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Avaliação Volumétrica da Via Aérea Superior em Pacientes com Apneia Obstrutiva do Sono.

Volumetric Evaluation of Upper Airway in Patients with Obstructive Sleep Apnea.

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Tutor: Prof. Dr. Luis Augusto Passeri

Volumetric Evaluation of Upper Airway in Patients with Obstructive Sleep Apnea.

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Dedicatória

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Epígrafe

"O sono é para o indivíduo o mesmo que dar corda ao relógio."

Arthur Schopenhauer

1788 - 1860

Resumo

Introdução: A apneia obstrutiva do sono (AOS) ocorre por colapsos recorrentes da via aérea superior durante o sono o que resulta em redução total (apneia) ou parcial (hipopneia) do fluxo aéreo. Tem íntima relação com as alterações na via aérea superior (VAS). A tomografia de feixe cônico permite a análise da VAS e do seu volume, por meio de reconstrução tridimensional.

Objetivo: Avaliar as alterações volumétricas da via aérea superior em pacientes com apneia obstrutiva do sono.

Metodologia: Dissertação desenvolvida a partir de dois artigos científicos. Ambos são estudos retrospectivos, por meio da revisão de 33 prontuários de pacientes adultos com queixas sugestivas de AOS.

Resultados: Foram avaliados 19 pacientes do gênero masculino e 14 do gênero feminino, com índice de massa corpórea (IMC) médio de 30,38kg/m^2 e idade média de 49,35 anos. Destes, 14 apresentavam AOS grave, 7 moderada, 7 leve e 5 indivíduos não eram portadores da patologia. No artigo 1 foi avaliada a relação entre o volume da via aérea e a gravidade da AOS. O índice de correlação de Spearman entre o volume da VAS e o Índice de Apneia e Hipopnéia foi de -0,100 com p= 0,580. O teste de Mann-Whitney entre as categorias da AOS e o volume teve p = 0,4630. O artigo 2 avaliou a relação entre o volume da VAS e o Sistema de Estagiamento de Friedman (SEF). O teste de ANOVA comparando o Volume com o SEF foi de 0,018.

Conclusão: O volume da via aérea superior não apresenta relação linear com a gravidade da Apneia Obstrutiva do Sono, quando avaliada pelo Índice de Apneia e Hipopneia. O volume da via aérea superior apresentou uma relação significativa e inversa com o Sistema de Estadiamento de Friedman, ou seja, quanto maior a classificação de Friedman menor o volume da via aérea superior.

Palavras Chave: via aérea superior, apnéia obstrutiva do sono, tomografia volumétrica de feixe cônico

Abstract

Introduction : Obstructive Sleep Apnea (OSA) occurs by recurrent collapse of the upper airway during sleep, resulting in total (apnea) or partial (hypopnea)reduction of airflow and has relationship with changes in upper airway (UA). The cone beam tomography allows the analysis of UA's volume (UAV) by three-dimensional reconstruction.

Objective: Evaluate the volumetric changes of the upper airway in patients with obstructive sleep apnea.

Methodology: Dissertation developed from two scientific articles. Both are retrospective studies by reviewing the medical records of 33 adult patients with complaints suggestive of OSA.

Results: We evaluated 19 male and 14 female, with average body mass index (BMI) of 30.38 kg/m^2 and mean age of 49.35 years. Among them, 14 had severe OSA, 7 moderate, 7 mild and 5 subjects were heatlhy. In article 1 the relationship between the UAV and severity of OSA was evaluated. The index Spearman correlation between UAV and the Apnea-Hypopnea Index was -0.100 with p=0.580. The Mann-Whitney between categories of OSA and UAV was p=0.4630. Article 2 evaluated the relationship between UAV and the Friedman Staging System (FSS). The ANOVA test comparing the volume with the FSS was 0.018.

Conclusion: The volume of the upper airway has no linear relationship with the severity of obstructive sleep apnea, as measured by the apnea-hypopnea index. The volume of the upper airway showed a significant inverse relationship with Friedman Staging System, high FSS is found in subjects with low volume of the upper airway.

Key words: upper airway, obstructive sleep apnea, cone beam computed tomography

Lista de Abreviaturas

AOS – Apneia Obstrutiva do Sono

VAS – Via Aérea Superior

REM – Fase do Sono de Movimento Rápidos dos Olhos (*Rapid Eye Moviment*)

Ptm – Pressão Transmural

P_L – Pressão Intraluminal

P_{TI} – Pressão Tecidual

IMC – Índice de Massa Córporea

TVFC - Tomografia Volumétrica de Feixe Cônico

3D – Tridimessional

OSA (AOS) – Obstructive Sleep Apnea

UA (VAS) – Upper Airway

AASM – American Academy of Sleep Medicine

AHI – Apnea Hypopnea Index

BMI (IMC)– Body Mass Index

CBVT (TVFC) - Cone-Beam Volumetric Tomography

Unicamp – Universidade de Campinas

Unesp – Universidade Estadual Paulista

Uniara – Centro Universitário de Araraquara

CT – Computed Tomography (Tomografia Computadorizada)

DVD - Digital Versatile Disc

EEG – Electroencephalogram

EOG – Electrooculogram

EMG – Electromyogram

EKG – Electrocardiogram

SAS - Statistical Analisis System

FTP - Friedman Tongue Position

ANOVA – Análise de Variância

FSS - Friedman Staging System (SEF)

ENT – Otorhinolaryngology (Otorrinolaringologia)

CI - Confidence Interval

DISE - Drug Induced Sleep Endoscopy

UATR - Upper Airway Total Resistance

SEF - Sistema de Estadiamento de Friedman

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Sumário

1. Introdução Geral

A via aérea superior (VAS) é o pertuito de passagem do ar inspirado até a traqueia torácica e pulmões. Sua estrutura é composta pelo nariz, faringe, laringe e segmento extratorácico da traqueia, sendo suas principais funções fisiológicas a respiração, a fonação e a digestão.

A faringe é o único segmento colapsável deste complexo, estando exposta às forças internas e externas, que determinam sua patência. Segundo Schwab *et al*[1]., em 2011, a faringe representa o principal segmento da via aérea para o surgimento da Apnéia Obstrutiva do Sono (AOS), vez que é o sítio de colapso e fechamento durante os eventos obstrutivos no sono. O lumen da orofaringe e hipofaringe se obstruem por alterações da luz ou por influência obstrutiva dos outros setores da via aérea em especial o nariz e a rinofaringe[1].

Isono *et al*[2]*.,* em 1993*,* fizeram um estudo pressórico da faringe em pacientes sedados. Por meio dos seus achados definiram que a patência da faringe é definida por meio da pressão transmural (P_{tm}), que é definida pela diferença entre a pressão intraluminal (P_L) e a pressão tecidual (P_{TI}), ou seja, $P_{tm} = P_L - P_{TI}$, ilustrado na Figura I. O aumento da Ptm distende a via aérea e a mantém aberta. Em contraste, a queda da P_{tm} tende a fechar a via aérea. Em pacientes com obstrução da via aérea, a P_L é negativa, reduzindo a P_{tm} e levando ao colapso da faringe[2].

Neste mesmo estudo Isono fez uma analogia do comportamento da faringe com a Lei do Tubo. A pressão de fechamento da via aérea é o valor da P_{tm} quando a aérea é zero. A razão entre a área da VAS e a P_{tm} é chamada de complacência da VAS. Em estados de baixa P_{tm}, a complacência é maior, o que aumenta o potencial de colapso da faringe[2].

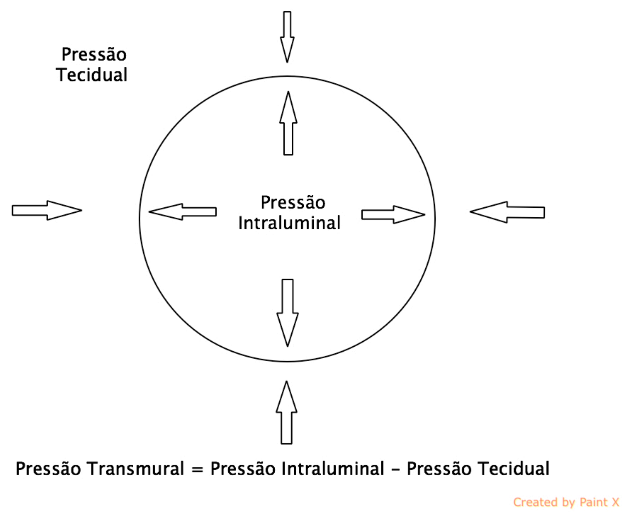

Figura 1 - Definição da Força Transmural

Os principais fatores estáticos que influenciam o comportamento da via aérea são: forças adesivas da superfície, posição do pescoço e da mandíbula, a tração traqueal e a gravidade. Em estudo de 2006, com pacientes saudáveis demostrou que existe uma relação positiva entre a queda tensão superficial da faringe e o seu fechamento. A respiração oral promove maior queda da tensão superficial. As forças adesivas mantém o palato mole aderido à base da língua, ajudando a abertura da via aérea. Quando há alterações da via aérea, ou respiração bucal, essas forças são desestabilizadas e podem promover o fechamento da faringe, no nível retropalatal[3].

