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Can MDCT Measures of Upper Airway Dimensions and Central Obesity Indices Predict the Severity of Obstructive Sleep Apnea (OSA)?

BASMA GADELHAK, M.D.*; MONA EL-BESHBISHI, M.D.**; EMAN EL-NADY, M.Sc.*** and MOHAMED EL-GAMAL, M.D.***

The Department of Diagnostic Radiology, Faculty of Medicine, Mansoura University, Students' Hospital**, Mansoura University and Chest Medicine Department***, Faculty of Medicine, Mansoura University*

Abstract

Background: Comparative evaluation of the CT measures of upper air way, tongue adiposity and central obesity in a group of obstructive sleep apnea (OSA) patients and in a control group, and their potential role in grading of OSA severity.

Aim of Study: The objective of the present study was to comparatively evaluate the different the upper air way, tongue adiposity and central obesity measures by CT scan in patients with obstructive sleep apnea syndrome (OSA) and in a control group, and their potential role in grading of OSA severity.

Material and Methods: This prospective case control study was carried out on 17 OSA patients diagnosed by PSG and 16 control subjects. Non contrast MDCT scan of the upper airway and mid abdomen was performed on Philips 128 detector scanner, 1mm slice collimation during quite breathing. Axial and Sagittal reformatted images were assessed. Mandibular plane hyoid distance (MPH), upper airway length (UAL), minimum cross-sectional area (MCA), transverse and antero-posterior diameters of the airway (TDA, APD), length and thickness of uvula and soft palate (LUV,TUV), tongue area and tongue base density (TA, TD) were measured. Image J program was used for quantification of neck and visceral adipose tissue (NAT, VAT).

Results: Statistically significant difference was found in most CT measures between the OSA and control groups, the highest significant values were found with MCA, TDA, TUV and TA (p<0.005). MCA and TA had the best diagnostic performance for OSA diagnosis. Statistically significant difference was found in MPH, UAL, MCA, TDA, TA, TD and NAT between the severe OSA and mild/moderate grades, The highest significant values was found with UAL and MCA (p=0.001, 0.002). For identifying severe OSA MCA, TDA and TA offered high diagnostic performances. Binary logistic regression found that TA and MPH were the significant predictors for severe OSA with overall % predicted=88.2%.

Conclusion: Our results indicate that CT offers added value in OSA diagnosis and prediction of severity, multiple CT measures varied significantly between OSA and control group as well as between different OSA grades.

Key Words: *Computed tomography – Obstructive sleep apnea – Obesity.*

Correspondence to: Dr. Basma Gadelhak,
E-Mail: basmagadelhak@hotmail.com.

Introduction

OBSTRUCTIVE sleep apnea (OSA) is a common sleep disorder, affecting approximately 2-4% of all middle-aged adults. OSA is characterized by recurrent episodes of upper airway (pharyngeal) collapse resulting in chronic intermittent hypoxia and interrupted sleep [1]. Obesity is the main risk factor for OSA, 80% of OSA patients are obese therefore OSA incidence is rising with the worldwide increase in obesity [2].

Continuous positive airway pressure (CPAP) is the standard treatment for OSA. Alternative treatments such as behavioral therapy, oral appliances, and surgery are recommended for OSA management if CPAP is not possible [1].

The definitive diagnosis of OSA requires an overnight Polysomnography (PSG); the total number of apneac (A) and hypopneac (H) episodes divided by the number of hours of sleep produces an apnea-hypopnea index (AHI). This requires an overnight hospital stay and trained specialists to interpret the data [3,4]. Because of these limitations, various alternative diagnostic techniques have been proposed. The abnormal anatomy of the upper airway is the key diagnostic factor for OSA. A small upper airway cross sectional area and increased upper airway length are common anatomical variables however, no consensus has been reached regarding the most relevant measure [5-7].

Radiocephalometry is widely used however it is two dimensional in nature with hazy non-precise landmarks [8]. Computed tomography (CT) [9-15], cone beam CT (CBCT) [16], and magnetic resonance imaging (MRI) are 3D imaging techniques that allow better evaluation of the airway [7,17,18]. The major advantages of CBCT scanners are their lower radiation dose and cost in comparison with helical or multi-slice CT [16] MRI provides excellent resolution of soft tissue structures and their relationship with the upper airway without radiation exposure however, there is less precise bony definition [7,18]. The diagnostic performances of these methods need further validation [10,11,19,20].

MDCT provides optimal delineation of the maxillofacial skeleton, upper airway dimensions and related soft tissue details [6,9-12,16,20,21].

Body mass index (BMI) is widely used as a measure of general obesity; the most important risk factor for OSA is elevated BMI [6] however it does not reflect the type of obesity. Central obesity can be determined by measuring neck circumference (NC) and waist circumference (WC) or more accurately by CT quantitative measures of the visceral adipose tissue (VAT) and neck adipose tissue (NAT) [22].

Awareness of the specific soft tissue and bony changes in OSA as well as patterns of airway narrowing can help radiologists to suggest the incidental diagnosis of OSA and to identify the possible etiology and level of airway obstruction in diagnosed cases [5]. For patients who have failed medical therapy and are considered for surgical procedures such as Maxillo-Mandibular Advancement; several studies recommended the use of imaging modalities for surgical planning, and outcomes assessment [9].

Regarding the role of CT in grading of OSA severity, there is still controversy regarding diagnostic efficiency of different CT measures [23]. We therefore investigated the differences in CT measures of upper airway, tongue adiposity and central obesity between OSA and non-OSA patients and among different OSA grades.

