNB angle) for the mandible Figure (7) However, there are some problems, lateral cephalometry provides a 2-dimensional, static image of a 3-dimensional, dynamic structure and is unable to provide volumetric data or evaluate important soft tissue structures including the uvulopalatal complex and tongue base. The method also does not provide any information related to tonsillar hypertrophy or other lateral soft tissue structures in the upper way(Eugene and Renaud . 2010)

2.8.1.1 Identification of cephalometric landmarks

These fall into groups:

2.8.1.1.1 Skull base points

Sella(S) - midpoint of sella turcica

Nasion(N) - junction of nasal and frontal bones

2.8.1.1.2 Upper jaw points

Anterior nasal spine (ANS) - the bony tip of the maxilla

Posterior nasal spine (PNS) - tip of the posterior nasal spine

Point A - the deepest concavity of the maxillary alveolus

2.8.1.1.3 Lower jaw points

Point B - deepest concavity on the mandibular alveolus

S-N- representing the skull base

Angles SNA & SNB - representing the relationship of maxilla and mandible to skull base in an a-p plane

ANS - PNS -the maxillary plane

SNA angle relates the maxilla to the skull base in an a-p plane. SNB angle relates the mandible to the skull base in an a-p plane .and ANB indicates the relative positions of maxilla and mandible to one another

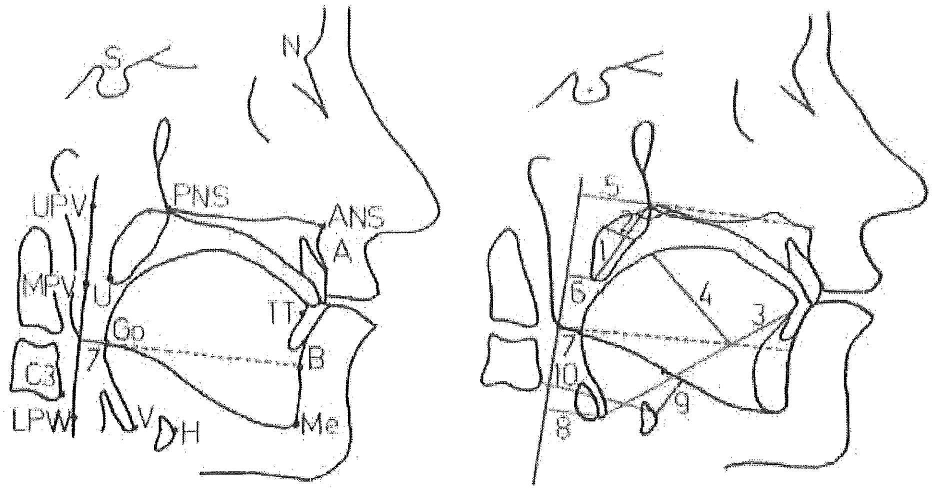

Figure 2.6 : Lateral cephalometric landmarks (A) and variables (B) (Eugene and Renaud .2010)

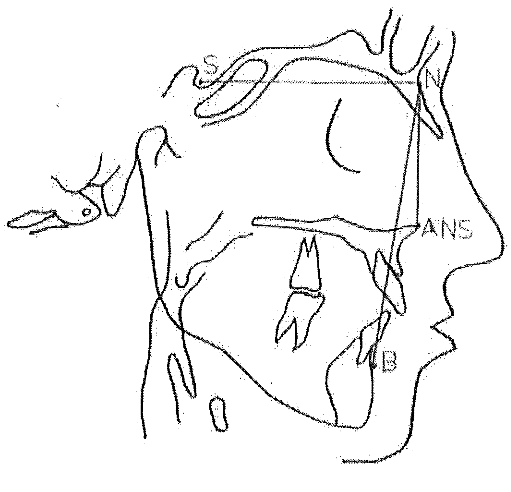

Figure 2.7 : Lateral cephalometric analysis, normal subject. SNA angle represents the relative position of the maxilla while SNB angle represents the relative position of the mandible to the skull base (Eugene and Renaud . 2010)

2.8.2 Computed Tomography Scanning

Computed tomography (CT) is a noninvasive technique that allows a detailed assessment of the entire upper airway. When compared to lateral cephalometry, CT scanning significantly improves soft tissue contrast, leads surgical interventions toward the abnormal anatomic sites and allows for precise measurements of cross-sectional areas at different levels. Although CT scan exquisitely displays bony details, it has a limited soft-tissue contrast resolution (poor contrast resolution) when compared to MRI scanning. This is particularly relevant to evaluating upper airway adipose tissue. Other restrictions of CT scan include relatively expensive, excessive radiation ,and the radiation exposure, and patient weight (Eugene and Renaud . 2010)

The anatomy of the upper airway mainly represents the static dimensions of the airway during wakefulness, and does not have a high predictive value for diagnosing snoring. In order to examine the upper airway, various techniques of CT imaging can be applied which include standard axial CT with the option of three-dimensional reconstruction the upper airway structures, spiral CT that have the ability to provide volumetric images, dynamic CT with high imaging speed, and. Spiral (helical) CT allows for a rapid acquisition of volumetric data of the part of the body under examination. The advantage of spiral CT includes the elimination of respiratory misregistration, decreased motion artifact, a shorter duration of examination, and high quality of reformatted images . This modern technology allows for reconstruction of the data from CT scan in forms of 3-dimensional images It is easier to assess the upper respiratory tract via three-dimensional reconstructed CT scan than it is by unreconstructed CT scans. It enables an accurate measurement of the airway dimensions and calculates airway volume. Static imaging may show areas of narrowing (Eugene and Renaud . 2010)

. Another advantage of CT scanning in the supine position is the accurate measurement of upper airway cross-sectional area. Attempts have been made to use CT analyses in order to distinguish healthy controls from snoring patients, to determine the severity of the underlying SDB, to choose more successful candidates for surgery, to determine the appropriate type of surgery, and to evaluate the outcome of surgery. (Eugene and Renaud . 2010)

Chapter Three

Materials and Methods

3.1 Materials

3.1.1 Sample 1

Two hundred patients undergoing CT scanning for head and neck were included in the study. 147 (73.5%) were males and 53 (26.5%) were females. The sample was divided into two groups (snoring group [n = 127] and non-snoring group [n = 73]) (mean age: 44.8 ± 15.9 years and 26.2 ± 7.0). The CT scans of patients without snoring or any sleep related symptoms or changes affected the upper air way tract were evaluated as controls and were used for comparison with snoring group. All participants were non traumatic. In the present study the Saudi population in the sample including 174 patients and the rest were from other Asian populations

3.1.2 Sample 2

64 non- snoring Saudi patients from 174 Saudi population patients underwent CT scanning for head and neck were included in the study. 43(67.2%) were males and 21 (32.8%) were females. (Mean age: 25.6875±6.6). All patients were from Jazan –Saudi Arabia region. The CT scans of patients without snoring or any sleep related symptoms or changes affected the upper air way tract were evaluated as normal subjects All participants were non traumatic

Verbal consent was firstly obtained from all potential participants. The aims, benefits of the present study were explained to all participants in details. As the majority of individuals who snore are unaware of their snoring, questions about snoring were answered by the bed partner or relatives and not by the snorer themselves and those with conditions that may in any way, alter the findings of the current study were excluded

3.2 Methods

3.2.1 CT Scan

Head and neck Computerized tomography examination was performed by multislice computed tomography with 16 line detector (Toshiba Aquilion (TSX-101A)16,(Jazan.jizan General hospital ,ksa)

3.2.1.1 CT Scan Technique

Exam performed in all patients awake in the supine position in the head holder with the Frankfort plane perpendicular to the floor their heads and neck in a neutral position. Patients asking to suspend the breathing during scan to avoid motion artifact , Slices in the helical plane, extending from the top of the head to the hypopharynx ,below the level of the Cricoid cartilage , AP and lateral scout view was taken first to determine the level of the scans,. The conditions of scanning were. pixel size 512x512, scanning plane transverse ,no gantry tilt, display field of view (DFOV) ~ 13, scan field of view (SFOV) large , with stander and bone algorithm , gantry rotation time 0.8s, Acquisition (detector width x number of detector rows) = coverage 0.628mm x 16 = 10 mm , reconstruction (slice thickness / interval) 2.50/ 1.25 , pitch 0.562 , kvp auto mA 140/125,325

The image were transport to another workstation measurements were done on the lateral scout view and sagittal views, using special computer soft ware (RadiAnt DICOM viewer 32 BIT). Cephalometric measurements were made on the lateral scout view . Neck circumference (NC) at the level of Cricothyroid membrane, ages and seven standard bony and soft-tissue measurements to show changes in snoring patients were obtained for sample (1) and ten standar bony and soft tissues measurement for sample 2 to show normal data in non snoring patients

3.2 .1.1.1 Identifying Variables:-

Soft palate length (PNS-U) that is the distance between posterior nasal spine and the uvula. Maximum thickness of soft palate (SP max), Upper airway length (UAL)is vertical distance from the hard palate to the hyoid bone, Retroplatal width (RP) behind the soft palate. Retroglosal width (RS) behind the tongue. MP-H is the distance between mandibular plane and hyoid bone. ANS-PNS is the linear distance between anterior nasal spine (ANS), and posterior nasal spine (PNS). SNA deg the angle between the nasion (N)–sella(S) line and the line from A. SNB deg the angle between the nasion (N)–sella(S) line and the line from B . ANB deg the angle can be calculated from the formula (ANB = SNA – SNB). (Point A (A) – the deepest point on the contour of the alveolar projection, between the spinal point and prosthion , point B (B) – the deepest midline point on the mandible between infra dental and pogonion)

3.2 .1.1.2 Cephalometric measurements: -

Lateral cephalometric image (scout view) showing the craniofacial skeletal reference points and lines used for linear and angular measurements.

