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Interrelationships Between the Posterior Pharyngeal Space and the Dento-Maxillary Anomalies

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Abstract

Introduction: Nocturnal breathing problems have become more common and cause problems during the day for both those affected by this condition and those around them. These problems are caused in most cases by a decrease in the size of the pharyngeal posterior space, which is associated with various abnormalities of the facial skeleton, and the positioning of the tongue. **Purpose:** The present study has the purpose to determine the existence of a correlation between different facial skeletal abnormalities and the size of the pharyngeal posterior space. **Materials and methods:** In the present study we performed the analysis of 131 teleradiographs from the database of the department of orthodontics and dentofacial orthopedics within UMFST "Târgu Mureș" performed on patients in order to perform an orthodontic treatment. Patients range in age from 10 to 21 years. **Results:** To observe the existence of a link between the median differences in values in the lower pharyngeal space between class I and class II, we used the Mann-Whitney U test to compare median values. Thus, the median value in class I is 0, while the median value in class II is 0.3. It was concluded that this difference is statistically significant ($p = 0.02$). **Conclusion:** Patients with skeletal class II

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have smaller dimensions of the lower pharyngeal space than patients with class I and class III. Patients with skeletal class II have an increased risk compared to those with class I or class III of developing obstructive sleep apnea-hypopnea syndrome during their lifetime.

Keywords: Posterior pharyngeal space, Class II, sleep apnea, ANB angle

Introduction

Nocturnal breathing problems have become more common and cause problems during the day for both those affected by this condition and those around them.(Achilleos, Krogstad, & Lyberg. 2000) Concentration problems, periods of drowsiness both at work and in free time, nervousness, all these lead to a lack of performance at work, increased possibility of car accidents (drowsiness while driving) and irritation of people around. („Health Quality Ontario“, 2006) These problems are caused in most cases by a decrease in the size of the pharyngeal posterior space, which is associated with various abnormalities of the facial skeleton, and the positioning of the tongue (Spicuzza, Caruso, & Di Maria, 2015).

Usually sleep apnea is the result of several factors that are in succession, such as a domino effect (Lowe, 1990) (eg the patient has excess adenoid tissue, the patient to be able to breathe becomes an oral respirator, the tongue is positioned down on the jaw , the tongue thus positioned increases the chances of obstructing the pharynx during the night causing sleep apnea) (Jyothi et al. 2019). In order to observe the size changes of the pharyngeal posterior space, we perform lateral teleradiographs, for which we have various analyzes (McNamara, Rickets, etc.) with which we can detect the presence or absence of this abnormality, its severity and the existence of other associated skeletal abnormalities. (Liao, Lacerda, Silva, & Ramos, 2015) The present study aims to determine the existence of a correlation between different facial skeletal abnormalities and the size of the pharyngeal posterior space (Perumalsamy, Charles, Reddy, Chokkalingam, & Balakrishnan, 2017).

Materials and methods

In the present study we performed the analysis of 131 teleradiographs from the database of the department of orthodontics and dentofacial orthopedics within UMFST “Târgu Mureș” performed on patients in order to perform an orthodontic treatment. Patients range in age from 10 to 21 years.

A modified McNamara analysis was performed, in which the anthropometric point B (the most concave point in the chin symphysis) and the angles SNB (position of the mandible according to the plane of the skull base) and ANB (position of the mandible relative to the jaw) were added. The analyzes were performed using AudaxCeph software.

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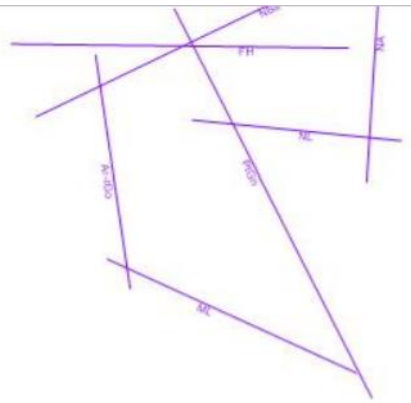
Depending on the ANB angle the patients were divided into 3 categories:

1. Skeletal class I: ANB between 1 and 3 (Fig. 2.1)
2. Skeletal class II: ANB greater than 3 (Fig. 2.2)
3. Skeletal class III: ANB less than 1 (Fig. 2.3)