Material and Methods

The study was conducted from April 2019 to February 2020. Patients were referred from the Chest Department and underwent the CT scan in the Radiology Department, Mansoura University Hospital.

Study design:

This prospective case control study was carried out on 35 patients. 19 patients diagnosed with OSA clinically by sleep related symptoms and by Polysomnography and 16 subjects free from sleep-related symptoms as a control group. 2 patients were excluded because of pregnancy in one patient and lost PSG results in another patient. Final study population were 33 subjects (17 in OSA group, 16 in Non-OSA group).

Polysomnography:

Standard overnight polysomnography (PSG) was performed for all patients in the OSA group and interpreted by experienced pulmonologist.

Apnea was defined as a reduction of $\geq$90% of thermistor signal amplitude for at least 10sec. Hypopnea was defined as a reduction of $\geq$30% of nasal pressure amplitude for at least 10sec followed by oxygen desaturation $\geq$3% or arousal. The apnea-hypopnea index (AHI) is the number of apnea and hypopnea events per hour of sleep. An AHI $\geq$5 is defined as OSA according to the American Academy of Sleep Medicine OSA severity is defined mild when AHI is between >5-< 15, moderate with AHI >15-<30 and severe if AHI >30 [24].

Non contrast CT of the upper airway and mid abdomen:

Non contrast MDCT scan of upper airway and neck & mid abdomen was performed on Philips 128 detector scanner, 1mm slice collimation during quite breathing with patient in the supine position. Patients were instructed to remain still and not to swallow.

Image analysis:

Axial and Sagittal reformatted images of the airway were assessed. The following measures were included (Fig. 1):

- The level of obstruction retro-palatal (from the hard palate to tip of uvula), retro-glossal (from tip of uvula to hyoid bone opposite the tongue base) or multilevel obstruction [12].
- The mandibular plane to hyoid distance (MPH) was determined as the distance between the inferior margins of the mandible to the superior margin of hyoid on the sagittal plane [25].
- Upper airway length (UAL) from the hard palate to the base of the epiglottis (23),
- Minimum Cross sectional Area (MCA), AP and Transverse dimensions (TDA) of the retro palatal airway [6].
- Soft palate and uvula length (LUV) and maximum thickness (TUV).
- Tongue area (TA) was measured by tracing the tongue contour on the mid sagittal reformatted image [7].

- Tongue base density (TD) was measured to express fatty deposition of the tongue [25].
- Image J program was used for fat quantification after adjusting the fat threshold to –30 to –150 HU. Neck adipose tissue (NAT) will be assessed at the level of C5 vertebra (26) and Visceral adipose tissue (VAT) will be estimated at the level of L3 vertebrae [27] (Fig. 2).

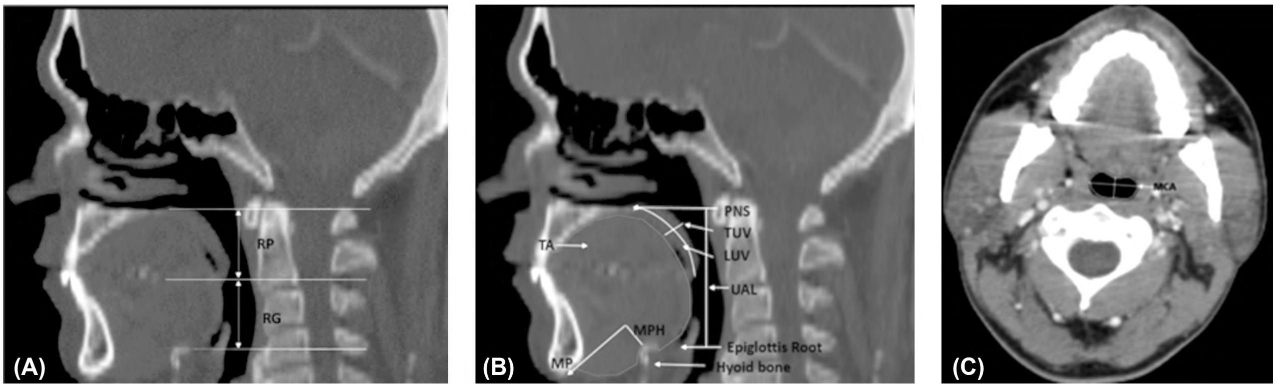

Fig. (1): CT images of a non OSA subject in the mid-sagittal (A,B) and axial planes (C). A. The retro-palatal (RP) and the retro-glossal (RG) regions of the upper airway are demonstrated. B. CT measures of the Mandibular Plane Hyoid distance (MPH), Upper Airway Length (UAL), Length and Thickness of the Uvula (LUV, TUV) and Tongue Area (TA) are illustrated. C. Minimal cross sectional area (MCA), antero-posterior diameter (APD) diameter and transverse airway diameter (TDA) were measured at the retro-palatal region.

