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RESEARCH ARTICLE

Upper Airways Modification Following Mandibular Thrust Treatment

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Abstract

Aim: The aim of the study is to evaluate morphological changes in upper airways in patients undergoing therapy with removable functional orthopedic devices used in the treatment of the II skeletal classes by mandibular retraction.

Materials and methods: 15 patients treated with mandibular thrust have been selected and the digital images of later-lateral teleradiographs prior to treatment and subsequent treatment have been retrieved. Cephalometric analyzes were performed using the Delta-Dent software.

Results: The cases treated with Occlus-o-Guide (OG) compared with the cases treated with activators of Andresen (A) and Frankel (F) had a greater effect on decreasing ANB, greater inhibition of maxillary protrusions, a general increase in Ar-Pog; Cases treated with F showed a slight increase in the angle of divergence with respect to cases treated with A and lower mandibular forward stimulation than Andresen activator treated cases, a greater increase in the depth of the upper portion of the oropharynx with activator of A and F compared to OG.

Conclusions: The treatment of skeletic classes II by mandibular retrusion involves an increase in the postero-front extension of the pharynx. The effects of the 3 mandibular propulsions are superimposable.

Keywords

Upper airways, Occlus-O-Guide, Frankel, Andresen, Thrust treatment

Abbreviations

UAS: Upper Airway Stenosis; OSAS: Obstructive Sleep Apnea Syndrome; CBCT: Cone Beam Computed Tomography; CPAP: Continuous Positive Airway Pressure; RPE: Rapid Palatal Expander; AS: Start Age of Treatment (years); AE: End Age of Treatment (years)

Introduction

Upper Airway Stenosis (UAS) causes considerable functional repercussions on the stomatognathic and inferior airways. The correlations between stomatognathic system and respiratory function and the different evaluation methods of the latter have been topics often studied by the Ortognatodontic School of the University of Milan. In an article published in 1985 [1] Prof. G. Farronato and Prof A. Salvato presented the results of a study on two distinct samples, the first comprising pediatric patients "nasal respirators", the second age pediatric patient "oral respirators". In particular, the results of the rhinomanometry performed on these patients were compared with those of the cephalometric analysis of their skull teleradiographs in latero-lateral and postero-anterior projection. In a recent article [2] of 2005, we analyzed changes in the UAS after Andresen monoblock therapy in patients with skeletal class II and Obstructive Apnea Syndrome Sleep (OSAS); In this case the evaluation was done by Cone Beam Computed Tomography (CBCT) tomography.

The skeletal II class is generally associated with a mandibular retraction condition which is for functional problems related to upper airways [3]. According to Muto, et al. [4], mandibular retraction, reduced mandibular body length and mandibular growth in post rotation can lead to a reduction in UAS's perpetuity. Study of UASs and their correlation with mandibular position and size is of utmost importance in the field of orthodontic diagnosis also with regard to Obstructive Sleep Apnea Syndrome (OSAS), frequently treated with a mandibular advancement, orthopedic or surgical procedure, depending on the therapeutic timing. If the space of the

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cervical spine and the mandibular body decreases, the tongue and the soft palate may take a very posterior position, increasing the possibility of an incongruous respiratory function and, during the night, of snoring and OSAS [2,5-7].

The treatment of OSAS obviously involves normalizing breathing during sleep, firstly through appropriate hygienic measures (taking a proper body position during sleep, excessive weight loss), and possibly using CPAP (Continuous Positive Airway Pressure), with surgical procedures or by means of functional devices (oral devices) whose purpose is to increase the volume of UAS by introducing mandibular advance [8,9].

The aim of our study is to evaluate, through radiographic analysis and a cephalometric study, changes in the Rhino-Oro-Pharyngeal airways following therapy with different types of orthopedic-functional equipment, attributable to the category "mandibular thrusters", used in the treatment of the skeletal mandibular retrapping classes, in particular we treated patients with Andresen activator, the function regulator Frankel type I or II and the "Occlus-O-Guide", looking for any differences between the different Patient groups [10-12].

Materials and Methods

We conducted a retrospective study on patients with skeletal class II (ANB > 4°), for mandibular retrusion treated at the Department of Orthodontics at the "Maggiore Policlinico" Hospital in Milan and selected after an accurate clinical record study aimed at Research of patients currently in orthodontic multibrackets therapy and which had previously been subjected to intercepted and functional orthopedic therapy with rapid expansive palatal and subsequent removable mandible thruster.