MEASUREMENT		NORMAL VALUE	VALUE	DIFFERENCE	BIAS
Maxilla to Cranial base					
A-NP distance	mm	1.1	-2.8	-3.9	● |
Angle SNA	°	82.0	84.9	2.9	| ●
Angle SNB	°	80.0	82.5	2.5	| ●
ANB	°	2.0	2.4	0.4	|
Mandible to Maxilla					
Co-A	mm	99.8	74.9	-24.9	●●● |
Co-Gn	mm	134.3	105.7	-28.6	●●● |
Max-Mand	mm	34.5	30.8	-3.7	|
ANS-Me	mm	74.6	59.2	-15.4	●●● |
NL/ML (anatomic)	°	22.7	18.8	-3.9	|
Facial axis	°	90.0	91.6	1.6	|
Mandible to Cranial base					
Pg-NP distance	mm	-1.8	3.6	5.4	| ●
Dentition					
+1/A II FH	mm	5.4	2.2	-3.2	●● |
-1i/APg	mm	2.7	-1.3	-4.0	●● |
Airway					
Upper pharyngeal space	mm	17.5	14.1	-3.4	● |
Lower pharyngeal space	mm	11.0	9.5	-1.5	● |

Fig. 2.1 Modified Mcnamara analysis; patient with skeletal class I.

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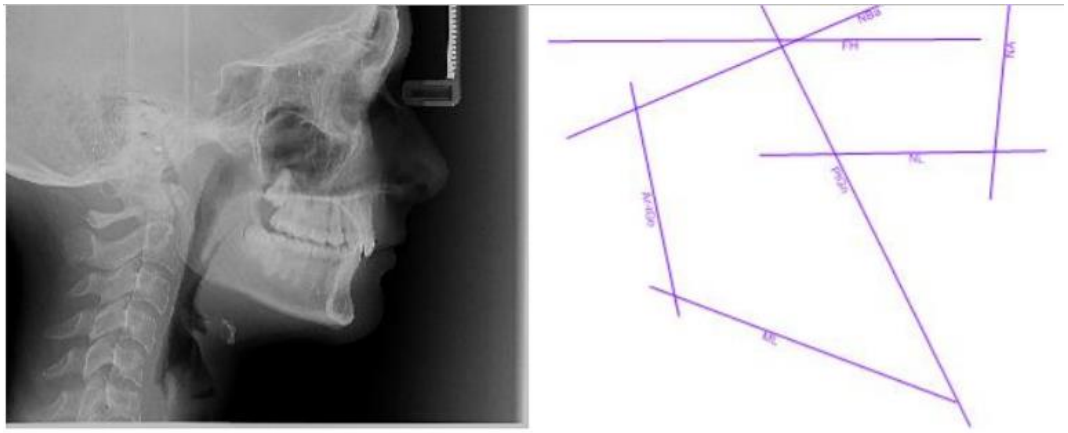

MEASUREMENT		NORMAL VALUE	VALUE	DIFFERENCE	BIAS
Maxilla to Cranial base					
A-NP distance	mm	1.1	-4.9	-6.0	●●
Angle SNA	°	82.0	83.3	1.3	
Angle SNB	°	80.0	79.8	-0.2	
ANB	°	2.0	3.5	1.5	
Mandible to Maxilla					
Co-A	mm	99.8	78.2	-21.6	●●●
Co-Gn	mm	134.3	96.6	-37.7	●●●
Max-Mand	mm	34.5	18.4	-16.1	●●●
ANS-Me	mm	74.6	54.0	-20.6	●●●
NL/ML (anatomic)	°	22.7	21.5	-1.2	
Facial axis	°	90.0	93.6	3.6	●
Mandible to Cranial base					
Pg-NP distance	mm	-1.8	11.7	13.5	●●
Dentition					
+1/A II FH	mm	5.4	-1.7	-7.1	●●●
-1i/APg	mm	2.7	-2.2	-4.9	●●
Airway					
Upper pharyngeal space	mm	17.5	9.5	-8.0	●●●
Lower pharyngeal space	mm	11.0	7.4	-3.6	●●●