A flexão cervical tende a fechar a faringe e a extensão tende a abrir. A abertura da mandíbula posiciona o tubérculo geniano e o osso hioide posteriormente, estreitando a faringe[4]. A tração traqueal, existente durante a inspiração, estabiliza a via aérea, traciona a faringe, reduz a complacência, descomprime a faringe e movimenta o osso hioide anteriormente[5].

A presença de um ponto de obstrução na VAS aumenta a força realizada, pela musculatura respiratória, para fazer o ar chegar aos pulmões. Há aumento da pressão negativa, intraluminal, no trecho localizado após o ponto de obstrução, o que desencadeia o estreitamento deste segmento. Pacientes com obstrução nasal são mais expostos ao colapso da VAS, por aumento da pressão negativa na luz da faringe.

Quando a VAS está estreitada, ocorre o Efeito Bernoulli. Este fenômeno causa um aumento da velocidade do ar inspirado em áreas com menor calibre, diminuindo a pressão intraluminal, o que facilita o colapso durante a inspiração. Portanto, quanto maior o estreitamento da VAS, maior a pressão negativa e maior o potencial de seu colapso.

A definição da Apneia Obstrutiva do Sono (AOS) foi realizada em 1999, pela força tarefa da Academia Americana de Medicina do Sono: colapsos recorrentes da via aérea superior durante o sono, o que resulta em redução total (apneia) ou parcial (hipopneia) do fluxo aéreo[6]. Durante o sono, existe uma redução, generalizada, do tônus muscular, que fica mais acentuada durante a fase “Rapid Eye Moviment” (REM), vez que há um relaxamento profundo da musculatura esquelética. A configuração anatômica e funcional da faringe, associada ao progressivo relaxamento muscular, pode promover o fechamento parcial e total desse segmento, durante o sono.

Os eventos respiratórios obstrutivos, que ocorrem durante o sono, causam dessaturação da oxi-hemoglobina, com consequente ativação de quimiorreceptores, que culminam com a liberação de noradrenalina. O evento terminal é o despertar cortical, que ativa a musculatura, revertendo o colapso da VAS. Essa sequência fisiopatológica ocorre repetidas vezes durante o período de sono e leva ao aumento do estresse oxidativo. A AOS é um fator de risco para pacientes portadores de doenças cardiovasculares e metabólicas[7,8].

A AOS tem prevalência de 32,8% da população adulta brasileira, sendo os mais atingidos: gênero masculino, índice de massa corpórea (IMC) > 25 kg/m^2, baixo nível socioeconômico, idade avançada e as mulheres na menopausa[9].

Esta síndrome está associada ao ronco, principalmente, em pacientes entre 40 e 65 anos, sexo masculino, obesos, tabagistas, etilistas e sedentários[9]. Os principais achados de exame físico incluem aumento da circunferência do pescoço, obstrução da orofaringe, flacidez palatal, obstrução nasal, hipertrofia de cornetos, deformidade septal, tumores de cavidade nasal, hipertrofia de amígdalas, macroglossia, retrognatia e deformidades craniofaciais e/ou dentofaciais[10].

Os principais sinais e sintomas da AOS são: roncos, apneias testemunhadas, engasgos durante o sono, sonolência diurna excessiva, sono não reparador, sono fragmentado, noctúria, cefaleia matinal, declínio cognitivo, perda de memória, redução da libido e irritabilidade[10].

Os pacientes com AOS apresentam a VAS com área transversal menor, comprimento mandibular reduzido, posicionamento inferior do osso hiode e retroposição da maxila, quando são comparados com indivíduos sadios[11]. Schwab e coloaboradores, em 2003, demonstraram, por meio de ressonancia magnética, que pacientes com AOS tem estruturas das partes moles da faringe (língua, parede lateral, tonsilas e tecido adiposo) com volume significativamente maior que os pacientes controles[11].

A pressão negativa e o repetitivo trauma da VAS causam um edema dos tecidos moles, contribuindo para a sua obstrução[12]. Os pacientes com AOS tendem a acumular gordura na região cervical e na adjacência da faringe, o que aumenta a pressão positiva tecidual, contribuindo para o colapso desta região[13]. A musculatura da VAS destes pacientes apresenta uma miopatia primária, que a torna mais suscetível ao colapso. Há um acúmulo de fibras musculares do tipo II, mais fatigáveis, na musculatura faríngea destes pacientes[14].

A avaliação da via aérea superior é realizada principalmente através do exame físico e dos exames de endoscopia nasal. Estes permitem a avaliação dos sítios obstrutivos existentes na luz da cavidade nasal e faringe. A avaliação das estruturas externas ao lumem é realizada pelos exames de imagem. Os principais exames utilizados são a tomografia computadorizada e a ressonância magnética. Esta última pode gerar uma análise dinâmica, com o registro da via aérea em movimento. Entretanto, este é um exame oneroso e demorado[15].

A Tomografia Volumétrica de Feixe Cônico (TVFC), associada aos programas de reconstrução em 3D, representou, nos últimos 5 anos, um importante avanço no estudo da via aérea em pacientes com AOS. Este exame permite a avaliação tridimensional da via aérea, aferição do volume e área de máxima constrição[16].

2. Objetivos

Objetivo 1 – Correlacionar o volume da via aérea superior com a gravidade da apneia obstrutiva do sono.

Objetivo 2 - Correlacionar o volume da via aérea superior com o Sistema de Estadiamento de Friedman em pacientes com AOS.

3. Publicações

3.1. Artigo 1

Volumetric evaluation of Upper Airway in Obstructive Sleep Apnea.

Submitted article in the Journal of Oral and Maxillofacial Surgery on April, 16, 2014 by the number JOMS-D-14-00424.

Subtitle: Upper Airway and Sleep Apnea

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This study had no external funding, did not use drugs off-label and has not been used for investigational use

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Abstract

Introduction: Obstructive Sleep Apnea (OSA) occurs by recurrent collapse of the upper airway during sleep, resulting in total (apnea) or partial (hypopnea) reduction or airflow and has intimate relation with changes in the upper airway (UA). Cone Beam CT allows the analysis of the upper airway and its volume by three-dimensional reconstruction.

Purpose: To correlate the volume of the upper airway in patients with the severity of obstructive sleep apnea.

Methods: Retrospective study with analysis of 33 patient records among whom 19 were male male and 14 female. The mean Body Mass Index (BMI) was 30.38 kg/m^2, the average age was 49.35 years. The sample consisted of 14 patients with severe OSA, 7 with moderate OSA, 7 with mild OSA and 5 normal subjects.

Results: The Spearman correlation index between the volume of the upper airway and the AHI was -0.100 with p=0.580. The Mann-Whitney test performed between categories of OSA and the volume showed p=0.4630.

Conclusion: The correlation between the volume of the airway and OSA assessed both by stratification as determined by the AASM (mild, moderate and severe) and also with the AHI was not positive. The volume of the airway is a factor in the pathogenesis of OSA which should be evaluated together with the forces of airway collapse. The volume of the upper airways as a isolated parameter did not correlate to the severity of the obstrucive sleep apnea syndrome.

Keywords : upper airway, obstructive sleep apnea, Cone Beam CT.
Trial Name: Volumetric evaluation of Upper Airway in Obstructive Sleep Apnea. Registered at German Clinical Trials Register (DRKS): http://www.germanctr.de by the number DRKS00005948.

Introduction:

The sleep respiratory disorders have a high prevalence in the world population and are a public health issue with clinical, economic and social repercussions. The obstructive sleep apnea syndrome (OSAS) is the main sleep respiratory disorder[1].

The American Academy of Sleep Medicine defines OSAS as a recurrent collapse of upper airway during sleep, resulting in a total (apnea) or partial (hypopnea) reduction of airflow. The primary snoring is a low frequency snore caused by soft palate and uvula vibrations during sleep[2].