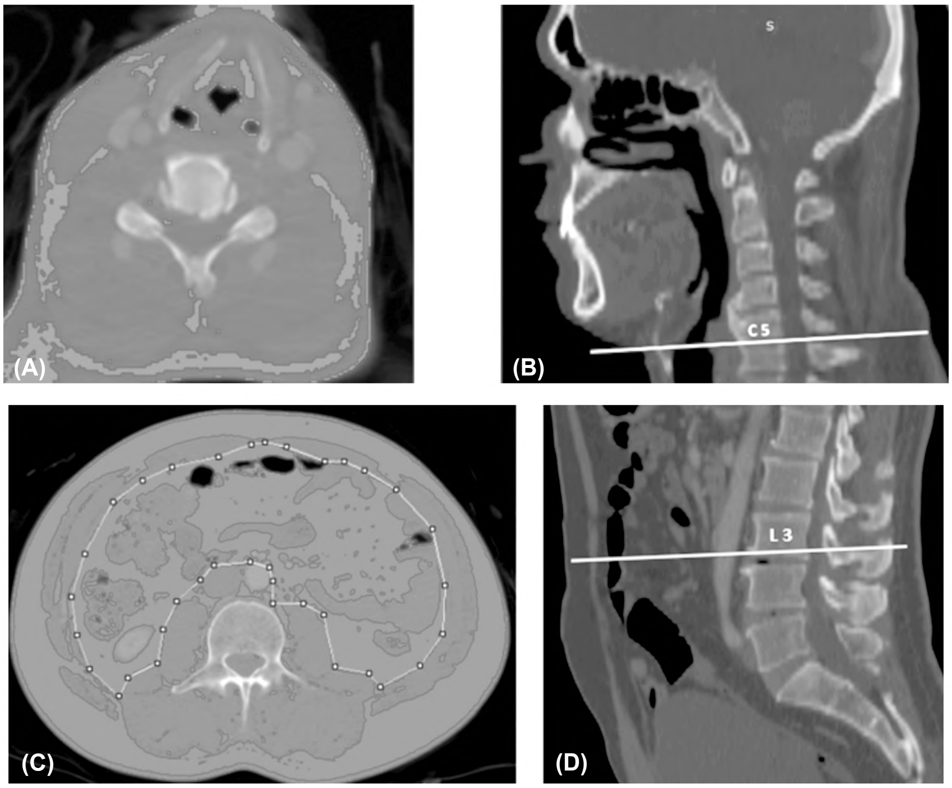

Fig. (2): CT fat quantification of the neck adipose tissue (NAT) at the level of C5 vertebrae (A,B) and visceral adipose tissue (VAT) at the level of L3 vertebra (C,D) in a non-OSA subject.

Statistical analysis:

Data were fed to the computer and analyzed using IBM SPSS Corp. Released 2013. IBM SPSS Statistics for Windows, Version 22.0. Armonk, NY: IBM Corp. Qualitative data were described using number and percent. Quantitative data were described using median (minimum and maximum) for non-parametric data and mean, standard deviation for parametric data after testing normality using Kolmogrov-Smirnov test. Significance of the obtained results was judged at the (0.05) level. Data analysis was done using Mann-Whitney U test to compare 2 independent groups and Kruskal Wallis test was used to compare more than 2 independent groups with Mann Whitney U test to detect pair-wise comparison.

The diagnostic performance of a test, or the accuracy of a test to discriminate diseased cases from non-diseased cases is evaluated using Receiver Operating Characteristic (ROC) curve analysis. Sensitivity and Specificity were detected from the curve and PPV, NPV and accuracy were calculated through cross tabulation.

Binary stepwise logistic regression analysis was used for prediction of independent variables of binary outcome (cases). Significant predictors in the Univariate analysis were entered into regression model using forward Wald method. Adjusted odds ratios and their 95% confidence interval were calculated.

Results

The final study population included 16 control subjects; 7 males and 9 females. 17 OSA patients; 11 males (65%) and 6 females (35%). Age mean was 41±13y and 39±9y for OSA and non-OSA groups respectively. BMI was 29.4±4.9 and 23±6.4 kg/m^2 for OSA and non-OSA groups respectively. NC was 38.4±5.3cm for OSA group, 31±3.1 for non-OSA group. WC 96.2±13.9cm for OSA versus 81±11 in non OSA group.

Clinical symptoms in OSA group were Daytime sleepiness (n=17), snoring (n=12), Fatigue (n=10) and poor concentration (n= 7). The mean AHI for OSA group was 30±27, range 2 to 86 events/h. 23.5% of patients met the criteria of mild OSA with AHI ≤15 (n=4), 41 % of patients met the criteria of moderate OSA with AHI 15-30 (n=7) and 35.5% of patients met the criteria of severe OSA AHI >30 (n=6).

Comparing CT measures of OSA and non-OSA groups:

Variable CT measurements in an OSA patient are shown in Fig. (3). Table (1) summarizes the values of CT measures in the OSA and control non-OSA groups. ROC curve analysis for diagnostic performance of each significant CT parameter are shown in Fig. (4), Table (2).