Over 105 clinical records of patients in orthodontic multibrackets, 63 were analyzed referring to patients previously treated for a mandibular skeletal II class problem.

The inclusion criteria of our research were:

- Patients who are not affected by craniofacial malformations and/or syndromic conditions.

- Patients with no Obstructive Sleep Apnea Syndrome (OSAS) or other relevant respiratory diseases.

- Patients with mixed respiration, predominantly oral, clinically highlighted by the search for Gudin test (compress alternately for 1 second the wings of the nose of the patient; if oral breathing is predominant, there is no reflected response to enlargement of the nostril) and Rosenthal test (twenty respiratory acts first with the two nostrils, then with each nostril separately; If the patient is an oral respirator it opens its mouth before the end of the test, while the pulse and breath increase in frequency).

- Patients undergoing intercepted and functional orthopedic therapy comprising only a rapid palatal expansion stage (implemented with ERP type Hyrax cemented on the first permanent molars or deciduous seconds molars) followed by a mandibular propulsion phase carried out with Andresen activator or function regulator of Frankel type I or II or Occlus-O-Guide.

- Patients who had radiographic documentation suitable for the study (teleradiography of the skull in latero-lateral projection before the beginning of the interceptional and orthopedic-functional therapy phase and a subsequent one at the end of this phase).

15 patients (9 females, 6 males) were selected, divided into 3 samples:

5 patients treated with RPE and activator of Andresen

-As1:11	-Ae1:13
-As2:12	-Ae2:15
-As3:12	-Ae3:14
-As4:12	-Ae4:15
-As5:12	-Ae5:14
Middle As: 11.8	Middle Ae: 14.2

5 patients treated with RPE and Frankel type I or II:

-As6:9	-Ae6:10
-As7:8	-Ae7:13
-As8:12	-Ae8:14
-As9:10	-Ae9:14
-As10:11	-Ae10:16
Middle As: 10	Middle Ae: 13.4

5 patients treated with RPE and Occlus-O-Guide:

-As11:8	-As11:10
-As12:10	-As12:11
-As13:9	-As13:12
-As14:8	-As14:12
-As15:7	-As15:10
Middle As: 8.4	Middle Ae: 11

The mean age at start of treatment was 10 years while the mean age at the end was 13 years. The digital images of teleradiographs prior to treatment (T0) and subsequent treatment (T1) have been retrieved (Figure 1 and Figure 2).

Cephalometric analysis was performed using the Delta-Dent (Outside Format) cephalometric analysis software. On our project and request was compiled by computer technicians a specific cephalometric analysis including the main parameters of the analysis of Gianni [5] and other functional parameters to describe the depth of rhino-pharyngeal and oro-pharyngeal. The other parameters are the 3 lines parallel to the SN plane passes for C1, C2, C3.

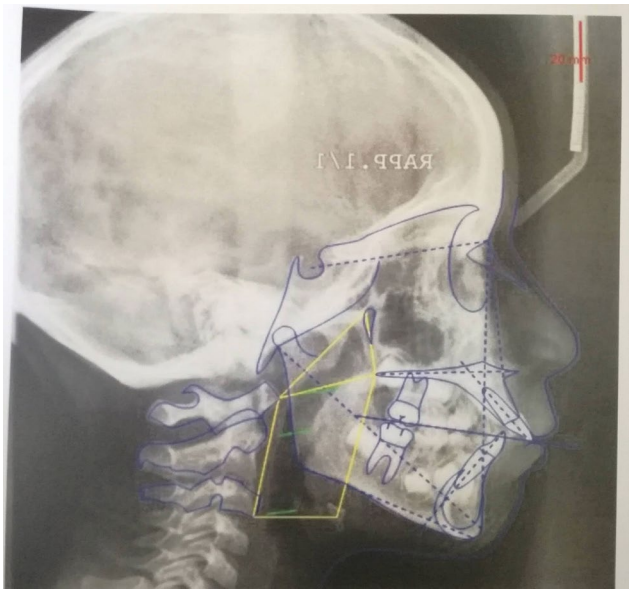

Figure 1: Teleradiographs prior to treatment (T0).