Researchers have shown diversity in this syndrome's prevalence because it reaches all ages and is associated with different risk factors, such as anatomical variations, diseases and habits. An epidemiologic study held at Sao Paulo, Brazil, has shown that OSAS prevalence is 32.8% in the adult population. The risk factors associated with the syndrome onset were: male sex, Body Mass Index (BMI) > 25 kg/m^2, low socioeconomic status, advanced age and menopause[3]. In the population between 30 and 60 years old snoring has a prevalence of 19.1% among men and 7.9% among women[4]. Around 20% of the adult population presents snoring complaints and this percentage increases to 60% if the male sex above 40 years old is considered[5].

OSAS and snoring occur primarily in patients between 40 and 65 years old, with a higher incidence on the male sex, obese persons, smokers, alcoholic and sedentary individuals[1,3]. The main physical examination findings include increased neck circumference, oropharyngeal obstruction, flaccid palate, nasal obstruction, turbinate hypertrophy, septum abnormalities, nasal cavity tumors, pharyngeal tonsils hypertrophy, macroglossia, mandibular retrognathia and craniofacial or dentofacial abnormalities[6].

Among the main symptoms are snoring, witnessed apneas, choking during sleep, excessive daytime sleepiness, insufficient quality of night time sleep, fragmented sleep, nocturia, headaches in the morning, cognitive decline, memory loss, decreased libido and irritability[6].

The American Academy of Sleep Medicine (AASM) recommends diagnostic investigation of OSAS by polysomnography in every patient with cardiovascular or metabolic disease, such as: obesity with BMI > 35 kg/m^2, congestive heart failure, atrial fibrillation, arterial hypertension refractory to treatment, type 2 diabetes, nocturnal arrhythmias, stroke, pulmonary hypertension, professional drivers and bariatric surgery preoperatively[6].

In children OSAS is more frequent in the case of chronic nasal obstruction, hypertrophic pharyngeal tonsils and craniofacial related syndromes such as Pierre Robin, Crouzon and Down[7].

The airway patency is a determinant factor of the disease. Several collapse points contribute to its onset. Obesity, edema and genetic factors may promote variations in the airway volume[6].

Airway evaluation has undergone a great improvement with the advent in the 1990's of the Cone-Beam Computed Tomography, also known as Cone-Beam Volumetric Tomography (CBVT)[8]. This method obtains an airway tomography with less radiation exposure of the patient. It played an important role in the progress of airway evaluation if compared to conventional cephalometry, once it allows the airway analysis in three dimensions. The cephalometric methods commonly used for surgical-orthodontic evaluations do not allow a transverse study of upper airways and present a high airway dimensional variation due to head positioning. However, in the sagittal plane, the cephalometric images do provide accurate evaluations[8].

The volumetric measurements and the airway transverse area became an important tool on planning the therapy for OSAS patients. Even though CBVT allows easy tridimensional visualization it's difficult to compare several studies which used this method since there is no protocol on how the exam is done[8].

Studies correlating OSAS with the upper airway volume and tomographic abnormalities are rare and conflicting. The CBVT is a powerful tool on the OSAS pathophysiology understanding and should be explored to facilitate the planning for the therapy of OSAS patients .

Purpose:

To correlate the volumetric status of the upper airway in patients with the severty of obstructive sleep apnea.

Methods:

This study followed was approved by the Araraquara Dental School Ethics and Research Committee (registration 13185113.9.0000. Notion 252.804 from April, 23, 2013).

It is a retrospective study performed by reviewing adult patients medical records from the Oral and Maxillofacial Surgery Division of the Dental School at Araraquara - Unesp and from the Otorhinolaryngology Clinics of the Medical School of the University of Araraquara - Uniara. Patients were evaluated in an ambulatory specific for diagnosis of sleep respiratory disorders and associated symptoms and complaints, such as snoring, daytime sleepiness, witnessed apneas and choking during sleep.

The following data was obtained: dental physical examination with facial morphology classification and otorhinolaryngology physical examination, anthropometric variables, Body Mass Index (BMI), basal polysomnography and volumetric tomography images for upper airway volume determination.

The volumetric tomography images were obtained in an equipment for dentofacial images (I- Cat, KaVo, Joinville, SC, Brazil). According to the manufacturer it is a 3D volumetric dental computed tomography equipment which reaches up to three times the speed of those used in medicine while emitting 10 times less radiation to the patients. The cycle lasts no more than 40 seconds and the emitted beam is pulsatile, reducing the amount of radiation employed.

To obtain the tomographic images, patients were seated and in natural head position. They were instructed to inhale and hold the breath during the exam, resuming normal breathing immediately after. The CT slices were obtained from the hard palate to C3 level. Images were obtained parallel to the C2-C3 intervertebral space. All images were stored on a DVD for specific software analysis.

The dicom images were imported and reconstructed using the DOLPHIN 3D software (Dolphin Imaging Management Solutions, Chatsworth, California, USA) for airway examination.

To measure the volume of the airway the sagittal slices were selected and planes were formed resorting to anatomical references, thus defining its upper and lower limits for determination of volume.

The upper and lower limits of the airway were determined on the sagittal CT slices. The superior limit began on the posterior limit of the hard palate and was parallel to the palatal plane. The inferior limit was determined as a plane built from the most anterior and inferior point of the second cervical vertebra, also parallel to the palatal plane.

From those planes the volumetric analysis of this tridimensional region was done with the specific software, demarcated in pink as shown in Figure 1. By summing of the volumes the software did the tridimensional calculation in cubic millimeters. Hence, it was possible to measure the total airway volume on the pharynx region.

The polysomnographies were performed in the Araraquara Sleep Clinic – SP, Brazil. The sleep was evaluated during an average period of 6 hours. The electrophysiological variables evaluated during sleep were: electroencephalogram

(EEG), electrooculogram (EOG), electromyogram (EMG), electrocardiogram (EKG), airway flow (oral and nasal), respiratory effort (thoracic and abdominal), other corporal movements (measured by EMG), blood gases (oxygen saturation) and body temperature. The exams were evaluated by criteria of 2007 AASM Manual.

A sleep disorders specialized physician obtained the apnea/hypopnea index by summing the apnea and hypopnea events divided by hours of sleep. According to the results, OSAS was classified as absent (AHI<5 events/h), mild (5 ≤ AHI < 15 events/h), moderate (15 ≤ AHI < 30 events/h) or severe (AHI ≥ 30 events/h).

The exclusion criteria were: morbid obesity (IMC>40); craniofacial abnormalities such as craniodysostosis, craniostenosis, meningomyelocele and craniofacial cleft; nasal obstruction by polyposis or nasal tumor; existence of any craniofacial or airway tumor; larynx or pharynx paralysis; and previous upper airway surgery.

Data were analyzed by statistical descriptive tests and frequency of results. For the airway volume, AHI and OSAS severity correlation analysis the Spearman's rank correlation coefficient was chosen. For the comparative analysis of OSAS severity as a categorical variable and the volume, the Mann-Whitney test was chosen. The SAS System for Windows (Statistical Analisis System), version 9.3 software (SAS Institute Inc, 2002-2008, Cary, NY, USA) was used for the analysis.

Results:

Thirty-nine patients were evaluated between June 2012 and December 2013. Six patients were excluded because 4 presented inadequate tomographic exams and 2 had incomplete records.

Therefore, 33 patients were included in the study, 14 female (42,4%) and 19 male (57,6%). The measurements of the 3D tomographic images were obtained by a calibrated examiner who was blind to any other study data, such as anthropometric elements, physical examination and polysomnography. Two volume determinations were obtained separated by a 30-day interval.

The descriptive data can be found in the following tables:

Table 1. Description of OSA severity according to AHI

OSA severity	Frequency	Percentage
Normal	5	15.2%
Mild	7	21.2%
Moderate	7	21.2%
Severe	14	42.4%
Total	33	100%

Table 2. Description of Continuous Variables

Variable	Minimum	Maximum	Mean	Standard-Deviation
Age (years)	26.00	76.00	49.35	11.53
BMI (kg/m^2)	25.00	38.40	30.38	3.56
AHI (events/hours)	2.2	89.0	29.17	23.59
Volume (mm^3)	3291.80	15773.80	9536.69	2946.74
Volume 2[a] (mm^3)	3830.80	14575.00	9242.17	3138.72

[a] Second determination of volume

To evaluate the strength of the airway volume measurement a paired Student's t test was used.