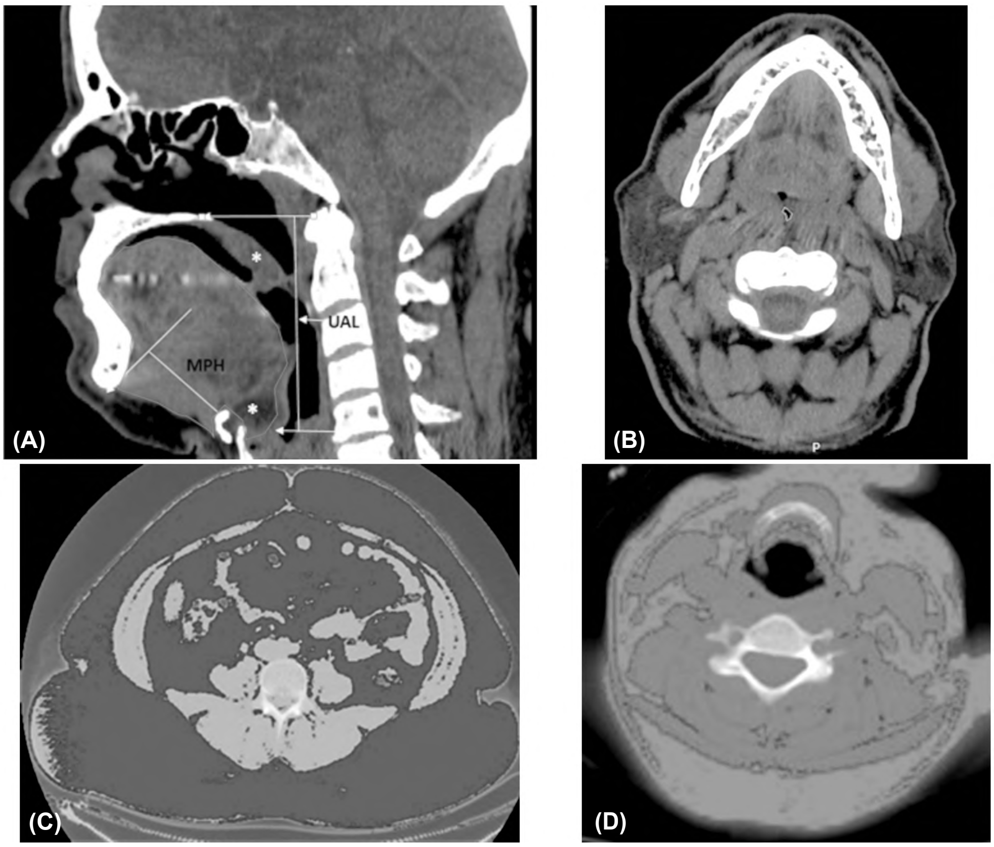

Fig. (3): CT images of a case of severe OSA A. mid sagittal image showing retro-palatal upper airway obstruction (RP). The air way is elongated with increase in the MPH and UAL, The tongue is enlarged with fatty deposition in the tongue base (white *). There is also increase thickness of the uvula (TUV) (yellow *). B. Axial image showing the marked reduction of the MCA, TDA and APD of the retro-palatal airway. C, D Marked increase of NAT and VAT quantified after adjusting the of CT images to fat threshold at –30 to –150.

Table (1): Comparison of CT measures of the upper air way, tongue adiposity and central obesity between obstructive sleep apnea (OSA) group and in the control group.

	Case N=17	Control N=16	Test of Significance	
			p-value	Z-value
Upper air way parameters:				
MPH (mm)	14.2±2.5	9.7±4.6	0.02*	3.31
UAL (mm)	72.4±7.8	63.3±10.5	0.04*	2.09
MCA (cm^2)	0.65±0.28	1.9±0.6	<0.005*	4.90
TDA (mm)	8.8±3.14	16±5.7	<0.005*	4.51
APD (mm)	9.8±2.5	10.4±3.5	0.07	0.22
LUV (mm)	40.1±5.7	33.25±4.7	0.24	0.18
TUV (mm)	11±3.1	7.3±1.4	<0.005*	4.02
Tongue adiposity measures:				
TA (cm^2)	55.8 ±21	26.4±7	<0.005*	4.3
TD (HU)	17.1±14	34±12	0.01 *	3.36
Central obesity measures:				
NAT (cm^2)	62±45	44±32	0.04*	2.1
VAT (cm^2)	204±46	124±27	0.003 *	3.78

All parameters described as mean ± SD.
Z: Mann Whitney U test.
*: Statistically significant.
MPH : Mandibular Plane Hyoid distance.
UAL : Upper Airway Length.
MCA : Minimum Cross-sectional Area.
TDA : Transverse Diameter of Airway.
APD : Antero-Posterior Diameter of the airway.
LUV : Length of Uvula and soft palate.
TUV : Thickness of Uvula and soft palate.
TA : Tongue Area.
TD : Tongue base Density.
NAT : Neck Adipose Tissue.
VAT : Visceral Adipose tissue.