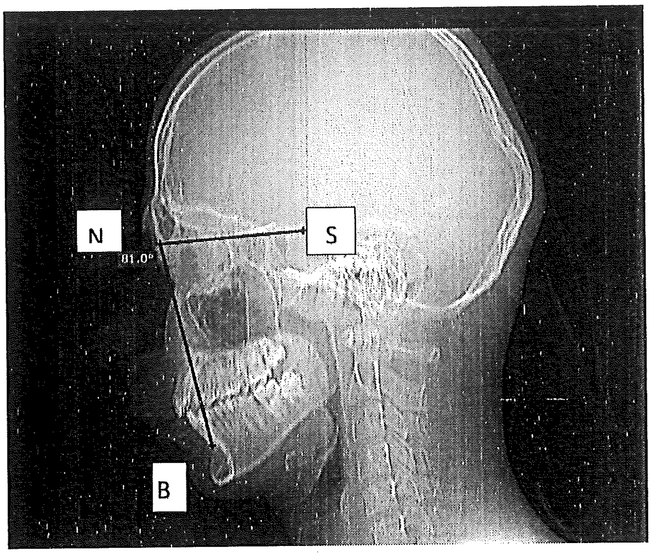

Figure 3.1 : Male . 29 years. (SNB :mandibular protrusion angle)

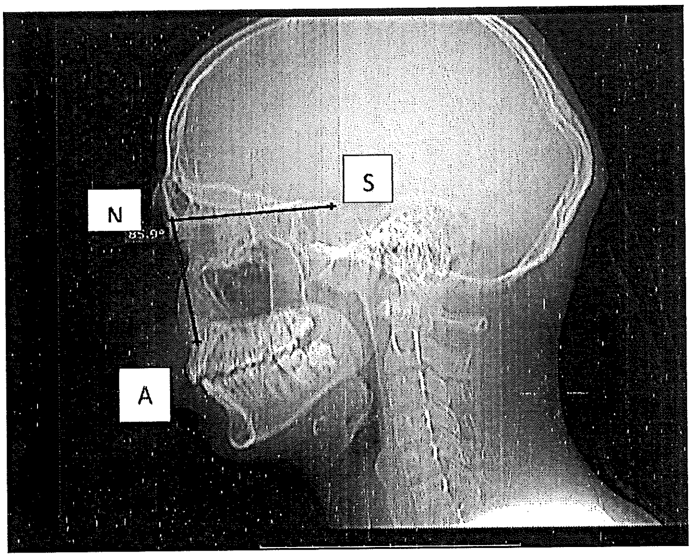

Figure 3. 2 : Male . 29 years. (SNA Maxilla protrusion angle)

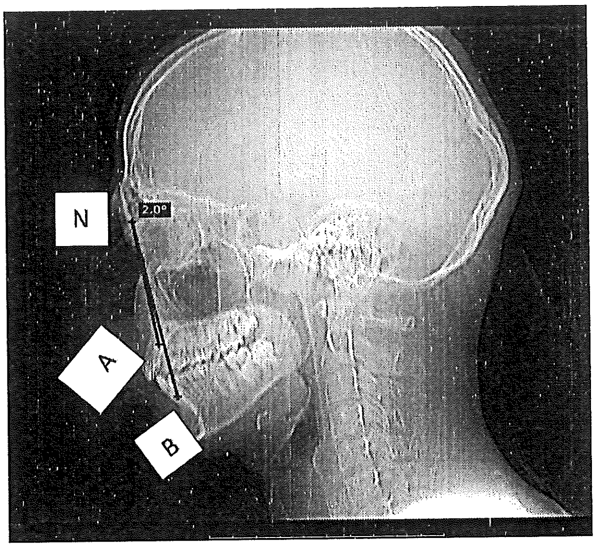

Figure 3.3 : Male . 29 years. (ANB maxilomandibular discrepancy)

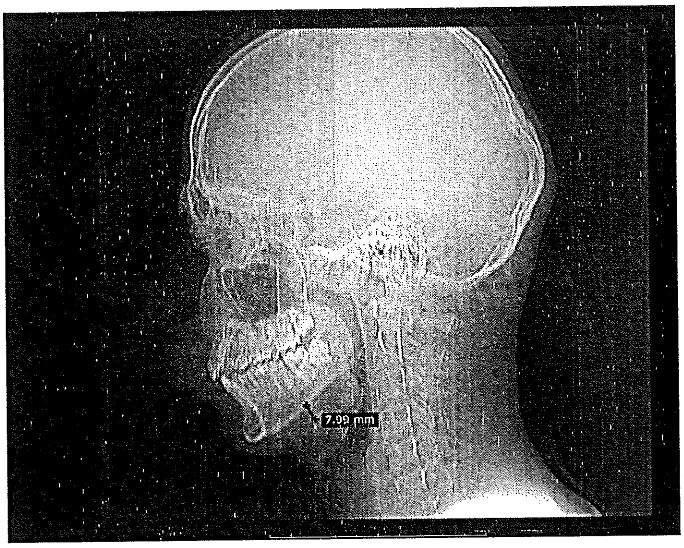

Figure 3.4 : Male . 29 years. (MP-H: mandibular plane hyoid distance)

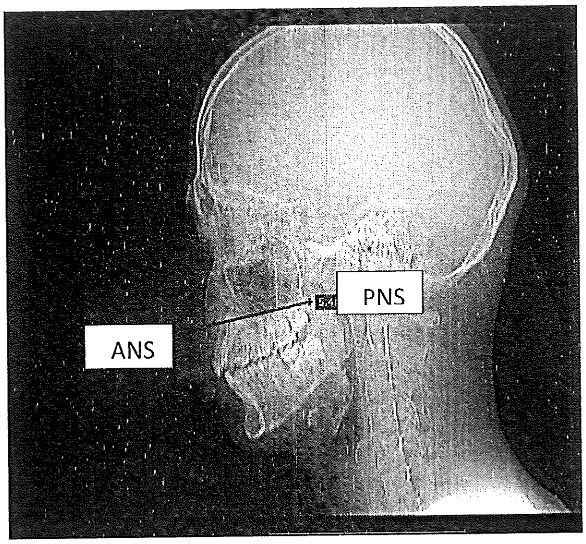

Figure 3.5 : Male . 29 years. (ANS-PNS: Sagittal length of maxilla)

3.2 .1.1.3 Sagittal measurements :

CT scan sagittal view showing upper air way tract reference measurements

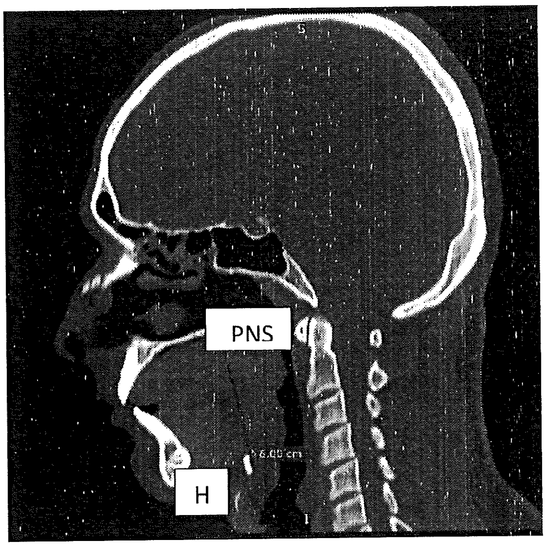

Figure 3.6:Male. 34 years (UAL: upper air way length)