Fig. 2.2 Modified Mcnamara analysis; patient with skeletal class II

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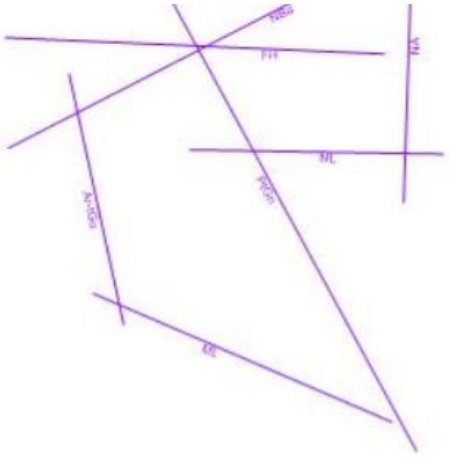

MEASUREMENT		NORMAL VALUE	VALUE	DIFFERENCE	BIAS
Maxilla to Cranial base					
A-NP distance	mm	1.1	0.6	-0.5	
Angle SNA	°	82.0	82.7	0.7	
Angle SNB	°	80.0	82.2	2.2	
ANB	°	2.0	0.5	-1.5	
Mandible to Maxilla					
Co-A	mm	99.8	86.8	-13.0	
Co-Gn	mm	134.3	118.7	-15.6	
Max-Mand	mm	34.5	31.9	-2.6	
ANS-Me	mm	74.6	64.3	-10.3	
NL/ML (anatomic)	°	22.7	22.2	-0.5	
Facial axis	°	90.0	91.5	1.5	
Mandible to Cranial base					
Pg-NP distance	mm	-1.8	-3.5	-1.7	
Dentition					
+1/A II FH	mm	5.4	2.2	-3.2	
-1i/APg	mm	2.7	-0.9	-3.6	
Airway					
Upper pharyngeal space	mm	17.5	15.7	-1.8	
Lower pharyngeal space	mm	11.0	12.5	1.5	

Fig. 2.3 Modified Mcnamara analysis; patient with skeletal class III

We had 36 patients with skeletal class I, 59 with skeletal class II and 36 with skeletal class III.

To observe changes in airway size, the Upper Pharyngeal Space (UPS) and Lower Pharyngeal Space (LPS) measurements were used.

Results

To observe the existence of statistically significant differences between the mean values of the upper pharyngeal space between classes, we

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used the ANOVA test to compare the means. Thus, patients in class I have an average value of 15.22 (± 2.82) while patients in class II have an average value of 14.31 (± 3.17), and patients in class III have an average value of 15.41 (± 3.04). Following the application of the ANOVA test, it was concluded that this difference is statistically insignificant (p = 0.16) (Table 3.1).

Tabel 3.1 Descriptive statistics

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum	P value
						Lower Bound	Upper Bound			
Superior pharyngeal space	Class I	36	15.2222	2.82460	.47077	14.2665	16.1779	7.40	20.30	0.16
	Class II	59	14.3102	3.17222	.41299	13.4835	15.1369	7.90	20.40	
	Class III	36	15.4139	3.04829	.50805	14.3825	16.4453	4.90	20.50	
	Total	131	14.8641	3.06559	.26784	14.3342	15.3940	4.90	20.50	

To observe the existence of statistically significant differences between the mean values of the lower pharyngeal space between classes, we used the ANOVA test to compare the means. Thus, patients in class I have an average value of 10.19 (± 1.31) while patients in class II have an average value of 9.23 (± 2.07), and patients in class III have an average value of 10.84 (± 2.27). Following the application of the ANOVA test, it was concluded that this difference is statistically significant (p = 0.01) (Table 3.2).

Tabel 3.2 Descriptive statistics

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum	P value
						Lower Bound	Upper Bound			
Inferior pharyngeal space	Class I	36	10.1972	1.31725	.21954	9.7515	10.6429	7.00	12.20	0.01
	Class II	59	9.2390	2.07323	.26991	8.6987	9.7793	4.40	12.00	
	Class III	36	10.8472	2.27816	.37969	10.0764	11.6180	4.60	17.10	
	Total	131	9.9443	2.06189	.18015	9.5879	10.3007	4.40	17.10	

To observe the existence of a link between the median value of the difference in value at the level of the superior pharyngeal space according to classes, we used the Kruskal-Wallis test to compare the samples. Thus, patients classified in class I have a median difference of 0.20 (0, 1.67), those in class II have a median difference of 0.70 (0, 3.10), and those in class III have a median difference of 0.37. Following the application of the test, it was concluded that this difference is statistically significant (p = 0.045) (fig.3.1).