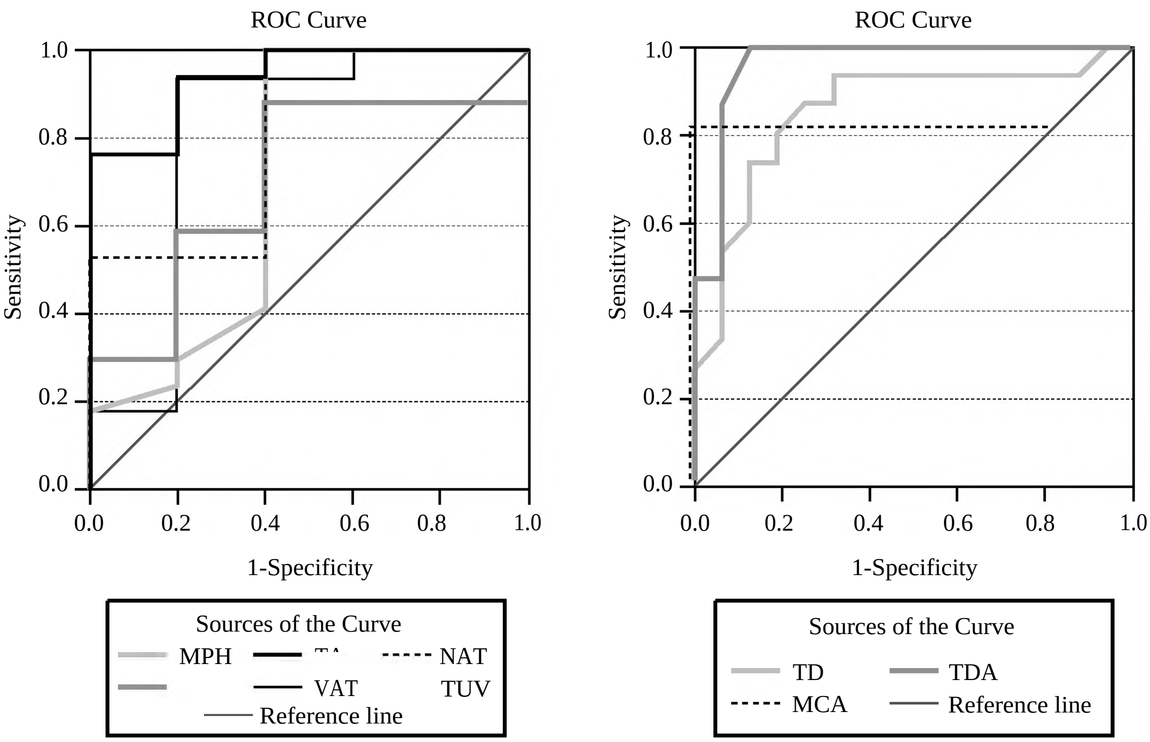

Fig. (4): ROC curve analysis for diagnostic performance of CT measures in OSA diagnosis Diagonal segments are produced by ties.

Table (2): Validity of the studied measurements in the diagnosis of OSA.

	AUC (95% CI)	Cut off point	Sensitivity %	Specificity %	PPV %	NPV %	Accuracy %
Upper air way measures:							
MPH (mm)	0.801 (0.608- 0.994)	10.5	94.1	69.2	80.0	92.3	84.8
UAL (mm)	0.724 (0.542-0.906)	67.5	70.6	60.0	60.0	61.5	60.6
MCA (cm^2)	1.0 (1.0-1.0)	0.55	93.3	100.0	100.0	94.1	96.9
TDA (mm)	0.960 (0.886-1.0)	12.5	86.7	93.8	93.8	88.2	90.9
TUV (mm)	1.0 (1.0-1.0)	1.525	93.3	100.0	66.7	76.9	70.97
Tongue adiposity measures:							
TA (cm^2)	0.957 (0.894-1.0)	32.5	94.1	80.0	88.9	93.3	90.9
TD (HU)	0.0.854 (0.710-0.998)	23.50	80.0	81.2	80.0	81.2	80.6
Central obesity measures:							
VAT (cm^2)	0.896 (0.763-1.0)	150.5	94.1	80.0	88.9	91.7	90.0
NAT (cm^2)	0.812 (0.583-1.0)	39.5	94.1	60.0	88.2	60.0	81.8

MPH : Mandibular Plane Hyoid distance.
UAL : Upper Airway Length.
MCA : Minimum Cross-sectional Area.
TDA : Transverse Diameter of Airway.
TUV : Thickness of Uvula and soft palate.
TA : Tongue Area.
TD : Tongue base Density.
VAT : Visceral Adipose tissue.
NAT : Neck Adipose Tissue.

Upper air way measures:

Statistically significant differences were found in the MPH, UAL, MCA, TDA, TUV between the OSA group and the control group, p-values were 0.02, 0.04, <0.005, <0.005, <0.005.

Reduction of the MCA showed the highest diagnostic accuracy among airway measures. The best detected cutoff point was 0.55cm ^{2} yielding 93, 100, 100, 94 and 97% sensitivity, specificity, PPV, NPP, accuracy respectively.

Tongue adiposity measures:

Both measures of tongue adiposity TA and TD were significantly different between the OSA group and the control group, p-values were <0.005 and 0.01 respectively.

On the ROC curve analysis the increase in tongue area (TA) above cutoff point 32.5cm ^{2} produces 94, 80, 89, 93,91% sensitivity, specificity, PPV, NPP, accuracy respectively and the decrease in tongue density (TD) below cutoff point 23.5 HU produces 80, 81, 80, 81 and 80.5% sensitivity, specificity, PPV, NPP, accuracy respectively.

Central obesity measures:

Our case-control groups were not matched for BMI. Statistical significance was found in both NAT and VAT measures, however VAT showed higher significance p=0.003 compared to p=0.04 for NAT. The proposed cutoff point for VAT was 150cm^2 yielding sensitivity, specificity, PPV, NPP, accuracy of 94, 84, 89, 92, 90% respectively. While the cutoff point for NAT was 39.5cm ^{2} yielding sensitivity, specificity, PPV, NPP, accuracy of 88, 60, 88, 60 and 82% respectively.

Comparing OSA grades and levels of airway obstruction:

The level of upper airway obstruction was at the retro-palatal region in 70.5% of subjects (n=12). Obstruction at the retro-glossal region was only found in one case 0.06%. Multilevel obstruction was observed in 23.5% of cases (n=4), all had severe OSA. Comparing the different CT measures and levels of airway obstruction among the different OSA grades are shown in Table (3).

Upper air way measures:

There was significant differences in UAL among different grades of OSA (p<0.005). The MPH distance was significantly higher in severe OSA compared to the mild and moderate grades (p 0.039) while no significant differences was found between the mild and moderate OSA. There was significant reduction in the MCA and TDA in the severe OSA compared to mild/moderate grades and moderate OSA (p 0.042 and 0.002) respectively.

No significant differences among OSA grades regarding the uvula length and thickness (LUV and TUV).

Tongue adiposity measures:

Tongue area (TA) as measured in the mid sagittal plane was larger is patients with severe OSA when compared mild/moderate grades (p=0.01). Tongue base HU (TD) was significantly different between severe and mild OSA grades (p=0.09), with no differences when comparing mild versus moderate OSA or Moderate versus severe groups.