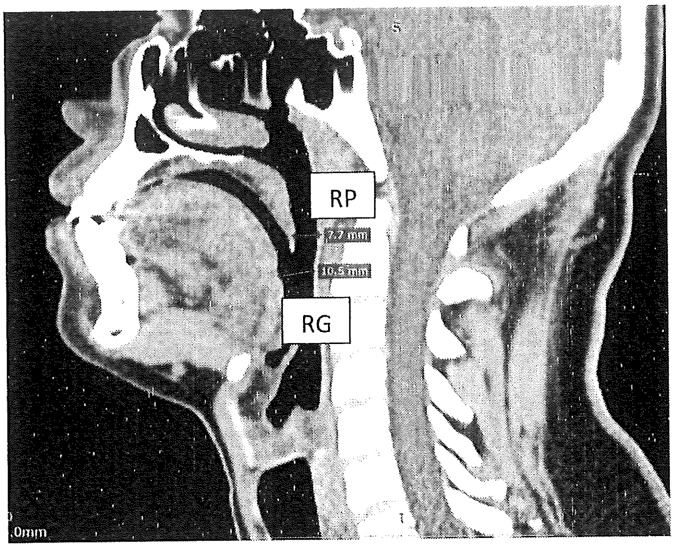

Figure 3.7 : Male 40 years (RP retropalate, RG retroglosal)

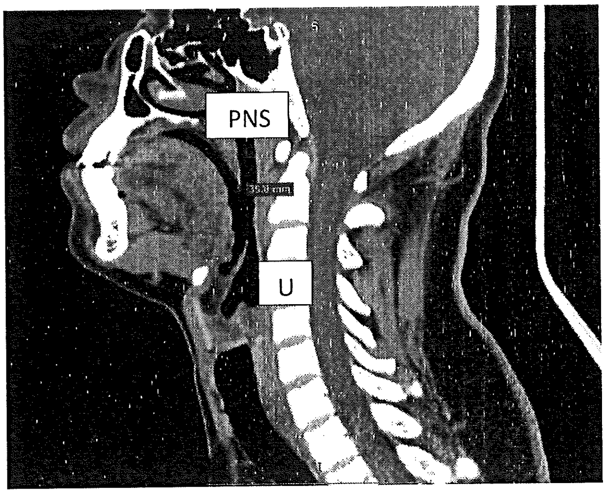

Figure 3.8 : Male 40 years (PNS -U length of soft palate)

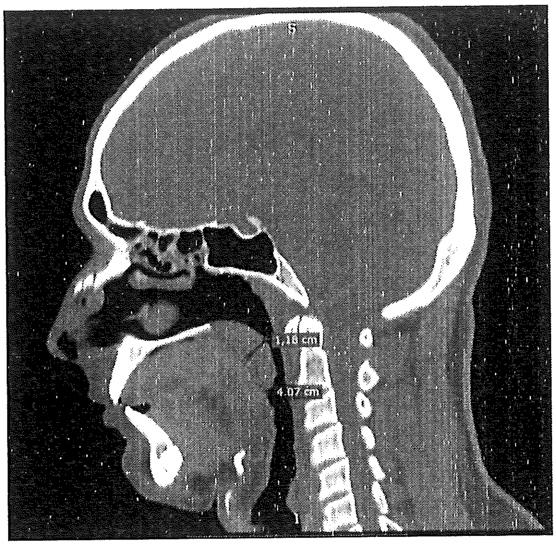

Figure 3.9 :Male. 34 years (SP – MAX maximum thickness of soft palate)

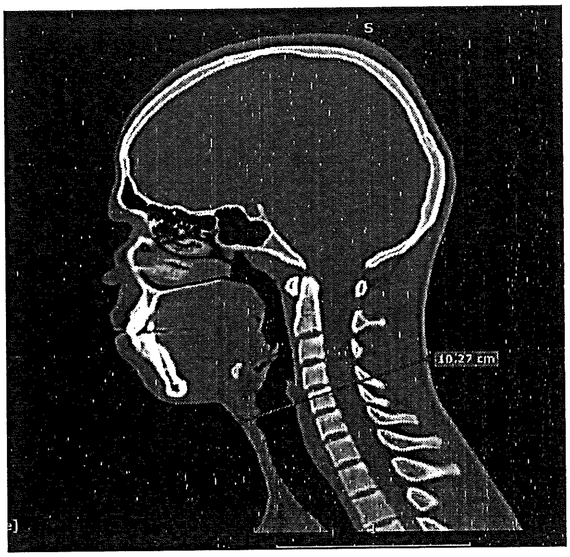

Figure 3.10: Male 31years (NC neck circumference)

3.3 Data Analyses

All data were analyzed using a statistical package (SPSS Version 19, SPSS Inc., Chicago, USA)., mean and standard deviations of all the measurement parameters were calculated. Independent t-tests was used to analyze gender differences. Paired t-test was used to analyze the differences of the airway dimensions among different anatomical sites. Paired t-test was also used to analyze intra-examiner differences. Statistical significance was set at the threshold of P<. 0.01 & 0.05.

Chapter Four

Chapter four

The Results

The total number of the subjects included in this study was two hundred (200) subjects: 127 patients enrolled as snoring and 73 control healthy subjects. There was 100 (78.7%) male patients and 27 (21.3%)female patients Table (4.1). 47 patients (64.4%) of the control group were male while 26 (35.6% patients) were females . The age of snoring patients were ranged from 18 to 85 years a mean age of 44.8±15.9years for patients and 26.2±7.0 for the control group while age ranged from15 to 47 years (table 4.1)

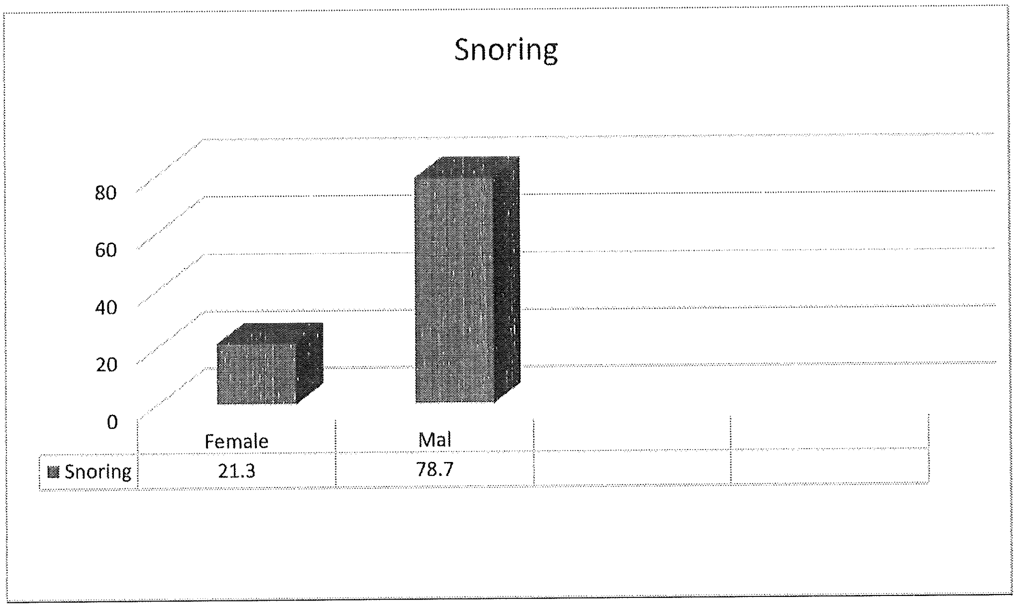

Figure 4.1 : Classification of snoring group according to gender presented in percentages %

Table 4. 1 : Independent Samples T- test for equality of means between Snoring and non Snoring groups studied for age and different anatomical areas

	Group	N	Mean ± SD	MAX	MIN	P-value
AGE	snoring	127	44.8±15.9	85	18	0.000**
	Non snoring	73	26.2±7.0	47	15	
NC	snoring	127	151.5±97.1	184.6	104.3	0.000**
	Non snoring	73	109.4±10.6	126	84.5	
MP-H	snoring	127	14.4±13.3	153	0.0	0.059
	Non snoring	73	11.3±5.1	31.8	4.10	
ANS-PNS	snoring	127	54.2±32.8	418	38	0.170
	Non snoring	73	48.9±4.5	62.6	41.7	
Rs	snoring	127	14.0±3.7	25	4.3	1.00
	Non snoring	73	13.1±3.2	22.3	7.5	
Rp	snoring	127	6.0±5.0	57	0.0	0.001**
	Non snoring	73	9.3±8.2	58	3.10	
UAL	snoring	127	60.7±7.7	80	45	0.000**
	Non snoring	73	55.1±6.8	72.4	39.9	
SP-MAX	snoring	127	11.8±1.8	18.2	5.8	0.000**
	Non snoring	73	8.6±1.5	11.8	5.3	
PNS-U	snoring	127	41.3±31.9	394	29	0.084
	Non snoring	73	34.7±5.2	49.7	23.7	
	**Significance at level 0.01					

Table 4 2: Correlation Coefficient between the Retroplatal and Age.