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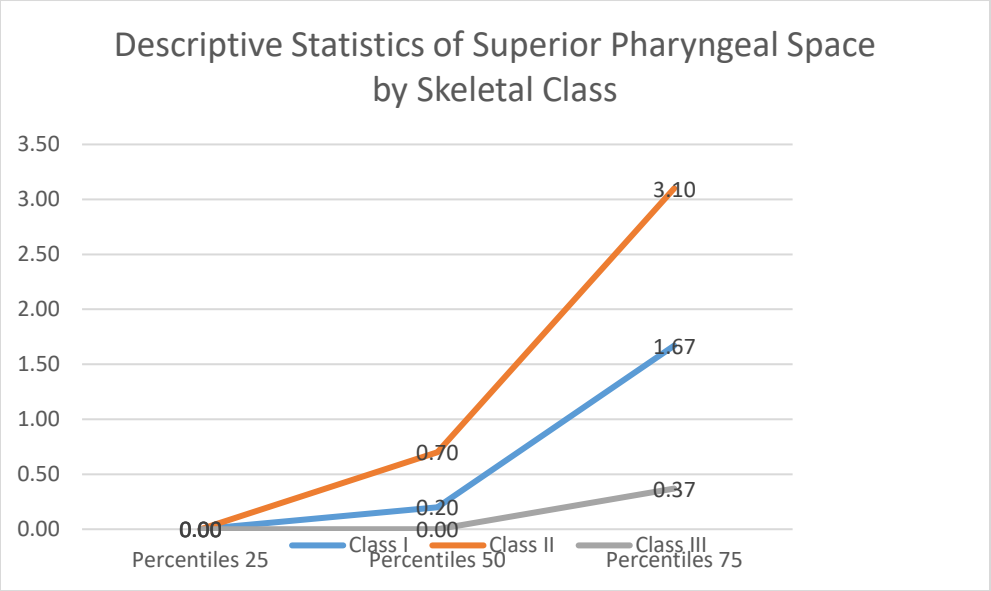

Fig 3.1 Descriptive statistics of superior pharyngeal space by skeletal class

To observe the existence of a link between the median value of the difference in value at the level of the lower pharyngeal space according to classes, we used the Kruskal-Wallis test to compare the samples. Thus, patients classified in class I have a median difference of 0.00 (0.0, 0.57), those in class II have a median difference of 0.3 (0, 2.6), and those in class III have a median difference of 0.00 (-0.3, 0.4). Following the application of the test, it was concluded that this difference is statistically significant ($p = 0.01$) (fig.3.2).

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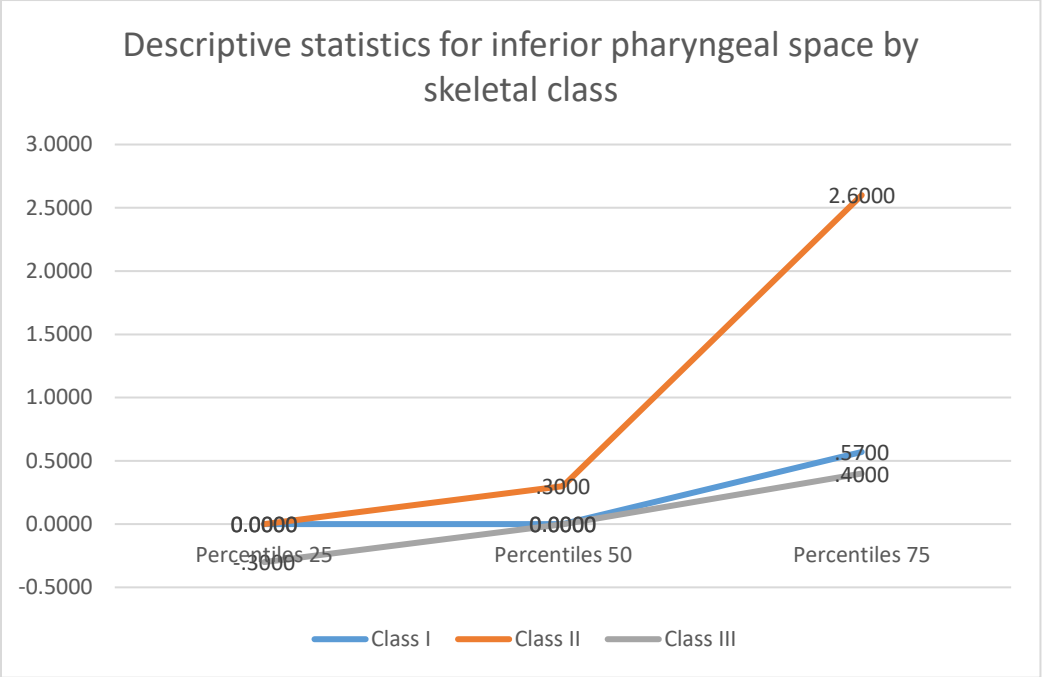