Body fat distribution measures:

NAT differed significantly between the mild and severe OSA grades (p=0.018). VAT values showed no significant difference among the OSA grades.

Table (3): CT measures of the upper air way, tongue adiposity and central obesity in Patients with Mild, Moderate and severe grades of Obstructive sleep apnea (OSA).

	Mild	Moderate	Severe	KW test of Significance
Number	4	7	6	
Levels of airway narrowing:				
Retro-palatal	4	6	2	
Retro-glossal	0	1		
Multi-level	0	0	4	
Upper air way parameters:				
MPH (mm)	12.2±1.7^{a}	13±2.5^{a}	16.2±1.9^{b}	0.039*
UAL (mm)	64.7±3.8^{a}	69.3±5.5^{b}	79±6.6^{c}	0.001*
MCA (cm^2)	0.8±0.1^{a}	0.71±0.21^{a}	0.48±0.09^{b}	0.004*
TDA (mm)	10.6±1.2^{a}	10.1±2.18^{a}	6.2±1.7^{b}	0.042*
APD (mm)	10.7±5.06	11.2±6.63	9.3±5.7	0.62
LUV (mm)	37.7±5.4	40.6±6.3	41.7±5.2	0.43
TUV (mm)	8.6±3.3	1±3.1	1.2±2.7	0.21
Tongue adiposity measures:				
TA (cm^2)	33.5±3.7^{a}	46.7±10^{a}	79.4±23^{b}	0.012*
TD (HU)	31±16^{a}	20.2±5.5^{a,b}	8±11^{b}	0.009*
Body fat composition:				
NAT (cm^2)	41±4.9^{a}	50±5.3^{a,b}	69±19^{b}	0.018*
VAT (cm^2)	162±34	210±31	225±52	0.079

All parameters described as mean ± SD.
KW: Kruskal Wallis test.
*: Statistically significant.
- Similar superscripted letters denote significant difference between groups.
MPH: Mandibular Plane Hyoid distance.
UAL: Upper Airway Length.
MCA: Minimum Cross-sectional Area.
TDA : Transverse Diameter of Airway.
APD : Antero-Posterior Diameter of the airway.
LUV : Length of Uvula and soft palate.
TUV : Thickness of Uvula and soft palate.
TA : Tongue Area.
TD : Tongue base Density.
NAT : Neck Adipose Tissue.
VAT : Visceral Adipose tissue.

Prediction of severe OSA:

ROC curve analysis was done to detect cutoff points and diagnostic performance of the CT parameters in differentiating patients with severe grades of OSA from the mild/moderate grades Fig. (5), Table (4).

The reduction of MCA below cutoff point 0.31cm^2 showed the highest diagnostic performance with sensitivity, specificity, PPV, NPP, accuracy 100, 91, 86,100 and 94% respectively. Followed by the increased TA above 58.5cm^2 and the reduced TDA below a cutoff point 6.9mm; both gave 83, 91, 83, 91 and 88% sensitivity, specificity, PPV, NPP, accuracy respectively. Increased NAT above a cutoff point of 56cm^2 yielded sensitivity, specificity, PPV, NPP, accuracy 83, 82, 71, 90 and 82% respectively for diagnosing severe OSA.

Binary logistic regression was done to detect predictors of severe OSA and found that TA and MPH were the significant predictors. With every increase one mm in TA increase risk of OSA by 1.14 (OR:1.14 , 95% CI : 1.02-1.28) with the overall % predicted was 88.2%. Results of binary regression analysis of the severe OSA independent variables are shown in Table (5).