Table 3. ***Paired Student's t test*** **between for the two volume determinations in mm^3**

	Mean	Std. Deviation	p
Volume	9536.6970	2946.74049	**0.4047**
Volume 2[a]	9242.1758	3138.72459	

[a] Second volume determination

The volume measurements were similar and did not show any statistical significant difference. The Apnea/Hypopnea Index (AHI) was statistically evaluated in two ways: as a continuous or ordinary variable (OSAS severity). In the first situation, the Spearman's rank correlation coefficient was chosen, for the second, The Mann-Whitney test was applied once distribution on this case was not normal. This analysis results are in the tables 4 and 5.

Table 4. Spearman's rank correlation coefficient

	Volume	AHI	Volume 2[a]	OSA severity[b]
Volume (first measurement)	1.000	-0.100	0.821	-0.095
p		**0.580**	0.000	**0.597**
AHI	-0.100	1.000	-0.049	0.950
p	0.580		0.785	0.000
Volume (second measurement)	0.821	-0.049	1.000	-0.062
p	0.000	**0.785**		**0.732**
OSAS severity	-0.095	0.950	-0.062	1.000
p	0.597	0.000	0.732	

[a] Second volume measurement
[b] OSAS severity according to the criteria defined on polysomnography

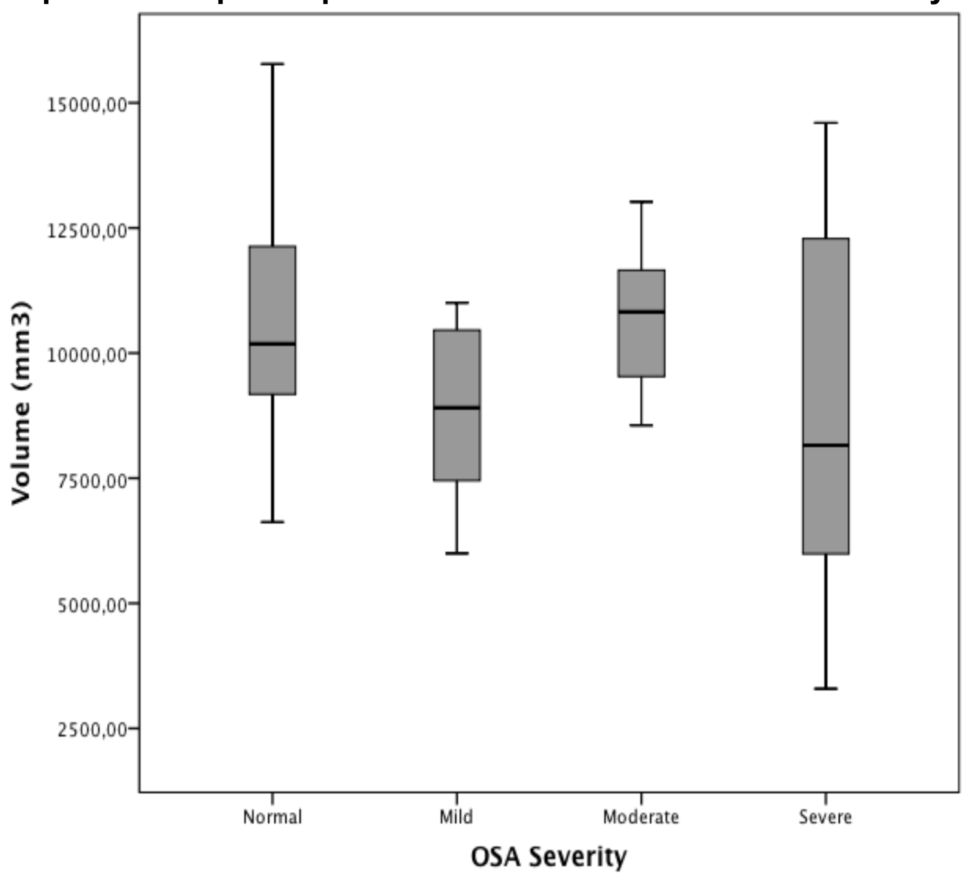
There was a weak correlation between AHI and both measurements (-0.100 e -0.049) which was not statistically significant (p= 0.580 e p = 0.785). The correlation between the OSAS severity as an ordinary variable and the volume measurements was also weak (-0.95 e -0.062) and had no statistical significance (p=0.597 e =0.732).

Table 5. Comparison between volume and OSA severity

OSA severity	Minimum	Maximum	Mean	p-value (Mann-Whitney)
Normal	6624.80	15773.80	10641.38	
Mild	5996.90	11004.30	8818.49	0.4630
Moderate	8690.80	13022.00	10824.56	
Severe	3291.80	14600.80	8879.84	

The comparison between OSA severity and upper airway volume by the Mann-Whitney test did not show any significant difference (p=0.4630).

Graphic 1 . Graphic representation of volume and OSA severity comparison.



The graphic representation on Table 5 illustrates the volume variability among different OSA severities, especially on severe cases.

The Spearman's rank correlation coefficient was used to exclude the influence of BMI and age on the relation between volume and AHI.

Table 6. Spearman's rank correlation coefficient between Volume and AHI, controlling BMI and age.

Controlled Variable	BMI	Age
Coefficient	-0.170	-0.124
p-value	0.396	0.537

The relation between AHI and volume was not affected either by BMI (p=0.396) or Age (p=0,537).

Discussion

OSAS is a dynamic disease which develops under upper airway total or partial obstruction during sleep, in one or more levels. Patients can show one or more obstructive sites located on nasal fossa, oropharynx, base of tongue and hypopharynx[9].

The whole airway evaluation is fundamental on diagnosing OSAS. Surgical treatment efficacy relies on determining and handling all multiple obstructive sites of the upper airway[9]. Several methods are useful on this analysis; most of them are performed with the patient sitting and conscious.

Initially, an otorhinolaryngology physical examination takes place. Despite its simplicity, it may provide useful information to the careful examiner about the airway configuration and suspicion of the disease. The patient can be classified according to the Friedman stages, which evaluate the oropharynx obstruction using the palatine tonsils size; to the Mallampati Modified Classification(MMC) and to the BMI, which can vary from 1 to 4[10]. The bigger the tonsils and the smaller the MMC and BMI, the lower the Friedman stage is. This score was developed to predict the success of oropharyngeal surgeries, such as uvulopalatopharyngoplasty. The lower the score, the higher the procedure success is. Those two parameters present a direct relationship with the OSAS severity as measured by AHI[3,11].

The upper airway endoscopy performed with a flexible fiberscope is a fundamental otorhinolaryngology physical examination complement by allowing complete evaluation of nasal cavity obstructive sites such as: septum deviation, turbinate hypertrophy, pharyngeal tonsils hypertrophy and nasal tumors. It also offers a pharynx evaluation from above, identifying the tongue base, lateral pharyngeal tissue, palatine and lingual tonsils. Usually this exam is conducted with a conscious and sitting patient. When conducted during induced sleep it is called sleep endoscopy[12].

In the past two decades image exams have increased in importance when it comes to studying the airway. The main exams available are Computed Tomography (CT) and Magnetic Resonance Imaging (MRI), which can provide a dynamic airway analysis capturing its movements but it is an expensive and time consuming method[13].

The airway study in OSAS patients has had an important advancement in the past 5 years due to the emergence of the Cone-Beam Volumetric Tomography (CBVT) in association with 3D reconstruction softwares. It allows a tridimensional airway evaluation, airway volume determination and detection of sites of maximum constriction[8].

In this study all OSAS severity patient groups were studied (from normal to severe) accordingly to Table 1. The higher incidence of severe patients was considered normal, since the patients came from an OSAS reference center.

The anthropometric data obtained from the patients, such as mean BMI compatible with obesity, age between 40 and 50 years and male sex prevalence allow us to say that OSAS predominated on obese middle aged males in this study[3].

The upper airway volume, a key variable for the study, was determined twice in different occasions by an examiner blind to any other study variable. This was necessary considering that the software Dolphin 3D needs a demarcation of the palatal and of the airway limiting planes in order to calculate the volumes. There was not any significant difference between the two distinct volume determinations (p=0.4047).

The correlation between the airway volume and OSAS (table 4), which was evaluated by the AASM categorization and by the AHI was not positive. This data goes against common sense, once the main analysis made by specialists while examining the upper airways is the relation of the airway with underlying structures, narrowing and volume[9].

One can argue that if the correlation described above is not linear, the simple strategy of increasing the airway volume will not reflect improvement on OSAS. On a careful analysis of Table 5, we observe that the severely affected patients mean airway volume is similar to the one found in mild OSAS patients. Patients with moderate OSAS and healthy individuals show a mean airway volume higher than other categories as shown on Table 5.