		AGE	RP	NC
AGE	Pearson Correlation	1	-.255(**)	.120
	Sig. (2-tailed)	.	.001	.116
	N	174	174	174

Correlation is significant at the 0.01 level (2-tailed

Table 4.3 : Mean and Stander Deviation T – test for equality Mean of the measured anatomical areas for snoring patients classified according to gender

	Gender	N	Mean± S. D	P-value
AGE	Male	100	42.6±14.61	.002**
	Female	27	53.2±18.25	
NC	Male	100	155.4±108.99	.390
	Female	27	137.2±14.65	
MP-H	Male	100	13.5±4.87	.158
	Female	27	17.6±27.52	
SNA	Male	100	84.5±2.7	.818
	Female	27	84.3±3.4	
ANB	Male	100	1.7±.81	.756
	Female	27	1.57±.87	
ANS-PNS	Male	100	51.8±4.73	.110
	Female	27	63.2±71.03	
SNB	Male	100	83.08±2.8	.630
	Female	27	82.7±3.8	

Continue

	GENDER	N	Mean ±S. D	P-value
Rs	Male	100	14.0±3.89	.979
	Female	27	14.0±3.32	
Rp	Male	100	6.2±5.57	.209
	Female	27	4.9±1.77	
UAL	Male	100	62.3±7.34	.000**
	Female	27	54.8±6.64	
SP-MAX	Male	100	11.9±1.77	.071
	Female	27	11.2±2.25	
PNS-U	Male	100	42.6±35.85	.373
	Female	27	36.4±4.39	

Snoring
**Significance at level 0.01

Table 4. 4: Mean and Stander Deviation T – test for equality Means of the measured anatomical areas for snoring patients classified according to age classes

		N	Mean± S.D	Minimum	Maximum	**ANOVA** P-value
Rs	15-30	20	14.2±4.27	7.60	23.40	.072
	31-45	57	14.0±3.63	6.50	21.40	
	46-60	30	12.8±3.46	4.30	19.30	
	61-75	12	16.5±4.21	12.00	25.00	
	>75	8	14.4±2.39	10.80	17.90	
	Total	127	14.0±3.77	4.30	25.00	
Rp	15-30	20	6.5±2.45	2.20	11.40	.627
	31-45	57	6.4±7.02	1.50	57.00	
	46-60	30	5.2±2.52	.00	11.50	
	61-75	12	6.2±2.41	2.30	10.00	
	>75	8	3.9±.66	3.00	4.90	
	Total	127	6.0±5.03	.00	57.00	
UAL	15-30	20	58.1±6.64	46.30	67.70	.075
	31-45	57	61.1±8.24	45.00	80.80	
	46-60	30	63.2±7.3	51.30	80.40	

	61-75	12	56.9±7.91	47.20	71.20	
	>75	8	60.3±6.12	46.30	66.90	
	Total	127	60.7±7.79	45.00	80.80	
continue						
SP-MAX	15-30	20	11.1±2.35	5.80	16.20	.234
	31-45	57	12.1±1.53	7.70	15.80	
	46-60	30	11.7±2.04	7.40	15.70	
	61-75	12	11.3±2.45	8.60	18.20	
	>75	8	12.2±1.23	10.80	14.70	
	Total	127	11.8±1.89	5.80	18.20	
PNS-U	15-30	20	38.0±4.74	31.90	47.00	.908
	31-45	57	44.4±47.39	29.10	394.00	
	46-60	30	39.2±4.84	31.50	50.00	
	61-75	12	38.0±6.65	29.40	52.50	
	>75	8	39.7±4.99	30.50	46.00	
	Total	127	41.3±31.94	29.10	394.00	

NC	15-30	20	137.9±15.54	112.00	177.40	0.916
	31-45	57	159.7±143.87	118.70	1222.0 0	
	46-60	30	150.8±18.49	117.70	184.60	
	61-75	12	140.5±21.34	104.30	174.50	
	>75	8	146.7±11.22	130.50	159.10	
	Total	127	151.5±97.13	104.30	1222.0 0	
MP-H	15-30	20	12.5±4.27	6.50	22.80	0.446
	31-45	57	13.0±5.09	.00	24.30	
	46-60	30	18.3±25.97	5.70	153.00	
	61-75	12	13.4±4.59	6.60	19.60	
	>75	8	15.3±4.48	8.10	22.20	
	Total	127	14.4±13.33	.00	153.00	
ANS-PNS	15-30	20	52.5±5.42	43.80	61.70	0.079
	31-45	57	51.2±5.25	38.00	64.20	
	46-60	30	51.6±3.93	42.60	61.60	
	61-75	12	80.2±106.40	44.00	418.00	
	>75	8	51.1±3.87	45.80	58.70	
	Total	127	54.2±32.87	38.00	418.00	

The following tables presented the data obtained from normal Saudi subjects. Mean age of the males was 25.00 ±7.08 years and the mean female's age was27.09 ± 5.61.the ages ranged between 15-24 constituting (45.30%),25-34 were (43.8%), ages between 35-44 (90.40%) and ages > 45 were 1.60%.

Table 4.5: Cephalometric measures applied in the scout view

	SNB (0)	SNA (0)	ANB (0)
N	64	64	64
Mean	82.4766	84.1172	1.7125
Std. Deviation	4.07753	3.51760	1.36609
Minimum	71.20	74.00	.10
Maximum	88.40	89.30	5.40

Table 4. 6: Anatomical measures applied in the sagittal 3D CT images for upper air way tract

	RS	RP	ANS-PNS	NC	UAL	PNS-U	SP-MAX	MP-H
N	64	64	64	64	64	64	64	64
Mean	13.1875	8.6531	49.0609	109.0234	54.6500	34.6375	8.6141	11.3187
Std. Deviation	3.35102	6.18929	4.78664	10.43845	6.67535	5.41812	1.58123	4.77865
Minimum	7.50	3.10	41.70	84.50	39.90	23.70	5.30	4.10
Maximum	22.30	53.50	62.60	126.00	72.40	49.70	11.80	31.80

Table 4 .7 : Independent Samples Test for the anatomical and cephalometric measures applied in the Sagittal 3D CT images classified according to gender

	Gender	N	Mean	Std. Deviation	P-value
RS	Male	43	13.5744	3.50300	.188
	Female	21	12.3952	2.93641	
RP	Male	43	9.1558	7.33181	.357
	Female	21	7.6238	2.47506	
ANS-PNS	Male	43	49.5442	5.16911	.251
	Female	21	48.0714	3.81197	
NC	Male	43	111.1791	9.77890	.017
	Female	21	104.6095	10.58130	
UAL	Male	43	55.1860	6.35046	.362
	Female	21	53.5524	7.33435	
ANB	Male	43	1.6860	1.36479	.827
	Female	21	1.7667	1.40083	
SNB	Male	43	81.9116	4.35213	.113
	Female	21	83.6333	3.24119	
SNA	Male	43	83.6209	3.82358	.107
	Female	21	85.1333	2.58096	
SP-MAX	Male	43	9.1000	1.55456	.000
	Female	21	7.6190	1.11965	
PNS-U	Male	43	35.4860	5.42387	.073
	Female	21	32.9000	5.09657	
MP-H	Male	43	10.7581	4.67996	.181
	Female	21	12.4667	4.88655	

Table 4.8: Correlation Coefficient between the neck circumference and age.

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	97.557	5.054		19.302	.000
	age	.446	.191	.285	2.343	.022

Established equation to predict the neck circumference for Saudi –Jazan population of known age. Correlation is significant at $p \leq 0.005, R2=0.081$.