Fig 3.2 Descriptive statistics for inferior pharyngeal space by skeletal class

To observe the existence of a link between the median differences in values in the lower pharyngeal space between class I and class II, we used the Mann-Whitney U test to compare median values. Thus, the median value of the differences in values in class I is 0. (0, 0.57), while the median value of the differences in values in class II is 0.3 (0, 2.6). Using the Mann-Whitney test, it was concluded that this difference is statistically significant ($p = 0.02$) (fig.3.3).

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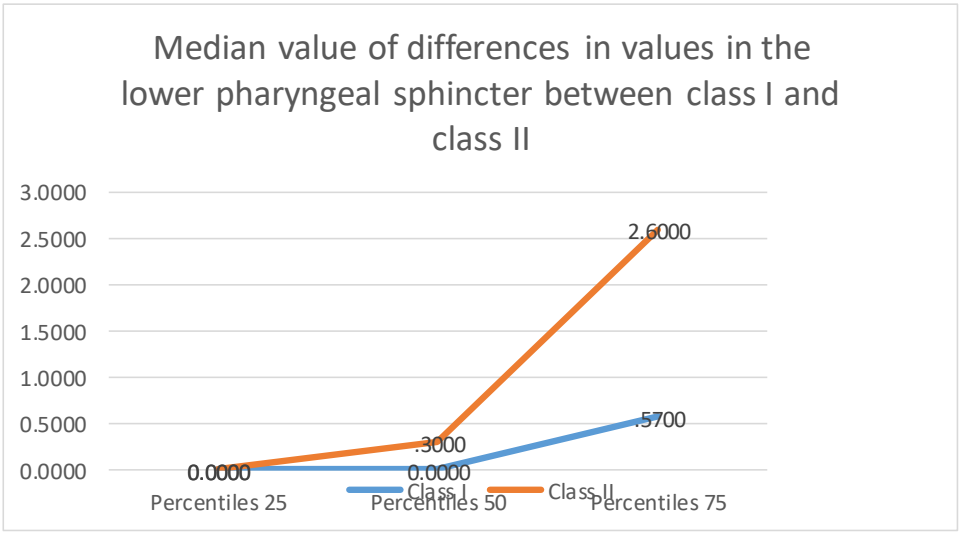

Fig.3.3 Median value of differences in values in the lower pharyngeal sphincter between class I and class II

To observe the existence of a link between the median differences in values in the lower pharyngeal space between class I and class II, we used the Mann-Whitney U test to compare median values. Thus, the median value of the differences in values in Class III is 0. (- 0.3, 0.4), while the median value of the differences in values in Class II is 0.3 (0, 2.6). Using the Mann-Whitney test, it was concluded that this difference is statistically significant (p = 0.016) (fig. 3.4).