The airway polymorphism becomes more evident when analyzing Graphic 1. The biggest airway measurement variation occurred in severe OSAS patients who have shown the smallest and also the second greater measurements of all patients. Thus, both a patient with a wide airway or one with a smaller airway can present severe OSAS.

There was not any influence of BMI and age on the airway volume and OSAS correlation. Table 6 shows that Spearman's rank correlation coefficient stayed non-significant after the analysis included BMI and age.

Abramson *et al.*, 2010[14], have shown that the linear analysis of airway volume and AIH was not positive. OSAS is also related to the airway length. As the length increases higher will be the chances of collapse to occur. Since the airway is a simple conduit, airflow resistance is combined serially resulting in increase of the total resistance[14]. The volume analysis controlling BMI and age also did not show any interaction with OSAS.

Results were similar on a South Korean study, where patients were divided into two groups: AHI higher or lower than 30 events/hour. Airway volume was similar between the two groups[15]. The same research group did another study comparing tomographic airway abnormalities in OSAS patients with open or closed mouth. They have found a significant reduction of upper airway length when the mouth was open. On the airway volume evaluation there was not any difference between the two groups. Therefore, the airway volume did not significantly fluctuate in different OSAS severity patients or due to mouth opening[16].

Ogawa *et a.l*[17], 2005, demonstrated a relation between OSAS patients total airway volume and the total airway volume of the control group as aligned by gender. This study reinforced the importance of CBCT to evaluate such patients[17].

Our study corroborates with most studies found on the literature. The airway volume does correlate in a linear fashion with OSAS. The isolated airway volume analysis may predispose to wrong interpretation and treatment. Such is the variation of the airway presented by those patients that it is not possible to create a stereotype for the OSAS typical upper airway. Patients with severe OSAS show the biggest tridimensional measurement variations.

The airway collapse is influenced by a negative intraluminal pressure and a positive extraluminal pressure[15]. Surgical procedures which increase the upper airway volume by eliminating obstructive sites, such as tonsillectomy, reduce the intraluminal pressure decrease and increase the pharynx diameter, thereby reducing the airway resistance. The imbalance which predisposes to airway collapse may be maintained even after an airway volume increase by intraluminal procedures since those procedures do not reduce extraluminal pressure.

Conclusion

Upper airway volume plays a role in airway collapse. However, if analyzed as an isolated factor it does not present a linear correlation with OSAS severity. Thus, it should not be considered in isolation in the diagnosis and treatment planning of that condition.

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3.2. Artigo 2

Correlation between the Friedman Staging System and the upper airway volume in patients with obstructive sleep apnea.

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Abstract

Objectives : This study was designed to evaluate the correlation between upper airway volume and the Friedman Staging System (FSS) in patients with obstructive sleep apnea (OSA).

Methods: Retrospective evaluation by reviewing the medical records of 33 patients (19 males and 14 females) with mean body mass index (BMI) of 30.38 kg/m^2 and mean age of 49.35 years. Among those patients 14 presented severe OSA, 7 moderate, 7 mild and 5 subjects were healthy.

Results: Patients were divided into two groups according to the FSS. Group A patients contained FSS I and II and group B FSS III. A positive relationship by Fisher's exact test between the FSS and Apnea-Hypopnea Index (AHI) (p=0.011) and between FSS and BMI (p=0.012) was found. There was no correlation between age (p=0.55) and gender (p=0.53) with the FSS. The ANOVA test comparing the volume of the airway between the two groups showed p=0.018.

Conclusions: In this sample the Friedman Staging System and volume of upper airway show inverse correlation and are useful in analyzing the mechanisms of airway collapse in patients with obstructive sleep apnea.

Key Words: upper airway, obstructive sleep apnea, cone beam computed tomography, Friedman staging system.

Introduction

The upper airway (UA) is the portion of the respiratory system located between the nostrils and the initial portion of the trachea. It conducts the inspired air from the external environment to the lower airways (trachea and lungs). Its structure is complex with wide variability among individuals. The upper airway can be divided into the following sections: nostrils, nasal cavity, nasopharynx, mouth, oropharynx, hypopharynx, larynx and extrathoracic tracheal segment.

It may present different intraluminal obstructive sites that may hinder the passage of the inspired air. The main causes of the nasal obstruction are nasal septum deviation, inferior turbinate hypertrophy, nasal valve insufficiency and pharyngeal tonsils hypertrophy. The oropharynx may be obstructed by the retroposition of the soft palate and the hypertrophy of the palatine tonsils. The retroposition of the tongue base and the hypertrophy of the lingual tonsil may obstruct the hypopharynx.

The collapse of the airway occurs because of a combination of factors. The imbalance between the negative intraluminal pressure and positive extraluminal pressure is considered to be the main pathophysiological mechanism[1].

Changes in the mechanical physiology of respiration occur during sleep. The human being breathes better awake than sleeping[2], the ventilation per minute and the functional residual capacity decrease by 13-15%[3]. During sleep the relaxation of the UA muscles almost doubles the total resistance of that segment[4]. During the phase of Rapid Eye Moviment Sleep (REM) the muscle relaxation of the UA and intercostal muscles is higher, the ventilatory drive decreases and the breathing becomes more irregular and variable[5,6]. These changes facilitate the UA collapse during sleep by favoring the imbalances between the luminal pressures mentioned above.

Obstructive Sleep Apnea (OSA) is the main breathing disorder during sleep and it is defined by the American Academy of Sleep Medicine as recurrent collapses of the upper airway during sleep, resulting in total (apnea) or partial (hypopnea) reduction of the airflow[7]. Since its definition in 1976, by Cristian Guilleminault[7], the OSA has been extensively studied and proved to be a disease with high morbidity and associated with coronary heart disease[8], stroke[9], dyslipidemia and diabetes mellitus[8]. It affects about 32.8% of the population[10] but is considered highly underdiagnosed. About 20% of the adult population reports snoring and 95% of the patients with OSA complain of snoring[10].

The most common phenotype in patients with OSA and snoring are individuals between 40 and 65 years old, male, obese, smokers, drinkers and sedentary[10]. The main physical findings include enlargement of the neck circumference, oropharyngeal obstruction, soft palate laxity, nasal obstruction, turbinate hypertrophy, nasal septum deformity, nasal cavity tumors, tonsil hypertrophy, macroglossia, retrognathia and craniofacial deformities[11].

Symptoms may diversify among patients depending on disease severity. The most frequent are snoring and excessive daytime sleepiness. Witnessed nocturnal apneas, choking during sleep, non-restorative sleep, fragmented sleep, nocturia, morning headaches, cognitive decline, memory loss, reduced libido and irritability are also observed according to the evolution of OSA[11].

The Friedman Staging System (FSS), developed in 1999, became prominent and is widely used to evaluate the UA in patients with OSA. It is a validated clinical predictor for the success of the palate and pharynx[12] surgeries. It also has a positive relationship with the severity of OSA[13].

Grade of palatine tonsils, Friedman Tongue Position (FTP), based on Mallampatti Classification with tongue inside the mouth, and Body Mass Index

(BMI) are evaluated in the FSS. Grade of palatine tonsils is evaluates the occupation of tonsils em oropharynx. Grade 0 is the absence of tonsils. Grade I tonsils ocupated under 25% of oropharynx. Grade 2 from 25% to 50%. Grade 3 from 50% to 75% and grade 4 from 75% to 100%. Patients are classified into four stages (I, II, III and IV) as shown in Table 1.

Table 1 - Friedman Staging System [12]

Stage	FTP	Grade of palatine tonsil	BMI
I	I	3 , 4	<40
	II	3 , 4	<40
II	I , II	1 , 2	<40
	III , IV	3 , 4	<40
III	III	0 , 1 , 2	<40
	IV	0 , 1 , 2	<40
IV	I,II,III,IV	0,1,2,3,4	>40

The emergence of the cone beam computed tomography (CBCT), associated with 3D reconstruction software, represented an important advance in the study of airway in patients with OSA in the last 5 years. CBCT can be used for tridimensional airway assessment, measuring the airway volume and the areas of maximum constriction. This instrument allows a more accurate assessment of the internal and the external structures of UA[1].

OBJECTIVE

To evaluate the correlation between upper airway volume and the Friedman Staging System (FSS) in patients with obstructive sleep apnea (OSA).

METHODOLOGY

This study was approved by the Araraquara Dental School Ethics and Research Committee (registration 13185113.9.0000 # 252.804 from April, 23, 2013).