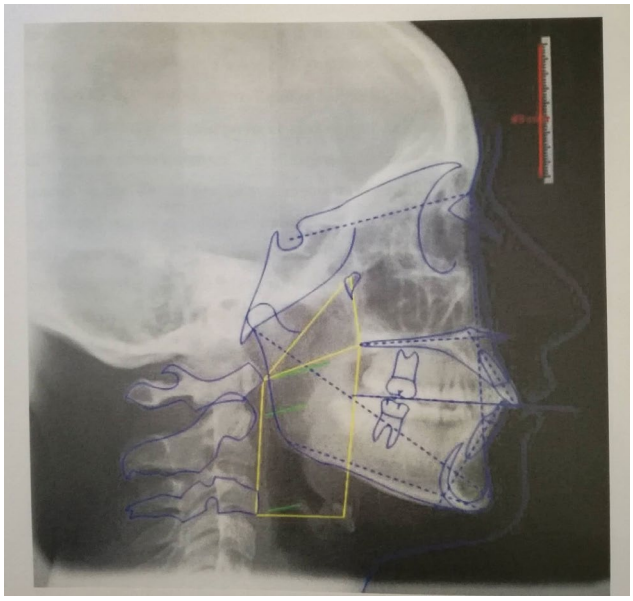

Figure 2: Teleradiographs subsequent treatment (T1).

The line parallel to the SN plane passing through C1 intersects the posterior pharyngeal wall and the frontal pharyngeal wall at the following points:

OSP: Upper Posterior Oropharyngeal

OSA: Upper Anterior Oropharyngeal

The line parallel to the SN plane passing through C2 intersects the posterior pharyngeal wall and the frontal pharyngeal wall at the following points:

OMP: Medial Posterior Oropharyngeal

OMA: Medial Anterior Oropharyngeal

The line parallel to the SN plane passing through C3 intersects the posterior pharyngeal wall and the frontal pharyngeal wall at the following points:

OIP: Lower Posterior Oropharyngeal

OIA: Lower Anterior Oropharyngeal

Finally, the area of a triangle having the vertices C1, Pt, Snp of a quadrilateral with the vertices C1, Snp, Hy, C3 and the summation of the above mentioned areas have been calculated.

All cephalometric pathways were performed three times by the same operator at two-week intervals and for each parameter the mean value was calculated from the 3 values found.

The collected data were subjected to statistical analysis. The mean and standard deviation was calculated for each parameter studied within each sample, and mean and standard deviations were also calculated by considering all 3 sample patients together. A specific statistical analysis was also carried out of the variations that affected each angular or linear parameter; Even in this case the mean and standard deviation was computed and the data were compared in pairs (monoblock vs. Occlus-O-Guide, Frankel vs. monoblock, Frankel vs. Occlus-O-Guide) by applying Student's test as there It was wondered whether it was possible to define statistically significant differences with respect to variations and therefore whether one of the three groups showed better results with respect to the increase in airway depths higher than the other two.

All data of all three groups were compared using the Pearson correlation index (r) useful to determine if the variables studied are associated or not and their possible degree of association.

Results and Discussion

The results of the cephalometric analyzes performed are summarized in the following tables: For each parameter, there are angular or linear values before RPE and mandibular thrust, after treatment end and variation (Δ) (Table 1, Table 2 and Table 3).

We observed about skeletal variations:

- A greater effect on the decrease of the ANB angle in the cases treated with Occlus-O-Guide compared to cases treated with activator of Andresen and Frankel I or II (average values of Δ relative to ANB are -3.04° respectively, -2.24°, -2.12°).

- Increased inhibition of maxillary protrusions in patients treated with Occlus-O-Guides (Δ = -1.66°) compared to patients treated with Andersen monoblock (Δ = 0.68°); Student's test in this case showed a statistically significant difference (p = 0.028).

Increased mandibular forward stimulation in patients treated with monoblock (Δ SNB = 2.88°; Δ SND = 2.64°) compared to patients treated with Frankel (Δ SNB = 1.38°; Δ SND = 1.72°) and Occlus-O-Guides (Δ SNB = 1.36°, Δ SND = 0.98°).

- An overall increase in Ar-Pog (greater in patients treated with activator, an average increase of 8.05 mm).