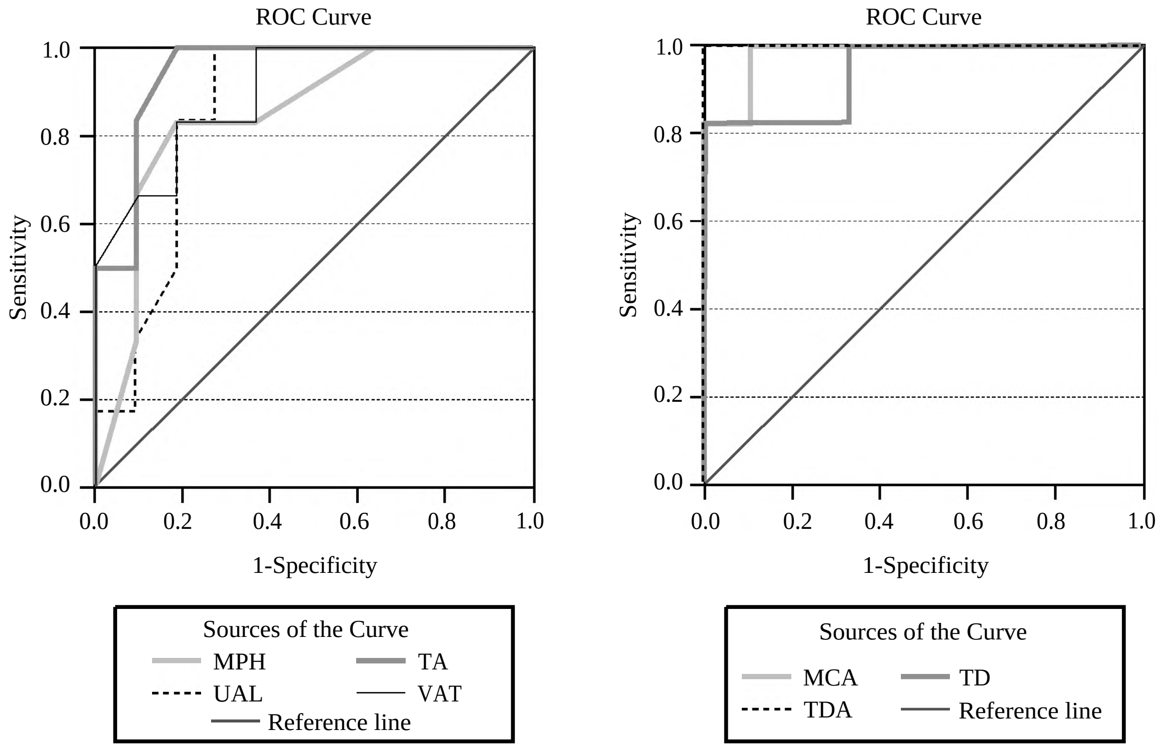

Fig. (5): ROC curve analysis for diagnostic performance of CT measures in severe OSA diagnosis Diagonal segments are produced by ties.

Table (4): Validity of the studied measurements in the diagnosis of severe OSA.

	AUC (95% CI)	Cut off point	Sensitivity %	Specificity %	PPV %	NPV %	Accuracy %
Upper air way measures:							
MPH (mm)	0.848 (0.651-1.0)	14.5	83.3	81.8	71.4	90.0	82.4
UAL (mm)	0.856 (0.673-1.0)	77.0	83.3	81.8	71.4	90.0	82.35
MCA (cm^2)	1.0 (1.0-1.0)	0.31	90.9	85.7	100.0	94.12	94.12
TDA (mm)	0.981 (0.925-1.0)	6.94	83.3	90.9	83.3	90.9	88.2
Tongue adiposity measures:							
TA (cm^2)	0.947 (0.843-1.0)	58.5	83.3	90.9	83.3	90.9	88.2
TD (HU)	0.944 (0.823-1.0)	15.0	83.3	88.9	83.3	88.9	76.5
Central obesity measures:							
NAT (cm^2)	0.947 (0.753-1.0)	56.0	83.3	81.8	71.4	90.0	82.3

All parameters described as mean ± SD.
MPH: Mandibular Plane Hyoid distance.
UAL: Upper Airway Length.
MCA: Minimum Cross-sectional Area.
TDA : Transverse Diameter of Airway.
TA : Tongue Area.
TD : Tongue base Density.
NAT : Neck Adipose Tissue.

Table (5): Binary logistic regression in prediction of severe OSA.

	β	*p*-value	OR (95%CI)
Upper air way measures:			
MPH (mm)	0.673	0.034*	1.96 (1.05-3.65)
UAL (mm)	0.331	0.071	1.39 (0.972-1.99)
MCA (cm^2)	–0.378	0.094	0.685 (0.44-1.07)
TDA (mm)	–74.67	0.99	Undefined
Tongue adiposity measures:			
TA (cm^2)	0.132	0.027*	1.14 (1.02-1.28)
TD (HU)	–47.19	0.17	Undefined
Central obesity measures:			
NAT (cm^2)	0.019	0.186	1.02 (0.99-1.05)
Overall % predicted =88.2%			

MPH : Mandibular Plane Hyoid distance.
UAL : Upper Airway Length.
MCA : Minimum Cross-sectional Area.
TDA : Transverse Diameter of Airway.
TA : Tongue Area.
TD : Tongue base Density.
NAT : Neck Adipose Tissue.

Discussion

Combining different CT measures of the airway, tongue adiposity and central obesity helps in OSA diagnosis as well as prediction of severity. MCA below $0.55cm^2$ and TA above $32.5cm^2$ were the best parameters for OSA diagnosis. For identifying severe OSA reduced MCA below $0.31cm^2$, reduced TDA below 6.9mm and increased TA more than $58.5cm^2$ offered high diagnostic performances. Binary logistic regression found that TA and MPH were the significant predictors for severe OSA.

In agreement with previous studies, the most common level of upper airway obstruction was the retro-palatal region, followed by the tongue base region. We found multilevel collapse in only 23.5% of cases, all had severe OSA. Chousangsuntorn et al., reported higher percentage of multilevel obstruction on their CT study likely because it was conducted during the apneic episode **[11]**.

The MCA of the upper airway in the OSA group was significantly smaller than that of the non-OSA group. MCA is reduced by both the enlarged upper airway structures and the external pressure by the excess fat deposition in the neck. It was therefore considered as a key airway measure for OSA in our study as well as in several studies using different modalities **[6,7,12,17,28]**.

Lengthening of the upper airway as expressed by the significant increase of UAL and MPH distances was found in OSA patients compared to control. For grading of severity, UAL was significantly different among the three OSA grades, MPH was significantly different between severe OSA cases and both mild and moderate groups. Results from previous studies support ours **[7,20,21,25]**.

We observed that OSA patients have larger tongue volumes with significantly increased TA and reduced TD compared to control group, significant differences were also found between the mild and severe OSA. The increased tongue adiposity in OSA patients was previously investigated **[14,20]** Barrera 2017 suggested that tongue volume is the strongest clinical predictor of OSA **[6]**.

Obesity can cause OSA by different mechanisms. Expansion of parapharyngeal spaces with fat results in reduction of the transverse pharyngeal diameter and pharyngeal area. Deposition of excess fat in tongue base decreases its effciency as a pharyngeal dilator. Abdominal visceral adiposity decreases lung volumes, reduces traction on the pharynx and can lead to increased pharyngeal collapsibility and OSA **[17,25]**.