Neck Circumference **(NC) = 97.55 + 0.446 *Age**

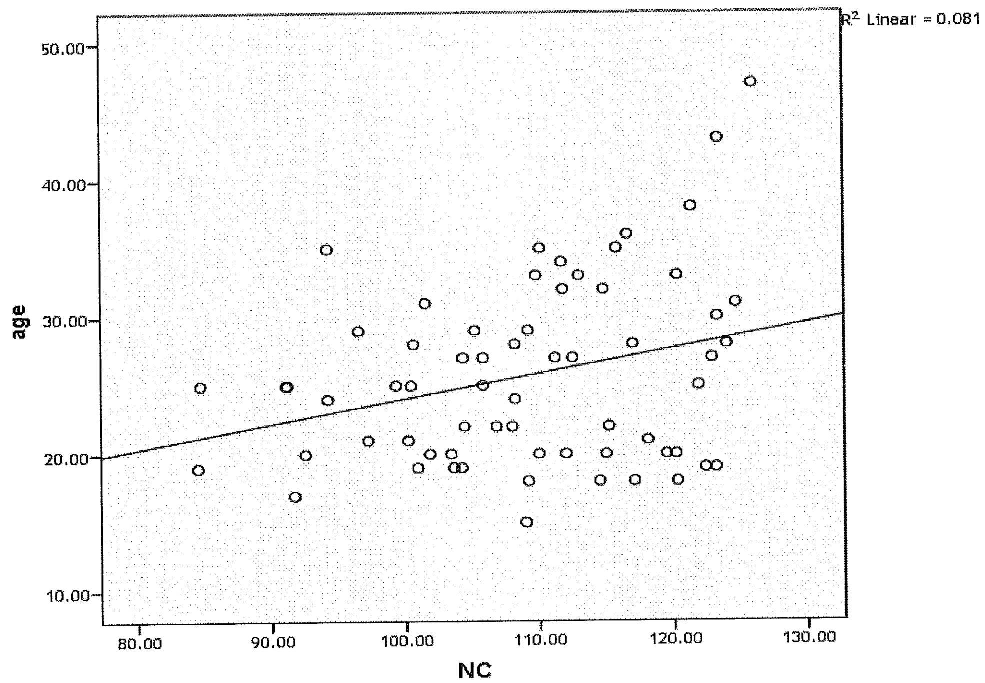

Figure 4.2: A scatter plot diagram shows the positive linear relationship between the neck circumference and age.

Table 4. 9: Correlation Coefficient between the MP-H and age

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	6.871	2.342		2.933	.005
	age	.173	.088	.242	1.961	.054

Established equation to predict the distance between mandibular plane and hyoid bone (MP-H) for Saudi-Jazan population of known age. Correlation is significant at $p \leq 0.005$, R2=0.058

MP-H =6.871 + 0.173 *Age

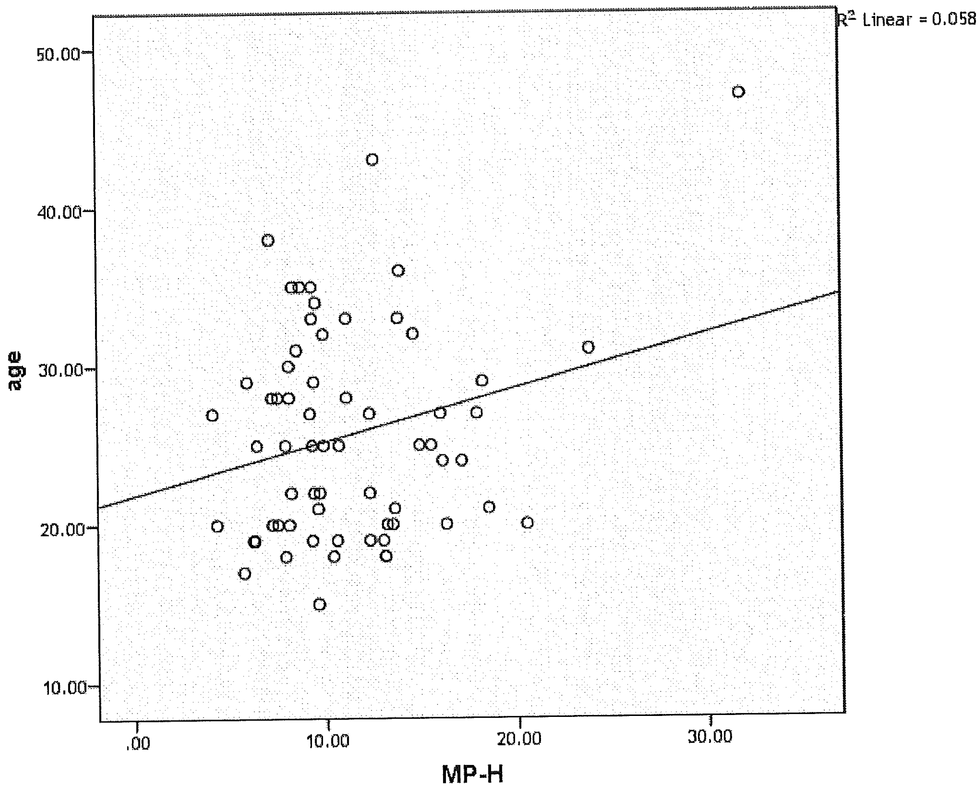

Figure 4.3 : A scatter plot diagram shows the positive linear relationship between the MP-H and age.

Table 4. 10: Correlation Coefficient between the ANS-PNS and age

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	54.686	2.303		23.749	.000
	age	-.219	.087	-.305	-2.523	.014

Established equation to predict the linear distance between anterior nasal spine (ANS) ,and posterior nasal spine(PNS) (ANS-PNS) for Saudi population of known age. Correlation is significant at p≤0.005,R2=0.093

ANS-PNS = 54.686 + (-0.219) *Age

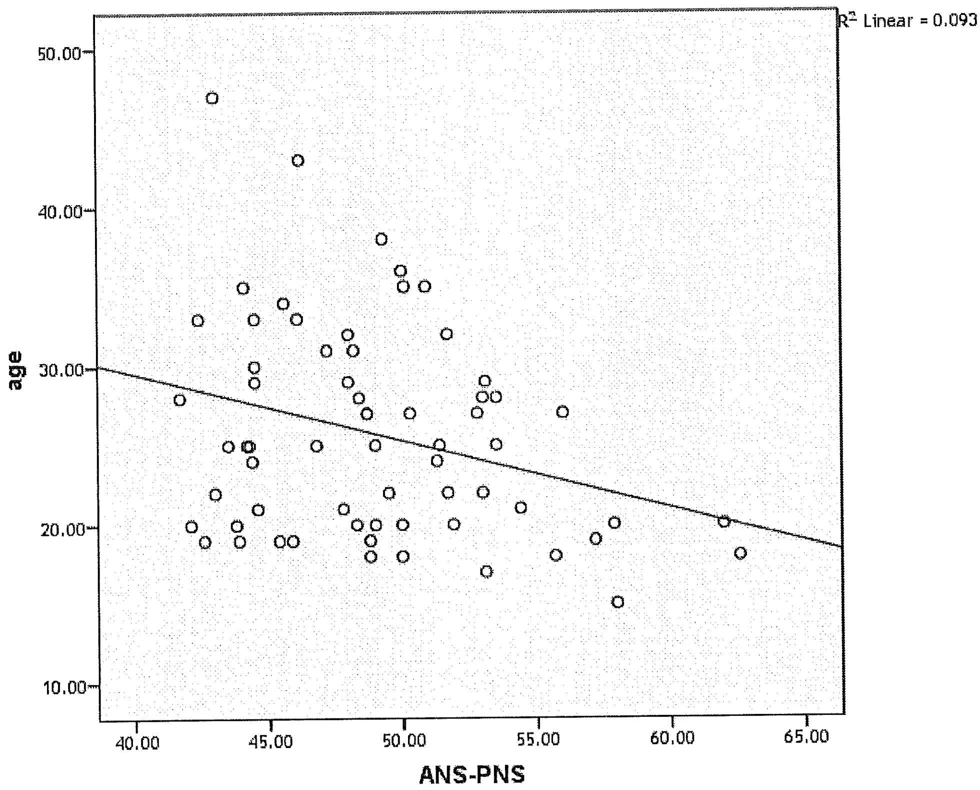

Figure 4.4: A scatter plot diagram shows the negative linear relationship between the ANS-PNS and age.