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Table 1: 5 patients treated with RPE and activator of Andresen.

Patients treated with RPE and activator of Andresen															
		A.D.			T.G.			E.L.			D.M.			C.M.	
	Pre	Post	Δ	Pre	Post	Δ	Pre	Post	Δ	Pre	Post	Δ	Pre	Post	Δ
Gianni	11 aa	13 aa		12 aa	15 aa		12 aa	14 aa		12 aa	15 aa		12 aa	14 aa	
SNA	81.5	82.6	1.09999999999999	83.7	84.2	0.5	83.3	85.1	1.8	84.1	85.1	1	83.7	82.7	-1
SNB	75.5	76.9	1.40000000000001	75.8	81	5.2	77.9	81.5	3.59999999999999	79.9	83	3.09999999999999	77.2	78.3	1.09999999999999
SND	72.9	73.9	1	73	78.1	5.09999999999999	75.4	78.5	3.09999999999999	76.7	79.9	3.2	75.1	75.9	0.800000000000011
ANB	6	5.7	-0.3	8	3.2	-4.8	5.5	3.6	-1.9	4.2	2.1	-2.1	6.6	4.5	-2.1
SOr:Sna	59.1	59.3	0.199999999999996	58.2	65	6.8	54.4	59.7	5.3	57.2	56.1	-1.1	58.2	61	2.8
Sna:Me	60.1	61.6	1.5	45.1	52.2	7.1	62.6	70.1	7.49999999999999	52	53	1	56.1	60.4	4.3
I+/Snp.Sna	108.2	110.3	2.09999999999999	130.3	134.2	3.89999999999998	121.3	119.9	-1.39999999999999	128.2	120.6	-7.59999999999999	108.6	119.3	10.7
I+/SN	99.4	101.2	1.8	118.7	123.4	4.7	112.8	112.3	-0.5	122.1	112.4	-9.69999999999999	99.2	109.1	9.89999999999999
I-/Go.Gn	103	95.9	-7.09999999999999	113.3	114.9	1.60000000000001	111.2	102.4	-8.8	113.6	100	-13.6	101.2	102.9	1.7
I+ ^ I-	124.2	126.5	2.3	106.1	100	-6.09999999999999	109.6	115.8	6.2	106.7	127.3	20.6	128.5	116	-12.5
Sna.Snp - Go.Gn	24.7	27.3	2.6	10.2	10.9	0.700000000000001	17.9	21.9	4	11.5	12	0.5	21.7	21.8	0.100000000000001
SN - Go.Gn	33.4	36.4	3	21.9	21.7	-0.199999999999999	26.4	29.5	3.1	17.6	20.3	2.7	31.1	32	0.899999999999999
SN - Oclp.Ocla	17.8	19	1.2	14.3	13.5	-0.800000000000001	14.3	15	0.699999999999999	10.6	8.3	-2.3	15.5	15.8	0.300000000000001
SN - Snp.Sna	8.8	9.1	0.299999999999999	11.6	10.8	-0.799999999999999	8.5	7.6	-0.9	6.1	8.3	2.2	9.4	10.2	0.799999999999999
Ar-Pog	92.1	99.3	7.2	93.3	109.7	16.4	102	115.2	13.2	92	97.4	5.40000000000001	93.5	100.3	6.8
Soft Tissues															
Upper Oropharyngeal	19.5	20.4	0.899999	16	21.1	5.1	15.1	18.4	3.3	11.7	12.6	0.9	15.5	20	4.5
Lower Oropharyngeal	15.3	12.1	-3.2	13.5	11.1	-2.4	3.6	4.5	0.9	6.9	8.3	1.4	7	8.4	1.4
Medial Oropharyngeal	15	21.1	6.1	17.2	23.6	6.4	11.6	14.9	3.3	5.6	7.7	2.1	9.2	11.7	2.5
Hard Tissues															
Rhinopharyngeal C1 Sn	41.1	35.6	-5.5	40.5	39.5	-1	35.6	37.2	1.6	38.2	30.5	-7.7	30.7	32.3	1.6
Oropharyngeal - C3 Hy	30.3	31	0.699999	30	34.5	4.5	29.3	33.6	4.3	27.4	27.8	0.400000	26.5	27.3	0.800000
Pharyngeal															
Rhino	469.7	411.9	-57.8	472.8	511.1	38.3	383.4	415.4	32	414.2	389.7	-24.5	332.6	376.4	43.8
Oro	1608.6	1876.2	267.6	1373.2	1959	585.8	1542.6	1926.5	383.9	1499.7	1375.8	-123.9	1373	1554.6	181.6
Area Ororhinopharyngeal	2078.3	2288.1	209.8	1846	2470.1	624.1	1926	2341.9	415.9	1913.9	1765.5	-148.4	1705.6	1931	225.4

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Table 2: 5 patients treated with RPE and Frankel type I or II.