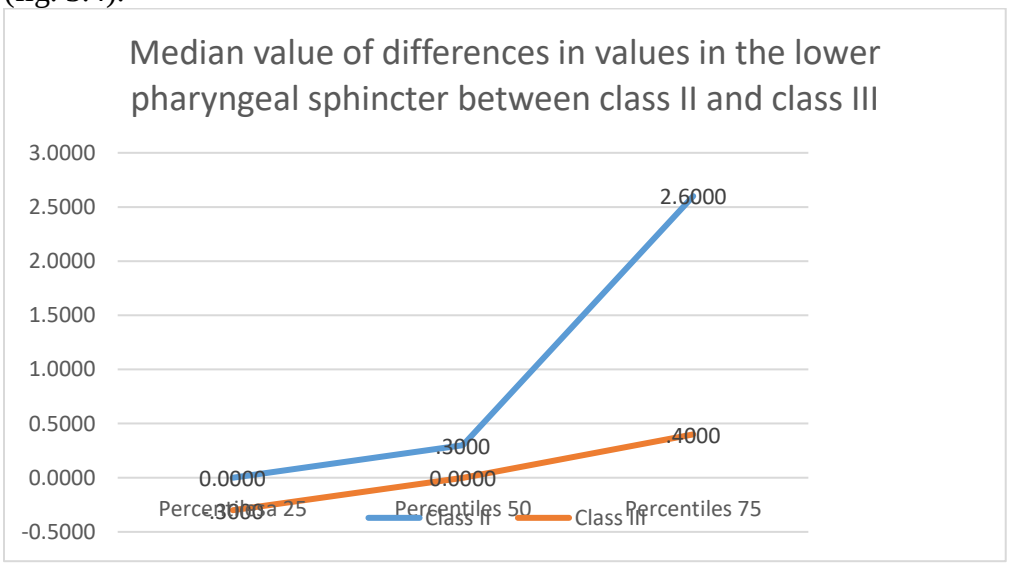

Fig.3.4 Median value of differences in values in the lower pharyngeal sphincter between class II and class III

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To observe the existence of a link between the median differences in values in the lower esophageal space between class I and class III, we used the Mann-Whitney U test to compare the median values. Thus, the median value of the differences in values in Class III is 0. (- 0.3, 0.4), while the median value of the differences in values in Class I is 0. (0, 0.57). Using the Mann-Whitney test, we concluded that this difference is statistically insignificant (p = 0.11) (fig. 3.5).

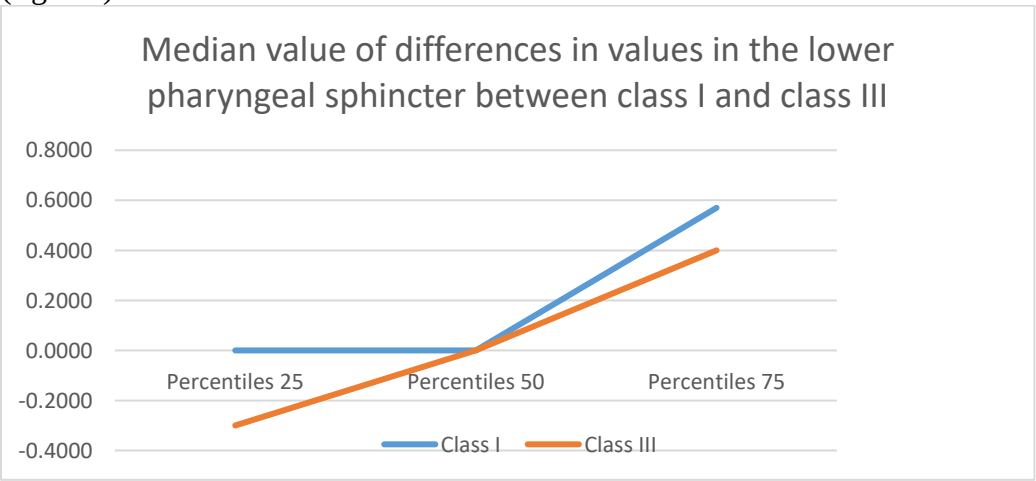

Fig. 3.5 Median value of differences in values in the lower pharyngeal sphincter between class I and class III

To observe the differences between the median values of the differences in the values of the upper and lower pharyngeal space in patients in class I, we used the Mann-Whitney U test. Thus, the median value of UPS is 0.2 (0, 1.67) and 0 (0, 0.57) within the LPS. Using the test, it was concluded that this difference is statistically significant (p = 0.02) (fig. 3.6).