BMI does not reflect the extent of obesity **[19]**. It is important to notice that subjects with similar BMI and WC can vary in their VAT and NAT measures **[29]**.

The quantitative NAT and VAT measures in the current study were significantly higher in OSA group than in the control group. There was also significant difference between the NAT of the mild and severe OSA grades. Our results were in line with previous studies who reported correlations between the increases neck fat areas and the upper airway dimensions **[25,26,30,31]**.

Regarding male and female distribution 65% of OSA patients in the current study were males. The difference in CT measures between males and females was not the subject of our study however previous studies have shown that UAL was significantly longer in men **[32]**. It was also observed that men have significantly more visceral fat than women in BMI matched groups which might explain the predisposition of men to OSA compared with women **[29]**.

We chose the regular breathing, awake CT. Other investigators perform different techniques as imaging in the supine and lateral decubitus positions, Image acquisition with Muller maneuver, or during apneic episodes and in different phases of respiration **[10-12,20]**.

Although CT scanning during apneic episodes can provide more relevant anatomic and pathologic findings in high grades of OSA [11], scanning of awake patients without a sleep tracking system is more rapid, simple and applicable way. It can provide informative measures predictive of OSA [10]. CT during different phases of respiration was previously studied, one study found MCA at the end of inspiration was the most predictive measure for OSA severity [10]. Another study concluded that an awake upper airway CT scan can properly diagnose palate-pharyngeal obstruction; however, it was less sensitive for detecting retro-glossal obstruction [13]. High radiation dose is a main concern of the previous studies.

This work suffered from some limitations, the sample size was relatively small. Single investigator performed all the measurements so Interobserver agreement was not evaluated. The CT acquisition on awake subjects does not reflect the anatomy or physiology of the upper airway during sleep. The control patients had no symptoms or clinical evidence of breathing- or sleep-related symptoms but they did not have overnight PSG to confirm the absence of OSA. Finally OSA and control groups were not matched for age, sex and BMI.

Conclusion:

Our results indicate that CT offers added value in OSA diagnosis and prediction of severity, multiple CT measures varied significantly between OSA and control group as well as between different OSA grades. MCA and TA were the best parameters for OSA diagnosis. For identifying severe OSA MCA, TDA and TA offered high diagnostic performances. Binary logistic regression found that TA and MPH were the significant predictors for severe OSA.

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هل يمكن لقياس أبعاد مجرى الهواء العلوى ومؤشرات السمنة المركزية بالاشعة المقطعية أن تفرق بين الدرجات المختلفة من انقطاع النفس الانسدادى أثناء النوم ؟

مقدمة: انقطاع النفس الانسدادى النومى (OSA) هو اضطراب شائع فى النوم، يصيب حوالى ٤٢٪ من البالغين فى منتصف العمر. ويتميز بنوبات متكررة من ضيق مجرى الهواء العلوى مما يؤدى إلى نقص الأكسجين أثناء النوبة والنوم المتقطع. مسببات OSA هى فى الأساس التغيرات التشريحية التى تؤدى إلى ضييق مجرى الهواء العلوى (البلعوم). وتعد السمنة عامل الخطر الرئيسى للإصابة بانقطاع التنفس أثناء النوم.

يعتمد تشخيص انقطاع التنفس أثناء النوم على مقياس خاص للنوم وهو ما يحتاج بقاء المريض فى المستشفى طوال الليل كما يتطلب خبرة كبيرة من الطبيب لتفسير نتائج المقياس بشكل صحيح.

تتميز الأشعة المقطعية بتوضيح ممتاز للهيكل العظمى للوجه والفكين وأبعاد مجرى الهواء العلوى وتفاصيل الأنسجة الرخوة المحيطة وتوفر الأشعة المقطعية أيضاً معلومات مباشرة حول توزيع الد هون فى الجسم. لذلك يمكن أن تكون احد بدائل تشخيص انقطاع النفس أثناء النوم بدرجاته المختلفة.

الهدف من الدراسة: تقييم أبعاد مجرى الهواء العلوى ومقاييس السمنة المركزية فى مرضى انقطاع النفس الانسدادى أثناء النوم مقارنة بالمجموعة الضابطة باستخدام الأ شعة المقطعية ودراسة إمكانية استخدام مقاييس الأشعة المقطعية المختلفة فى التفرقة بين الدرجات المختلفة لانقطاع النفس الانسدادى أثناء النوم.

الخطة البحثية: أجريت هذه الدراسة على حوالى ٣٣ مريض ١٧ من مرضى انقطاع النفس الانسدادى أثناء النوم بعد تشخيصهم بمقياس النوم و١٦ شخص لا يعانون من أعراض تنفسية أو أضطرابات أثناء النوم.

خضع جميع المرضى للتصوير بالاشعة المقطعية بدون صبغة وتحليل صور الاشعة لقياس أبعاد المجرى التنفسى العلوى ومقاييس حجم ونسبة الدهون فى اللسان ومقاييس السمنة المركزية. ثم تحليل النتائج إحصائياً بإستخدام البرامج المناسبة.

النتائج: يوجد إختلاف إحصائى بين مقاييس الأشعة المقطعية لمرضى إنقطاع التنفس الانسدادى أثناء النوم والمجموعة الضابطة كما أختلفت بعض المقاييس بين درجات ضيق المجرى التنفسى العلوى الثلاث. تتفاوت مقاييس الأشعة المختلفة فى وقتها وقدارتها على تشخيص وتحديد درجات ضيق مجرى الهواء فى مرضى إنقطاع التنفس الانسدادى أثناء النوم.