Patients treated with RPE and Frankel type I or II															
		I.B.			E.L.			I.P.			B.R.			B.V.	
	Pre	Post	Δ	Pre	Post	Δ	Pre	Post	Δ	Pre	Post	Δ	Pre	Post	Δ
Gianni	9 aa	10 aa		8 aa	13 aa		12 aa	14 aa		10 aa	14 aa		11 aa	16 aa	
SNA	72.6	73.2	0.600000000000009	86.2	82.2	-4	78.6	79.5	0.900000000000006	80.2	79.7	-0.5	82.9	82.2	-0.700000000000003
SNB	65.5	67.2	1.7	78.9	77.2	-1.7	71.3	75.9	4.60000000000001	75.7	77	1.3	75.7	76.7	1
SND	63.6	65.5	1.9	75.9	74.8	-1.10000000000001	69.2	74.2	5	72.2	73.8	1.59999999999999	73.8	75	1.2
ANB	7.1	6	-1.1	7.3	5	-2.3	7.3	3.6	-3.7	4.5	2.7	-1.8	7.2	5.5	-1.7
SOr:sna	52.6	56	3.4	54.1	59.7	5.6	57.9	58	0.100000000000001	108.4	108.5	0.0999999999999943	56.7	59.8	3.09999999999999
sna:Me	57.9	60.9	3	57	60.9	3.9	67.9	68.1	0.199999999999989	119.2	118.4	-0.799999999999997	56.1	64.4	8.3
I+/Snp.Sna	109.9	98.3	-11.6	126.9	116	-10.9	106.2	105.1	-1.10000000000001	129.9	127	-2.90000000000001	117	108.2	-8.8
I+/SN	96.7	85	-11.7	119.4	105.1	-14.3	96.3	95.4	-0.899999999999991	121.7	119.6	-2.10000000000001	109.8	101.7	-8.09999999999999
I-/Go.Gn	105.4	105.3	-0.100000000000009	106	101.6	-4.40000000000001	98.2	98.4	0.200000000000003	103.4	98.8	-4.60000000000001	91.6	94.2	2.60000000000001
I+ ^ I-	116.9	130	13.1	101.9	119.1	17.2	121.7	122.9	1.2	92.7	101.6	8.89999999999999	120	128	8
Sna.Snp - Go.Gn	27.8	26.4	-1.4	25.2	23.3	-1.9	33.9	33	-0.899999999999999	34.1	32.6	-1.5	31.4	29.5	-1.9
SN - Go.Gn	41	39.8	-1.2	32.7	34.3	1.59999999999999	43.8	42.9	-0.899999999999999	42.3	40	-2.3	38.6	36.1	-2.5
SN - Oclp.Ocla	24.9	26.4	1.5	17.6	18	0.399999999999999	25.2	24.7	-0.5	21.5	19.5	-2	15.6	14.9	-0.699999999999999
SN - Snp.Sna	13.2	13.4	0.200000000000001	7.5	10.9	3.4	9.9	9.9	0	8.2	7.4	-0.799999999999999	7.2	6.5	-0.7
Ar-Pog	81	86.7	5.7	85.3	95.1	9.8	94.3	100.1	5.8	168	171.6	3.59999999999999	85.5	96.7	11.2
Soft Tissues															
Upper Oropharyngeal	15	14.9	-0.099999999999999	14.2	19.2	5	20.3	23.6	3.3	30.9	33	2.1	15.6	24.6	9
Lower Oropharyngeal	8.4	7.4	-1	8.5	10.6	2.1	5.4	7.9	2.5	12.1	16.8	4.7	9.9	16.5	6.6
Medial Oropharyngeal	12	12.9	0.9	10.3	13	2.7	9.5	10.8	1.3	16.1	17.3	1.2	8.8	15.9	7.1
Hard Tissues															
Rhinopharyngeal C1 Snp	34.8	32	-2.8	31	34	3	31.5	34.7	3.2	66.9	52.9	-14	28.7	32.9	4.2
Oropharyngeal - C3 Hy	20	21.5	1.5	25.5	28.5	3	23.2	26.3	3.1	40.9	41.2	0.300000000000004	25.2	28.2	3
Pharyngeal															
Rhino	385.1	331.6	-53.5	322.4	397.8	75.4	342.1	390.5	48.4	1236.8	1001.9	-234.9	362.3	485.2	122.9
Oro	1103.8	1115.4	11.6000000000001	1117.4	1549	431.6	1395.2	1587.9	192.7	4606.3	4457.1	-149.2	1130.5	1626.9	496.4
Area Ororhinopharyngeal	1488.9	1447	-41.9000000000001	1439.8	1946.8	507	1737.3	1978.4	241.1	5843.1	5459	-384.1	1492.8	2112.1	619.3