Chapter Five

Chapter five

Discussion. Conclusion and recommendations

5.1 Discussion

Snoring is causes by upper airway narrowing when soft tissues relax and decreasing pharyngeal muscles tone during sleep , it also caused by vibration tissues during sleep. Snoring is a symptom of OSAS , which are case serious health complication. Obstructive sleep apnea syndrome (OSAS) is a highly prevalent disease leading to severe medical consequences if left untreated (Mitle et al . 1988). OSAS has been recognized as an independent risk factor for disorders such as hypertension, cardiovascular disease and sleepiness-related accidents. Currently, it is considered to be a systemic disease (Wetter et al.1994). 200 subject conducted in this study were 127 snorers and 73 control group, there was significance difference regarding age between snoring and control group (p= 0.000) whereas snorers older than non snorers (**Table 4.1**) The present study included both genders. The prevalence of snoring was found to be 127 patients including 100 males (78.7%), their ages were 42.6 ± 14.61 and 27 females (21.3%), and their ages were 53.2 ± 18.25 age ranged between 15 and >75 years (**Figure 4.1**) female snorers were older than males most of them around menopausal age , mean value (53.2versus 42.6) respectively with significance difference (p = 0.002) (Kapsimalis et al .2002): study reveal that most of the female OSAS patients were postmenopausal and older than male patients, also .(Kapsimalis et al .2002)found progesterone protects premenopausal women from developing OSAS, They also reported that testosterone on the other hand may increase the risk of OSAS(Jennum et al.1992). Comparing with previous studies done for snoring; men and women showed an increase of snoring in mid-life (Martikainen et al.1994)-(Lindberg et al.1998). In other study of patients between 30 and 60 years of age, the highest prevalence were found among men between 50 and 60 years. 53% of men and 31% of women in this age group reported snoring (Young T et al.1993). Large population based studies have shown an increasing trend in prevalence of snoring up to the age group of 60 - 69 years in Finland (Koskenvuo et al.1985) and up to 60 - 70 years in Spain (Durán et al . 2001). Other studies have reported higher prevalence among middle-aged populations: 44% in men and 28% in women in the USA and 28% - 44% and 6% - 19% in Finland, respectively (Martikainen et al. 1994;Young T et al.1993;Koskenvuo et al.1985). Men have 2- to 3- fold greater risk of snoring than women, but mechanisms underlying this difference are not clear. Results from a recent study suggest that increased collapsibility in the pharyngeal airway in men is based on anatomical differences (Malhotra et al. 2002)

Table 4. 1 shows independent samples t-test for equality of mean between the snoring and non snoring groups studied for age and different anatomical areas differences. Significant difference between the ages of snoring patients and non snoring group at $p \leq 0.000$ was detected. Obesity and large neck circumference is risk factor of snoring and OSA, fat deposition around pharyngeal airway increase collapsibility of the pharyngeal airway . obesity has been associated with functional impairment in upper airway muscles (Martikainen et al.1994). (F. AKTA et al .2016) were confirm neck diameter is significantly higher in patients who snore. In most the studies .`OSAS patients had significantly higher BMI and larger neck size than did normal subjects (Battagel et al 2000)). In this study confirm the neck circumference (NC) was significantly differ and greater in snoring patients than non-snoring at $p \leq 0.000$. The importance of considering the measurement of NC because it is was

established that having a neck circumference (NC) of 40 cm or more is one of the most significant risk factor for the development of Obstructive Sleep Apnea Syndrome (OSAS) and it is a cutoff point as a risk factor for OSAS (Young et al. 2002). Our sample have less measurement and not reach the cutoff point of obstruction diagnosis, but it differ from non-snoring; it means the measurements increased by 8.5 cm from 30.3 cm for patients measurements ranged from 36.9 – 20.8 cm , may consider as snoring complain but not broaden to be diagnosed as obstruction sleep apnea. We justify this findings is that to be anatomical variations between different studied ethnic groups (Lee et al.2010; Malhotra et al.2002). Despite the clear association between snoring underlying causes and obesity, the mechanisms behind this relationship is not yet fully understood. Particular patterns of fat distribution may be specifically relevant and underlie the pathophysiological mechanisms. Neck fat deposition (neck circumference), have been specifically related to snoring (Young, T et al.1993; Carmelli, D.et al . 2000). Obesity has also been clearly shown to be linked to sleep disturbance breathing. It seems that this is in part a proxy marker for neck circumference (Stradling et al .1991). Therefore weight particularly is coincident with a presence of snoring. The linear distance between mandibular plane and hyoid bone (Mp-H) was found to be greater and differ between the two groups In the present study there was significant difference between snoring and control group regarding MP-H ($P \leq 0.05$). In snoring patients, the hyoid bone was found to be more inferiorly placed. The justification of the presence of snoring in such patients is that the lower position of the hyoid increase the mandibular consignment because of the requirement of extra energy to elevate the tongue; this, worsen apnea by resulting in the open-mouth posture during sleep concluded with snoring, .addition to that inferiorly place of hyoid bone would pull the tongue backwards further narrowing the pharyngeal airway then cause snoring and the inferior of hyoid bone may be the result of tongue mass and increase adipose tissues which lead to narrowing airway this was similar to the finding mentioned in previous study (Arya, D., et al. 2010), similarly Wong *et al.* found that the hyoid bone was located more posteriorly in Chinese snoring subjects when compared with Malays and Indians (Woodson BT, et al. 1991). Hui et al ,The position of the hyoid bone, which has an impact on the tongue shape and posture affects the patency of the hypopharyngeal airway. Inferiorly positioned hyoid bone in OSAS is well documented (Hui et al. 2003) and our study population were Saudi and other Asian populations. In this study Retroplatal width (RP) was found to be smaller in snoring patients and differed significantly at $p \leq 0.001$, snoring and OSAS can be classified into three types of obstruction (retroplatal ,retroglosal ,or retroplatal and retroglosal)In the current study, The minimal airway area (smallest site of obstruction) was in the retroplatal region(Rp) . Our results coincide with Ikeda et al., and Shepard et al , they found the retropalatal obstructive type is the most common of all of the obstructive types of OSAS.(Ikeda .2001; Shepard 1996) . **(Table 4.2)** reveals negative correlation between retroplatal and age of snoring group .the correlation explain when age increase the retroplatal diameter be smaller in size . No significant in the retroglossal width so the caliber in this region increase than retroplatal region .this coincide with(Schwab et al.1995)he reported(airway caliber in the retroglossal region is greater than in the retroplatal region). the adipose tissue is deposited adjacent to the pharyngeal airway and then narrowing or obstructed pharyngeal lumen in one or more part then presence of snoring and , So we concluded that lateral wall thickness is consider a more risk factor . Upper airway length (UAL) which was measured as the vertical distance from hard palate to the hyoid bone differed significantly at $p \leq 0.000$, also study reveal positive correlation between UAL and both neck circumference and MP-H distance with significant difference p=(0.004, 0.014) respectively . these correlation is positive relationship ,when UAL increase lead to increasing NC and MP-H . When compared to snoring group, length of soft palate (PNS-U) was found to be longer in snoring than in non-snoring group but the difference is not significant (P < 0.084). Adverse results were found in a study done by (Dubey et al 2015).The maximum thickness of the soft palate (SP max) differs significantly at p ≤ 0.000 between the two groups . (Woodson BT et al. 1991), explained (Increases in soft tissue dimensions that have been found in imaging studies include enlargement of the soft palate, tongue, parapharyngeal fat pads, and lateral pharyngeal walls. These increases contribute to anatomic narrowing and may also contribute to increased tissue pressure, which favors airway collapse.Igor Fajdiga clarify. (soft palate is the structure that defines the constriction, then it is also the only structure that is retracted by negative pressure and thus responsible for snoring(Igor Fajdiga . 2004).

The snoring patients in another similar study in different population showed significantly longer soft palate ,which occupied more space in the oropharyngeal area. Studies had indicated that continuous vibration of the soft palate during snoring leads to continuous trauma and causes mucosal edema, further reducing upper airway patency (Veldi et al . 2004). The increased muscular stiffness of the soft palate suggests that its tissues undergo morphological and functional changes, supported by the findings of the uvular and soft palate muscles in snoring (Veldi et al . 2004). The changes thought to be due to varying combinations of anatomical and neuromuscular factors resulting in airway changes (Lee, R.W.et al. 2010). In our sample, there is no pathological findings or underlying cause for obstruction were detected except the changing in the measurements.