The study was carried out retrospectively by review of medical records of adult patients from the Oral and Maxillofacial Surgery Clinic, Dental School at Araraquara - Unesp and Otorhinolaryngology Clinic – University of Araraquara - Uniara. Patients were evaluated at a specific ambulatory clinic for patients with complaints and symptoms related to respiratory sleep disorders, such as snoring, daytime sleepiness, nocturnal choking and reports of witnessed sleep apnea.

The following data were obtained from the medical records: dental physical exam, facial morphology classification, otorhinolaryngology (ENT) examination, anthropometric variables, body mass index (BMI), baseline polysomnography and volumetric computed tomography (CT) scans to define the upper airway volume.

Volumetric CT scans were obtained in a CT scanner for dentofacial imaging (I- Cat, KaVo, Joinville, SC, Brazil). According to the manufacturer's information, it is a 3D volumetric dental computed tomograph which presents a three-time greater speed than the medical scanners and a ten-time lower radiation exposure of the patient. The cycle can take up to 40 seconds but as the emitted X-ray is pulsating the effective real-time radiation exposure becomes lower.

To obtain the CT images the patients were seated with the head in natural position and all were instructed to inhale and to maintain the apnea during image taking, exhaling immediately after. The sections were obtained from the hard palate to the level of C3. The images were collected parallel to the intervertebral space of C2-C3. All images were stored on DVD for later analysis by specific software.

The tridimensional images of the CT scans were imported and reconstructed using the DOLPHIN 3D software (Dolphin Imaging Management Solutions, Chatsworth, CA, USA) in order to define the airway volume.

To obtain the volume of the UA its sagittal cuts were selected and planes were formed, using anatomical references to define the upper and lower boundaries of that region and thus enabling to determine its volume.

The upper and the lower limits of the UA were determined on the sagittal image. The upper limit was defined by a plane constructed from the posterior border of the hard palate and parallel to the Palatal plane. The lower limit was defined by a plane constructed by a line from the most anterior and inferior point of the second cervical vertebra and also parallel to the Palatal plane.

The volumetric analysis of that three-dimensionally configured area was obtained with the specific software and marked in pink as shown in Figure 1. The software carried out the tridimensional calculation in cubic millimeters using the summation of the volume.

Regarding the analysis of the tomographic images, the measurements were acquired by a calibrated and blinded examiner in relation to all the other survey data, such as anthropometric factors, physical examination and polysomnography. Two measurements of the airway volume were collected with a 30-day interval.

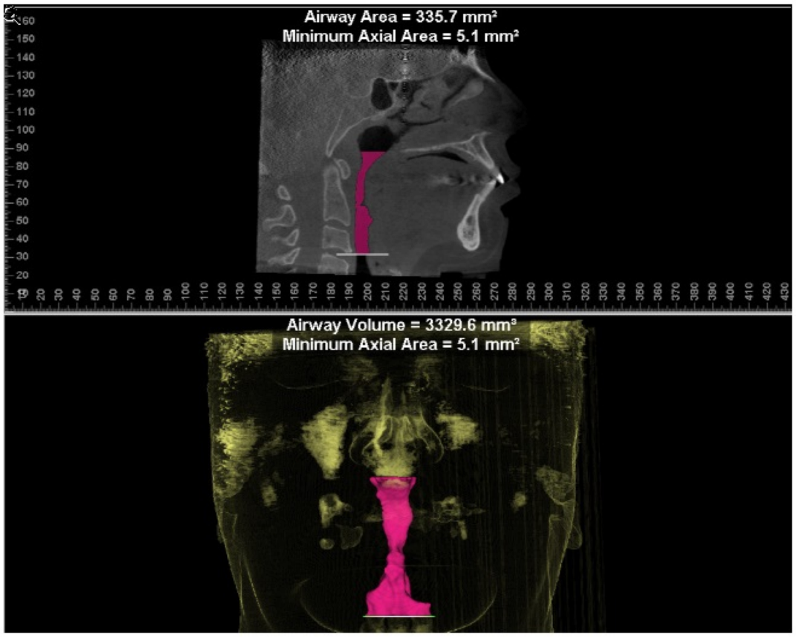


Figure 2 - Tomographic evaluation of the upper air way space in Dolphin 3D

The polysomnographies were performed at the Araraquara Sleep Clinic. The sleep was assessed during a six-hour average period. The electrophysiological parameters evaluated during sleep were: electroencephalography (EEC), electrooculography (EOG), electromyography (EMG), electrocardiography (ECG), airflow (nasal and oral), respiratory effort (thoracic and abdominal), other body movements (through the EMG), blood gases (oxygen saturation) and body position. The exams were evaluated by criteria of 2007 AASM Manual.

A medical specialist in sleep calculated the apnea-hypopnea index (AHI) of the patients, obtained by the sum of the events of apnea and hypopnea divided by the hours of sleep. Through this index the severity of OSA was classified: normal (AHI < 5 events/hour), mild OSA (AHI between 5 and 15 events/hour), moderate OSA (AHI between 15 and 30 events/hour) and severe OSA (AHI>30 events/hour).

The exclusion criteria were: morbid obesity (BMI > 40), craniofacial abnormalities (cranio-dysostosis, craniostenosis and meningomyelocele), nasal obstruction due to nasal polyps, presence of any craniofacial or airway tumor, laryngeal and pharynx paralysis and previous surgery on the UA.

The exploratory data analysis was carried out, using the measurements of the descriptive statistics and the results frequencies. The Mann-Whitney test was performed for the study of the relationship between FSS (ordinal variable), age, OSA severity and BMI. Fisher's exact test was used in the analysis between FSS and gender. The airway volume and the FSS were associated by the ANOVA test. The SAS System for Windows, version 9.3 (SAS Institute Inc, 2002-2008, Cary, NY, USA) was used.

RESULTS

Thirty-nine patients were evaluated from June 2012 to December 2013. Six patients were excluded from the sample because four had tomographic scans with poor definition of the limits determined in the methodology and two had incomplete data necessary for the research protocol. Therefore, 33 patients were included in the study, 14 (42.4 %) females and 19 (57.6 %) males.

The analyzed descriptive data are listed in the table below:

Table 2. OSA Classification Statistics.

OSA Severity	Frequency	Percentage
Normal	5	15.2%
Mild	7	21.2%
Moderate	7	21.2%
Severe	14	42.4%
Total	33	100%

Table 3. Description of the Continuous Variables

Variable	Minimum	Maximum	Mean	St. Deviation
Age (years)	26.00	76.00	49.35	11.53
BMI (kg/m^2)	25.00	38.40	30.38	3.56
AHI (events/hour)	2.2	89.0	29.17	23.59
Volume (mm^3)	3291.80	15773.80	9536.69	2946.74
Volume 2[a] (mm^3)	3830.80	14575.00	9242.17	3138.72

[a] Second measurement of volume

The Student's t-test was carried out to assess the strength of the test of the airway volume. The difference between the two measurements performed by the three-dimensional volume was made by blind reviews. Both measurements were performed with an interval of thirty days.

Table 4. Student's t-test between the two tomographic measurements

	Mean	Standard Deviation	p
Volume	9536.69	2946.74	0.4047
Volume (second measurement)	9242.17	3138.72	

The volume measurements were similar and they did not present statistically significant difference. The average of the two volume measurements will be considered in the calculation for statistical purposes.

The FSS is distributed in the sample as shown in Table 5.

Table 5 - Descriptive Statistics of the Friedman Staging System

FSS	Frequency	Percentage
I	1	3.0%
II	17	51.5%
III	15	45.5%
IV	0	0.0%

In order to facilitate the calculation the elements were divided into two groups according to the FSS: Group A - Friedman I and II and Group B - Friedman III. The Absence of FSS IV is explained by the exclusion of the subjects with BMI > 40kg/m2 from this data.

Table 6 - Anthropometric Variables Comparison between the Groups

	FSS	Mean ± St. Dev	Percentage	p
Age	Group A	49.55 ± 13.92	-	0.5505*(ns)**
	Group B	48.67,88 ± 9.71	-	
BMI	Group A	28.93 ± 3.48	-	0.011*(s)**
	Group B	32.16 ± 3.06	-	
AHI	Group A	23.85 ± 23.64	-	0.012*(s)**
	Group B	35.54 ± 22.67	-	
Males	Group A	-	8/18 (57.1%)	0.539*(ns)***
	Group B	-	6/15 (42.9%)	

* Mann-Whitney Test

** Fisher´s Exact Test

The variables in Table 6 did not achieve a normal distribution, the Mann-Whitney test was used. We observed no statistical difference between the groups regarding the age (p=0.5505) and the gender (p=0.539). The Friedman Stage and the BMI showed a positive and significant correlation (p=0.011). A positive correlation was found between the OSA and the FSS (p=0.012).