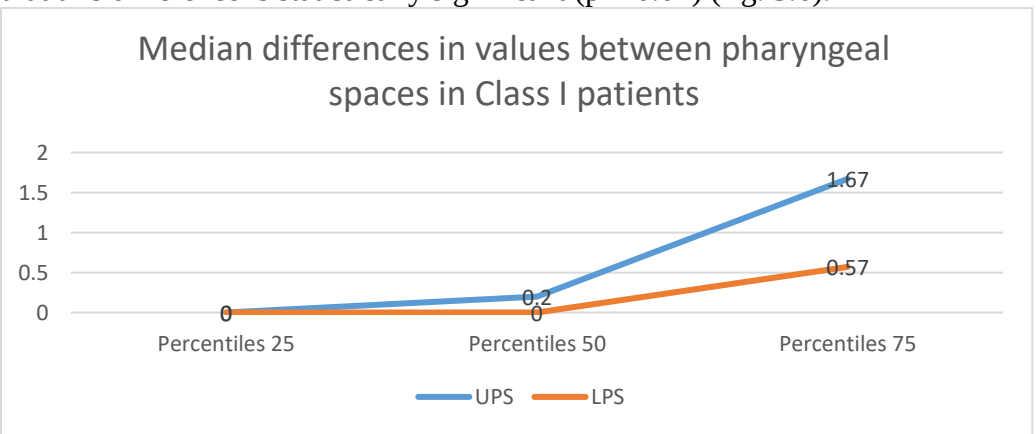

Fig. 3.6 Median differences in values between pharyngeal spaces in Class I patients

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To observe the differences between the median values of the differences in values of the upper and lower pharyngeal space in class II patients, we used the Mann-Whitney U test. Thus, the median value of the UPS is 0.7 (0, 3.4) and 0.3 (0, 2.6) within the LPS. Using the test, it was concluded that this difference is statistically insignificant (p = 0.37) (fig. 3.7)

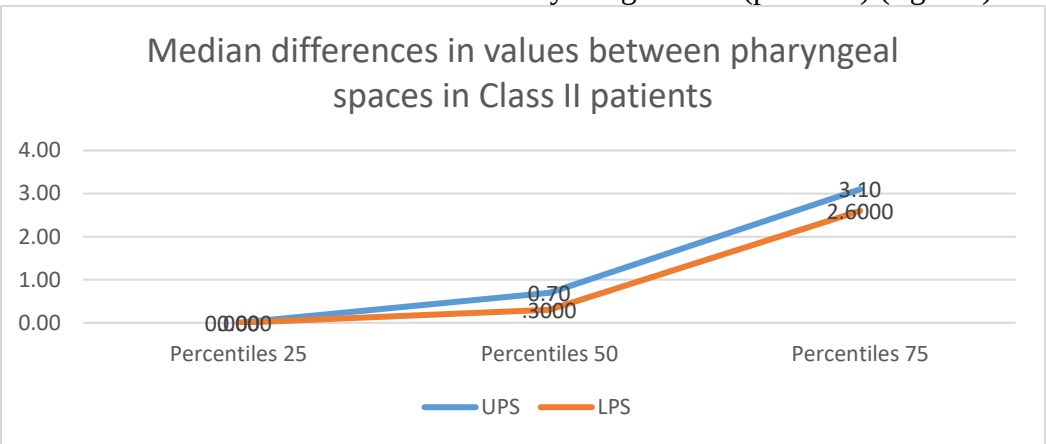

Fig. 3.7 Median differences in values between pharyngeal spaces in Class II patients

To observe the differences between the median values of the differences in values of the upper and lower pharyngeal space in patients in class III, we used the Mann-Whitney U test. Thus, the median value of the STS is 0 (0, 0.37) and 0 (-0.3, 0.4) within the SFI. Using the test, it was concluded that this difference is statistically insignificant (p = 0.16) (fig. 3.8).