Predictive factors in upper airway anatomy or detected variation that explaining the progression of snoring were not found, another similarly study done by (Pendlebury et al.1997) mentioned similar findings However, this mechanism depends on the morphology orofacial musculature. Many other studies have also found that the interrelationship of craniofacial morphology and muscle function of the upper airway is important in the understanding pathogenesis behind snoring (Chowdhuri et al . 2008). Different ethnic groups have significant differences in craniofacial and soft tissue features. These ethnic differences in craniofacial morphology greatly affect airway dimensions (Dubey et al .2015). These differences were due to ethnicity changes. We suppose that the difference between the two groups is that they are of different ethnicity. Mean and standard deviation, t-test for equality of mean of the measured anatomical areas for snoring patients classified according to gender were studied and the measurements were presented in (**Table 4.3**). No significant difference was detected in the evaluated anatomical structures between genders except the UAL. Ronen et al. reported that, before the prepubertal period, boys have an equal or shorter UAL compared to those of girls. However, after puberty, the UAL is significantly longer in boys, suggesting that a longer UAL could explain the adult male predisposition for pharyngeal collapse. (Ronen O et al .2007) ; the men have greater measurements than females in the studied population. Results from a recent study suggest that increased collapsibility in the pharyngeal airway in men is based on anatomical differences between genders as mentioned by (Malhotra A et al . 2002). reported that UAL was significantly longer in men, as compared with women, and proposed that this anatomic difference could partially explain the predisposition of men to OSAS. Age classes have no impact on the measured anatomical areas for snoring patients this was presented in (**Table 4.4**). Studies showed that the reasons for differences in prevalence of snoring with age are poorly understood as mentioned in previous studies (Virkkula P. 2003)

One of the aims of this study to obtain normative data of Saudi populations who are living in Jazan region The present study included a group of South Saudi -Arabian subjects who were living in Jazan area. They were clinically normal facial profile and absence of any reported abnormality of the upper airway or complain of snoring. Similar studies have been conducted on normal adults in various populations.(Samman N 2003; Maltais 1991) All the measured norms values including cephalometric and upper air way tract measurements were presented in **(Tables 4. 5 and 4.6).** It has become apparent that there is the need to determine what comprises the normal face for the Saudi- Jazan population. Treatment plans and clinical procedure should not be freely switched without consideration of the racial group involved and without thorough understanding of the differences between races and their normal ranges.(Nasser M. Al-Jasser.2000) Studies on different ethnic groups including those of Chan's (Chan GKH.1972) on Chinese, Garcia's (Garcia CJ. 1975) on Mexican Americans, and Park's (In-Chool . et al .1989) on Korean adults have indicated that normal measurements of one group cannot be considered normal for other racial groups. The current study is an attempt to establish a norm or standard for the skeletal and upper air way pattern of Saudi-Jazan adults. The results for the selected Saudi-Jazan population were compared with the other norms. A comparison was also made between Saudi-Jazan male and female adult subjects.**(Table 4.7)** The present study revealed that the means for the Saudi –Jazan sample were similar in most measurement items from the means of Bangladesh and Caucasians. Similarly, when comparison was made between male and female subjects to find out any significant gender difference of cephalometric craniofacial parameters, there was no significant difference between both genders except in 2 parameters NC and SP-MAX at $p \leq 0.05$. When evaluating SNA and SNB angles, it is interesting to note that both exhibited a significantly greater value in Saudi -Jazan subjects than in the Caucasians. It indicated that the maxillary and mandibular apical bases were more prognathic. ANB angle indicates an antero-posterior relationship between the mandibular and maxillary apical bases relative to the cranial base. There was no significant difference in ANB angle between male and female Saudi-Jazan subjects. Hassan, 2006 has reported that Saudis living in the western area represented a new Saudi race established through interbreeding among the different communities and the multiracial population settled in the western province for a long period. When the results of normal cephalometric evaluation obtained by Hassan were compared with the other studies, significant differences were found in SNA, SNB, ANB measurements when compare to Caucasian. (Ali H. Hassana .2006) the current study results showed that Saudi –Jazan results differ from the western area. In Saudi Jazan subjects; the SNB was found to be greater and the ANB was found to be less the western population. Significant gender dimorphism in airway measurements was evident in both the study done on Chinese (Samman et al .2003) and (Shen et al.1993) study although slightly different patterns were observed. (Bacon et al .1990) reported the mean soft palate length in the male was found to be 38.7 ± 3.2 mm. Riley et al(Veldi, M et al . 2004) reported a normal soft palate length in Caucasian males of 37.0 mm, while Chinese (Samman et al .2003) results indicate a soft palate length of 34.3 ±3.9 mm. (Hochban W, Brandenburg U.1994)) reported the measurements of Caucasian males length of the soft palate was 45.1 mm; thickness of the soft palate, 12.2 mm. Cephalometric norms measurements were also reported by (Poole et al.1980) Norms were calculated for various ages and both sexes, and found to vary according to age and sex. Our study found that only the neck circumference and MP-H, and (ANS-PNS) have significant relationship with age, this were presented in **Figures (4.2 , 4.3 , 4.4).** The implication of the present study include vertical distances of hyoid bone were bigger in females than in males implying more inferiorly and anteriorly positioned hyoid bone in females. Also, retroglossal and retro palatal spaces were larger in males. In establishing norms, these research used regression equations to predict the measurements of upper air way tract for the Saudi-jazan of known ages, **Tables (4.8 , 4.9 , 4.10).**Thus, although a small number of studies have made analyses of upper airway measurements, these had notable limitations and reported results are not directly comparable to the current study for the fact that the majority of investigations did not use ordinary subjects and hence lacked reference measurements for the norms. Rather, comparisons between normal and abnormal groups were made (OSA or snoring) in order to identify changes in upper airway measurements. We can predict the measurements for Saudi–Jazan for the upper air way tract (ANS-PNS , MP-H and NC) for the Saudi-Jazan of known ages .Saudis-Jazan have distinct cephalometric and upper air way tract features, for which specific norms should be used as a reference in treating orthodontic patients. Norms for the airway in the Saudi-Jazan population have been established in this study. Data derived from this study should thus prove useful as a reference for assessment of obstructive sleep apnea for Saudi-Jazan if present.

Several imaging methods had evaluated and measured the upper air way tract (Abramson et al . 2010). Two-dimensional (2D) lateral cephalograms have traditionally served as the radiographic standard for airway assessment in patients with upper respiratory tract problems. Although lateral cephalometric measurements are useful for analyzing airway size in the sagittal plane, they do not accurately depict the 3-dimensional (3D) airway anatomy. In addition ,the correlation of commonly used linear and angular measurements obtained from lateral cephalograms with the severity of disease, has not been documented in published studies (Zucconi et al. 1992; Guilleminault et al.1984) Finally, although the most physiologically relevant information is obtained from axial images, perpendicular to the direction of airflow, the axial plane is not visualized on lateral cephalograms (Isono et al .1993).In contrast, an accurate 3D image of the airway can be obtained using computed tomographic (CT) data in the coronal, axial, and sagittal planes (Schwab et al.1995). Although multiple reports have been published on the use of CT imaging for assessment of the upper airway, few data are available on the reliability of this technique (Shigeta et al .2008; Walsh et al. 2008).The advantage of our usage of the based technique and imaging methods in the current study is that with MDCT, thin-section images of the entire central airways was obtained in only a few seconds, creating an isotropic data set in which the resolution is excellent (Choi et al . 2001). MDCT technique provides higher spatial resolution, faster speed, greater anatomic coverage, and higher quality multiplanar reformation and 3-D reconstruction images. Multiplanar and 3-D reconstruction images help to overcome the limitations of axial images by providing a more anatomically meaningful display of complex structures of the airways (Boiselle et al .(2002a); Boiselle et al .(2002b)). These images have been shown to enhance the detection of airway stenosis if present and to aid the assessment of the craniocaudal extent of the stenosis, and to clarify complex airway abnormalities (Remy et al. 1998). They have also been shown to improve diagnostic confidence of interpretation, measurements and enhance pre-procedural planning for bronchoscopy and surgery (Boiselle et al .2002a). Although multiplanar and 3-D reconstruction images do not actually create new data, they provide an alternative method of viewing CT data that is often more visually accessible and anatomically meaningful. The progress in CT technology allowed us to obtain high resolution 1, 2-mm-thick sections. The setting of computer window and zoom factor ensured high accuracy in measurements. We believe that the measurements of the upper air way tract by modern CT technique can be used as a guide for the evaluation of norms, diseases and their severity before and after surgery. Sagittal reconstruction can demonstrate the narrowing at the level of the uvulopalatinal complex and at the base of the tongue. The CT reconstruction can be important when there are difficulties in deciding which the procedure of choice is. Uvulopalatopharyngoplasty should be the choice when there is only uvulopalatinal narrowing (Virkkula, P. 2003) However the CT reconstruction is a nonaggressive technique for demonstrating the location of the pharyngeal narrowing if present.