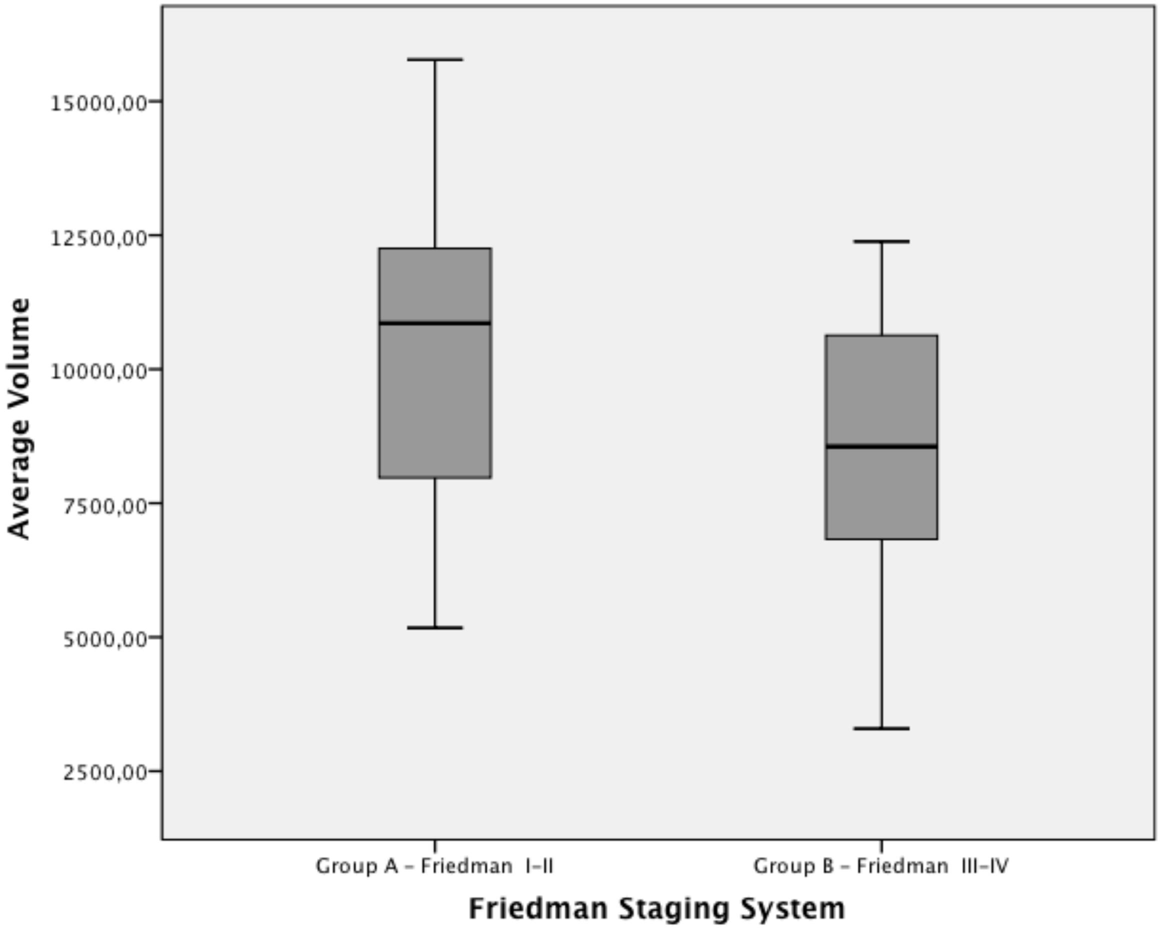
The evaluation of the interaction between the volume of the tridimensional tomographic reconstruction and the FSS was performed using ANOVA test as described in Table 7.

Table 7 – ANOVA test between the FSS and the Upper Airway Volume

	N	Mean	Standard Deviation	Confidence Interval (CI) 95%		p
Group A	18	10448.85	2759.89	9076.38	11821.31	0.018(s)
Group B	15	8118.14	2534.76	6714.43	9521.84	
Total	33	9389.43	2871.65	8371.19	10407.68	

A positive correlation between the volume and the FSS (p = 0.018) was found. The graphical representation of this relationship is shown in Graphic 1.

Graphic 1 - Correlation between Avarege Volume and Friedman Staging System



Discussion

The OSA is the most prevalent sleep respiratory disease and affects, by definition, the Upper Airway (UA). The UA is an anatomical structural complex, which is influenced by airway intrinsic and extrinsic forces. The nasal cavity is a non-collapsible portion and therefore influenced only by intraluminal alterations (i.e. nasal septum deviation and turbinate hypertrophy), which reduce the negative pressure of the rest of the airway during lung traction[14].

The pharynx is a collapsible and the less stable segment of the UA. During sleep the reduced muscle pre-activation occurs and promotes muscular tonus loss, increased resistance and pharyngeal negative pressure during inspiration[15,16].

These pathophysiological effects are more significant during the sleep of the patients with obstructive anatomies and OSA that facilitate the closing of the UA[17].

The balance of the abovementioned forces should be adressed during the physical evaluation of these patients. The main extrinsic component is obesity and the main intrinsic components are obstructive sites and airway collapse. The Friedman Staging System, originally developed as a predictor of the success of the uvulopalatopharyngoplasty (UPPP)[12,18], is a systematic evaluation of the internal (migratory myoelectric complex-MMC and palatine tonsils) and external (BMI) components of the pharynx .

The FSS is directly related to the severity of the OSA as measured by AHI. In other words, patients with higher staging have a greater chance of severe OSA[13]. Lee et al. found a positive association between the FSS and the pharyngeal manometry performed during polysomnography, with strong correlation with obstruction at the retrolingual site[19]. The drug induced sleep endoscopy (DISE) is an examination with adequate simulation of natural sleep[20]. The FSS performed in awake patients significantly correlates to DISE (Kappa=0.61). That correlation is higher than for the other traditional tests such as lateral cephalometry and Müller maneuver (k=0:01 to 0:20) [21].

The tomographic analysis in this study was completely blinded. The examiner of the tomographic scans did not know the patients and had no access to the research data. As shown in table 4, the two volumetric determinations were similar ($p = 0.404$).

As observed in table 6, the sample was not influenced by age and gender ($p > 0.05$). The influence of obesity was significant. The higher the BMI average of the group is, the greater the Friedman Staging. The FSS also related positively and significantly with the severity of the OSA measured by AHI, as it was already previously shown[19,20].

The sum of the resistance at all levels of the UA defines the upper airway total resistance (UATR) and it is directly related to its collapsibility and therefore with OSA[1]. Poiseuille's law shows that the resistance is inversely proportional to the radius. The smaller the radius is, the smaller the volume of air.

Table 7 demonstrates a significant inverse relationship between the FSS and the UA volume. The FSS is a significant predictor of the volume of UA. The tridimensional evaluation of the pharynx is an important tool in the analysis of the relationship with the forces, which promote UA collapse. Patients with higher scores on the FSS have a proportionally smaller pharynx volume (Graphic 1).

Patients with high grades of FSS have a smaller volume and a greater compliance of the UA, justifying its relationship with the severity of OSA.

CONCLUSION

Based on the methodology and the sample used we conclude that the Friedman Staging System and the upper airway volume show inverse an significant relationship and are useful in analyzing the mechanisms of airway collapse in patients with obstructive sleep apnea.

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4. Discussão Geral

A Apneia Obstrutiva do Sono (AOS) é uma doença que envolve a via aérea, sendo que os principais segmentos atingidos são a orofaringe e hipofaringe, que sofrem colapso durante o sono. Os estudos fisiopatogênicos da AOS se concentram nessa área. O enfoque desta dissertação foi o uso da Tomografia Volumétrica de Feixe Cônico (TVFC), técnica validada para o estudo de imagem da via aérea superior[16], em especial da faringe. Na avaliação desta obtêm-se informações da forma, volume e área de constrição máxima. Os estudos apresentados foram focados na avaliação do volume da faringe.

A correlação entre o volume da via aérea e a gravidade da AOS, medida pelo IAH, não foi estatisticamente significativa. Essa relação foi mantida após o controle para IMC e idade. Esses dados concordam com a maioria dos estudos disponíveis na literatura[15,17,18,19].