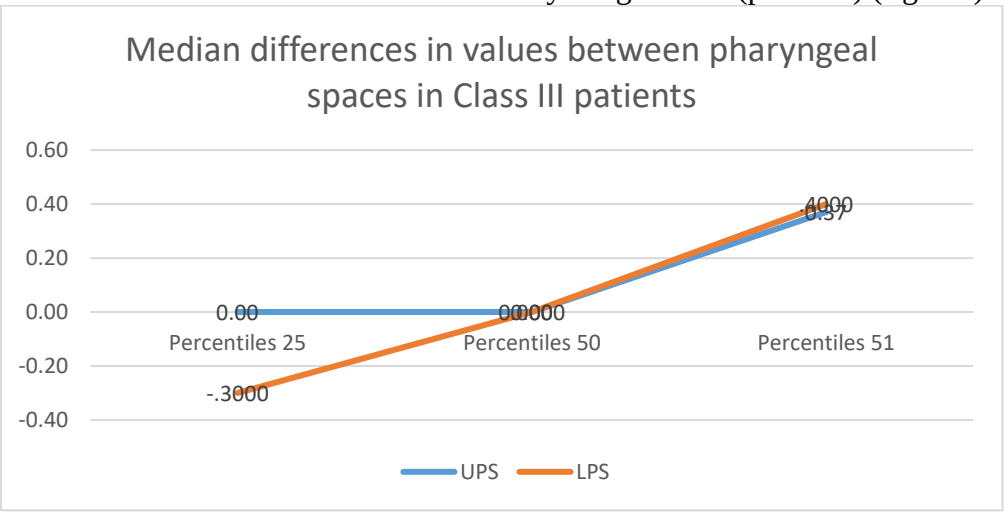

Fig. 3.7 Median differences in values between pharyngeal spaces in Class III patients

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Discussions

The majority of the population suffering from sleep apnea is not aware that they suffer from this syndrome. A method to determine patients at risk of developing this syndrome has not yet been implemented.

The results of the present study demonstrate that in patients with skeletal class II, there is a decrease in the size of the upper airways compared to patients with class I and III. (Silva, Lacerda, Silva, & Ramos, 2015) These results are consistent with other studies in this area (M Kirjavainen; & Turkka, 2007), but a direct link only between this skeletal abnormality and sleep apnea cannot be deduced, even though it has been shown that a decrease in mandibular body length was found in patients with OSA (Joanna, Johal, & Kotecha 2000). Mandibular advancement alone is unlikely to be succesfull (Anaesth, 1989). There are several factors involved, this anomaly being only one of them.

These results should also be seen within the study. The analyzes were performed in two-dimensional plane, a complex 3D analysis of the superior airspace and the position of the mandible, hyoid bone and tongue would reveal several aspects on the morphology of this area in the three skeletal patterns.

Two other studies show that by treating the class II abnormality, the size of the posterior pharyngeal space can be increased and the symptoms of those suffering from obstructive sleep apnea-hypopnea syndrome can be improved (Pavoni et al. 2017). At the same time, it is observed that not all patients with skeletal class II suffer from this syndrome.(Ghodke, Utreja, Singh, & Jena, 2014)

Among the patients in the present study in the anamnesis, no signs of sleep apnea were found. This can be based on the young age of the patients, although it can occur at a younger age, obstructive sleep apnea syndrome occurs with age. Thus we cannot know for sure which of the patients in this study will develop these problems or whether they will develop them.

In his analysis of the airway, McNamara showed that an increased in upper pharyngeal space could possible have an adenoid obstruction of the upper airway and that this part of the airway increases it’s dimensions with age. In the present study the patients have ages between 10-21; being this young we could not test this aspect, but we keep this in mind for a future study with the same groups of patients. (McNamara, 1984)

It can be said that early treatment of skeletal class II abnormality has a positive influence on the upper airways and can help patients prevent the onset of obstructive sleep apnea-hypopnea syndrome in adulthood, where treatment is no longer it's so easy.

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Conclusion:

1. Patients with skeletal class II have smaller dimensions of the lower pharyngeal space than patients with class I and class III.
2. There is no major difference between the dimensions of the lower pharyngeal space between class I and class III, both classes having values close to normal.
3. There are no major differences between the dimensions of the superior pharyngeal space between skeletal classes I, II and III.
4. Patients with skeletal class II have an increased risk compared to those with class I or class III of developing obstructive sleep apnea-hypopnea syndrome during their lifetime.
5. There is a proportionality between the size of the upper pharyngeal space and the size of the lower pharyngeal space in patients with skeletal class II and skeletal class III. In patients with skeletal class I there was no such proportionality of size.

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