5.2 Conclusion

Results showed that the NC, UAL, and SP max were significantly higher in snoring group; however RP was also found to be significantly .lower Inferior positioning of hyoid bone gives longer measurement for MP-H. In snoring group UAL was found to be significantly different at $p \leq 0.000$ between the two genders. All the measured variables showed no significant differences in respect to age. UA CT quantitative features play an important role in the characterization of the anatomy and are compared between snoring patients and non-snoring subjects adding information about the ethnicity and gender related difference. Further investigation was required using large sample of snores and non-snores concerning only Saudi population in order to establish norms for their measurements so as to predict early changes in UA in cases of sleep-disordered breathing diagnosing series of disorders ranging from primary snoring to severe OSA. From this point of view, however, the axial images provide a more comprehensive review of the entirety of the thoracic structures and also serve as an important point of reference for optimal interpretation of multiplanar and 3-D images. Thus, we recommended that the radiologist should review the traditional axial images in addition to the alternative display images (multiplanar and 3-D reconstruction images) when interpreting a CT study of the upper air way tract, in addition to evaluate the lower respiratory tract and related thoracic structures. Despite the study done on the selected anatomical structures with age and gender, additional studies, with larger numbers of patients, are required to document the benefits of this technology using axial and multiplanar 3D images to characterize the upper and lower air way tract.

for establishing reference of normative data for saudi who living in jazan region showed that there were no significant differences between males and females except in NC, SP-MAX .due to consideration of small sample size . We can predict the measurements for Saudi–Jazan for the upper air way tract (ANS-PNS , MP-H and NC) for the Saudi-Jazan of known ages .Saudis-Jazan have distinct cephalometric and upper air way tract features, for which specific norms should be used as a reference in treating orthodontic patients. Norms for the airway in the Saudi-Jazan population have been established in this study. Data derived from this study should thus prove useful as a reference for assessment of obstructive sleep apnea for Saudi-Jazan if present.

5.3 Recommendations

Because snoring is serious health condition so recommend to avoid some factors which increase the risk of snoring such as obesity, smoking, and alcohol consumption

Many snorers snore when they sleep on back because tongue and pharyngeal muscles relax causing narrowing of the airway if lying on side will reduce the problem

Children whose snoring is caused by enlarged tonsils or adenoids surgical removed is recommended.

Avoid nasal congestion from cold or allergy which cause temporary snoring

There is no any reports about snoring or normal upper air way in Sudan . therefore recommend studying snoring Sudanese patients and establishing reference of the normal upper airway and craniofacial structure for Sudanese population

CT scan is useful to evaluate upper airway of normal and snoring patients , it can determine narrowing part but MRI very helpful to evaluate soft tissues and fat deposition Furthermore avoid radiation hazard

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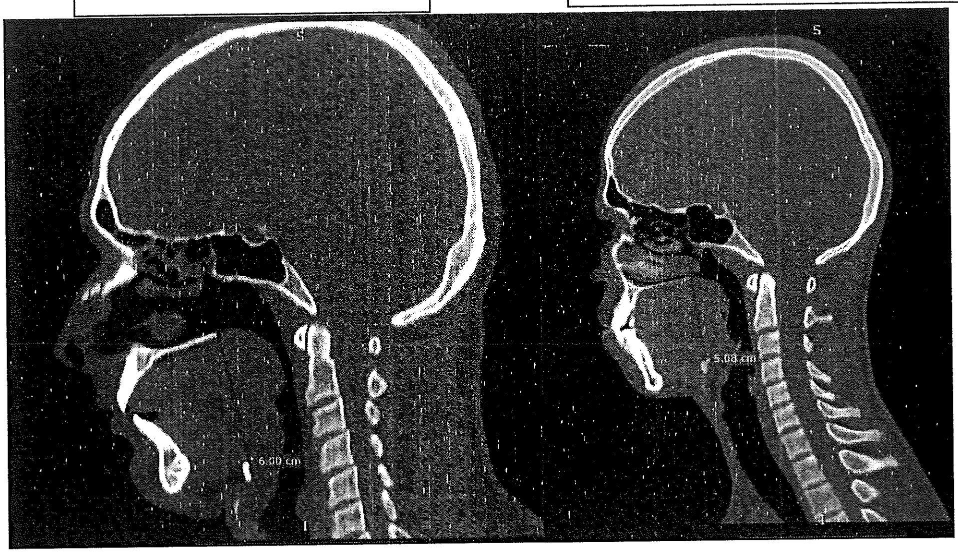
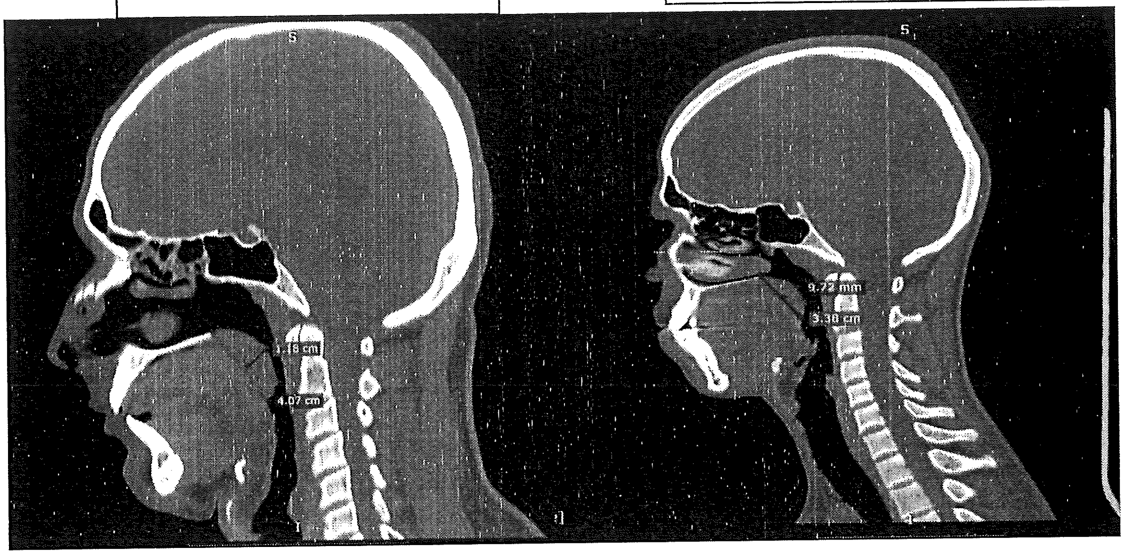
Comparison between snoring and non snoring in the upper airway measurements

Snoring patient Male. 34 years	Non snoring patient Male 31vears



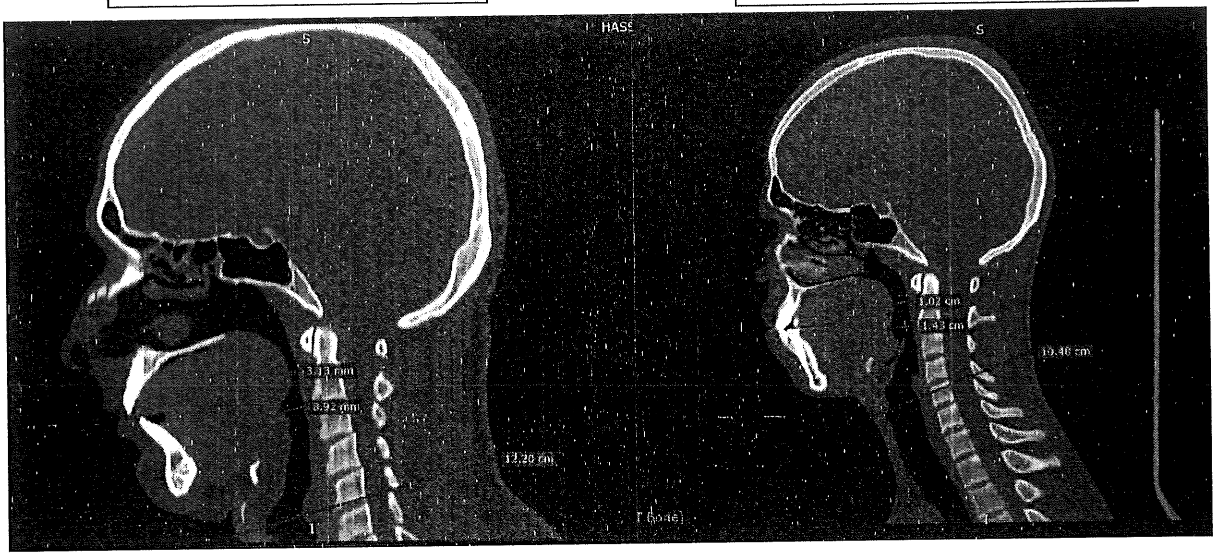
Upper air way length UAL

Snoring patient Male. 34 years	Non snoring patient Male 31years



Maximum thickness of soft palate(SP MAX) and length of soft palate (PNS –U)

Snoring patient Male. 34 years	Non snoring patient Male 31years



Retroplatal width (RP), Retroglosal (RS), Neck circumference(NC)