O dados apresentados mostram uma grande diversidade no padrão da via aérea do paciente com AOS. Um indivíduo com AOS grave pode ter uma via aérea volumetricamente semelhante a um paciente sem AOS. O espaço livre e estático da faringe não prediz a gravidade da AOS. A doença é multifatorial e a avaliação localizada de um setor da via aérea leva a erros de interpretação e tratamento, pois, não avalia conjuntamente todos os níveis da via aérea e não avalia os fatores de compressão extrínseca sobre a faringe.

Os procedimentos cirúrgicos que visam o aumento volumétrico da faringe por meio da ressecção de estruturas endofaríngeas (tonsilas palatinas, palato mole e musculatura lateral) tem baixas taxas de sucesso a longo prazo[20,21]. A tática isolada de aumentar o volume da via aérea pode apresentar falhas no tratamento da AOS, uma vez que não há relação linear entre o volume da VAS e a AOS. Goh *et al.,* em 2007, fizeram um estudo avaliando a qualidade de vida 18 anos após Uvulopalatofaringoplastia isolada, demonstraram que 85,8% dos pacientes continuavam com roncos, a sonolência diurna estava presente em 79,5% e 89,3% apresentavam sono fragmentado[21].

A Academia Americana de Medicina do Sono (AASM) publicou, em 2010, uma metanálise sobre os procedimentos cirúrgicos de via aérea superior. Esse estudo concluiu que os procedimentos isolados na via aérea não apresentaram consistência na redução do AIH, com AOS residual após o procedimento. Os melhores resultados foram obtidos em cirurgias com abordagem em multiníveis[20]. Infere-se que uma das causas destas conclusões são a não correlação entre o volume da via aérea com o AIH.

A análise volumétrica foi relacionada com dados do exame físico, sistematizado por meio do Sistema de Estadiamento de Friedman (SEF)[22,23], escolhido por ser de fácil aplicação e bem difundido na literatura. Este sistema relaciona a gravidade da AOS[24], com os dados da manometria da faringe[25] e com dados provenientes da Sonoendoscopia[26]. Observamos que o SEF se relaciona inversamente e significativamente com o volume total da VAS. Os pacientes com maiores escores no SEF tem uma faringe com volume proporcionalmente menor.

A análise tomográfica tridimensional da via aérea é muito utilizada no planejamento de cirurgias esqueléticas faciais. Seu uso na avaliação de pacientes com AOS é tema de estudos mais recentes[15,16,17,18,19]. Além do volume, fornece muitos dados como a forma, medidas e ângulos entre quaisquer pontos da VAS.

O volume da via aérea é um dado muito amplo e demonstrou alta variabilidade. Os pacientes com AOS apresentam muitas alterações em mais de um nível da VAS[22]. A relação significativa entre o volume e o SEF pode ser explicada pelo fato de serem duas variáveis focadas na faringe. Apesar do SEF avaliar apenas cavidade oral e a orofaringe, esse segmento parece ter papel fundamental na definição do volume de toda a faringe, por provável influência do volume da base da língua.

Quando comparamos o volume total da faringe com a gravidade da AOS, medida pelo IAH, estamos correlacionando uma variável focada na faringe com a AOS, que é uma doença relacionada com alterações extrínsecas e intrínsecas de toda a via aérea superior. Apesar da faringe ter um papel central no desenvolvimento da apneia obstrutiva do sono, a correlação desse setor isolado da via aérea com a AOS não é significante. Neste estudo não avaliamos a patência nasal, pela dificuldade técnica da avaliação do volume desta aérea.

A TVFC é uma exame rápido e de baixo risco para o paciente, pela pequena emissão de radiação. Suas características podem ter influenciado os resultados dos artigos por ser um exame estático, feito com o paciente na posição sentada e em apneia inspirada. O SEF também é obtido com o indivíduo sentado, o que influi na relação significativa entre o SEF e o volume da faringe. Já a aferição do IAH, que define a gravidade da AOS, é obtido com o paciente deitado, em sono natural. A diferença de posição e a análise estática da faringe podem levar a diferentes resultados entre o volume e IAH.

O IAH utilizado nestes trabalhos foi obtido em polissonografia de noite única. Este índice é utilizado na maioria dos estudos e apresenta diferenças quando avaliado em duas polissonografias sucessivas[27]. Esta oscilação pode ter influenciado a relação com o volume tridimensional da faringe. Esta variabilidade demonstra a imperfeição do AIH como variável para o estudo da AOS, mas não há outra variável objetiva para mensurar a gravidade da AOS[20].

A TVFC apresentou correlação diferente em relação ao AIH e o SEF. Estas variáveis se correlacionam diretamente e significativamente[25]. Apesar do SEF ser focado na faringe, utiliza o IMC para o estadiamento, ou seja, uma variável que avalia a principal força extrínseca que age sobre a faringe, a obesidade. O SEF utiliza também a Classificação Modificada de Malampatti, que avalia o volume da língua e sua relação com a orofaringe. O volume da língua é relacionado com a AOS e com a obesidade devido a deposição de gordura na base da língua[11], portanto, obesidade aumenta a pressão extraluminal e aumenta a pressão negativa intraluminal, situações que favorecem o colapso da via aérea e a AOS. A TVFC não avalia a obesidade, que é um dos fatores que explicam a sua relação com o AIH.

5. Conclusão

Por meio da metodologia e amostra utilizadas podemos concluir que:

- O volume da via aérea superior não apresenta relação linear com a gravidade da Apneia Obstrutiva do Sono, quando avaliada pelo Índice de Apneia e Hipopneia;

- O volume da via aérea superior apresentou uma relação significativa e inversa com o Sistema de Estadiamento de Friedman, ou seja, quanto maior a classificação de Friedman menor o volume da via aérea superior.

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7. Anexos

FACULDADE DE
ODONTOLOGIA DE
ARARAQUARA - UNESP

PARECER CONSUBSTANCIADO DO CEP

DADOS DO PROJETO DE PESQUISA

Título da Pesquisa: Avaliação das alterações volumétricas da via aérea superior em pacientes portadores da síndrome da apnéia do sono. Estudo Retrospectivo

Pesquisador: Valfrido Antonio Pereira Filho

Área Temática:

Versão: 2

CAAE: 13185113.9.0000.5416

Instituição Proponente: Faculdade de Odontologia de Araraquara - UNESP

Patrocinador Principal: Financiamento Próprio

DADOS DO PARECER

Número do Parecer: 252.804

Data da Relatoria: 23/04/2013

Apresentação do Projeto:

A fisiopatogênia da síndrome da apnéia e hipopnéia obstrutiva do sono (SAHOS) está intimamente ligada a via aérea superior (VAS) e ao posicionamento das estruturas da faringe e sua relação com o arcabouço ósseo. Os eventos de apnéia e hipopnéia noturna são associados ao aumento da pressão negativa imposta às vias aéreas durante a inspiração. Tais fatos promovem alterações nos tecidos faringianos causando a longo prazo edema intersticial e inflamação. A consequência direta é a menor resposta do tecido muscular ao estimulo neural e a hipotética redução de volume da via aérea

Objetivo da Pesquisa:

O objetivo deste estudo será o de relacionar os achados volumétricos da VAS, com os exames polissonográficos em pacientes portadores de diferentes níveis de gravidade da SAHOS (leve, moderada e grave)

Avaliação dos Riscos e Benefícios:

A síndrome da apnéia e hipoapnéia obstrutiva do sono vem sendo cada vez mais estuda. É uma doença com alta prevalência afetando 32,8% na
população adulta. Apresenta também importante co-morbidades bem documentas como: o infarto agudo do miocárdio, acidente vascular cerebral,
diabetes mielitus tipo II,entre outros. A fisiopatogenia e o tratamento da doença são obscuros e

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intensamente discutidos. Existe a necessidade de
entender melhor a sua relação com a via aérea por ser este o sítio que determina o surgimento da SAHOS.
Acreditamos que a avaliação volumétrica
trará dados importantes para estabelecermos uma relação entre o tamanho da VAS e a SAHOS

Comentários e Considerações sobre a Pesquisa:

A pesquisa tem relevancia clínica nos achados volumetricos VAS relacionados aos exames polissonográficos.

Considerações sobre os Termos de apresentação obrigatória:

Os autores apresentaram todos os documentos necessários

Recomendações:

Nada a declarar

Conclusões ou Pendências e Lista de Inadequações:

Somos de parecer favorável a sua execução

Situação do Parecer:

Aprovado

Necessita Apreciação da CONEP:

Não

Considerações Finais a critério do CEP:

APROVADO em sessão de 23 de abril de 2013.

ARARAQUARA, 23 de Abril de 2013

Assinador por:
Maurício Meirelles Nagle
(Coordenador)