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Table 3: 5 patients treated with RPE and Occlus-O-Guide.

Patients treated with RPE and Occlus-O-Guide															
		C.B.			D.B.G.			L.R.A.			S.C			T.B	
	Pre	Post	Δ	Pre	Post	Δ	Pre	Post	Δ	Pre	Post	Δ	Pre	Post	Δ
Gianni	8 aa	10 aa		10 aa	11 aa		9 aa	12 aa		8 aa	12 aa		7 aa	10 aa	
SNA	88.1	84.4	-3.69999999999999	82.2	83	0.799999999999997	79.3	77.5	-1.8	88.7	86.4	-2.3	82.5	81.2	-1.3
SNB	81.1	82.4	1.30000000000001	78.2	80.5	2.3	75.3	77.2	1.90000000000001	83.8	83.9	0.100000000000009	76.2	77.4	1.2
SND	78.7	80.4	1.7	75.3	76.6	1.3	74.4	76.2	1.8	82.4	81	-1.40000000000001	73.6	75.1	1.5
ANB	7	1.9	-5.1	4	2.5	-1.5	4	0.3	-3.7	4.9	2.5	-2.4	6.3	3.8	-2.5
SOr:sna	58.8	67.2	8.40000000000001	71.2	64.4	-6.8	66	64.8	-1.2	51.9	56.3	4.4	59.1	66.5	7.4
sna:Me	59.8	64.9	5.10000000000001	65.4	60.8	-4.60000000000001	63.3	62.8	-0.5	52.1	57.4	5.3	61.9	70.5	8.6
I+/Snp.Sna	117.1	117.9	0.800000000000011	116.6	116.4	-0.199999999999989	113.6	116.3	2.7	109.7	106.4	-3.3	126.4	112.1	-14.3
I+/SN	111.4	113.4	2	109.6	111.9	2.30000000000001	104.9	107.2	2.3	106.5	102.2	-4.3	118.5	104	-14.5
I-/Go.Gn	106.7	105.1	-1.60000000000001	109.7	110.1	0.399999999999991	100.6	91.9	-8.69999999999999	94.4	101.9	7.5	110.3	117	6.7
I+ ^ I-	111.4	115.8	6.00000000000001	112.1	113.1	1	124.3	130.8	6.50000000000001	139.2	136.6	-2.59999999999999	97.7	107.8	10.1
Sna.Snp - Go.Gn	24.7	21.2	-3.5	21.7	20.5	-1.2	21.5	21.1	-0.399999999999999	16.7	15.1	-1.6	25.6	28	2.4
SN - Go.Gn	30.5	25.7	-4.8	18.6	24.9	6.3	30.2	30.2	0	19.9	19.3	-0.599999999999998	33.4	35	1.6
SN - Oclp.Ocla	16.8	9.6	-7.2	16.7	10.7	-6	15.9	16.7	0.799999999999999	11.6	10.5	-1.1	17.7	19.9	2.2
SN - Snp.Sna	5.7	4.5	-1.2	6.9	4.4	-2.5	8.7	9.1	0.4	3.2	4.2	1	7.8	8.1	0.3
Ar-Pog	101	118.7	17.7	119	110.8	-8.2	110.8	114.2	3.40000000000001	93.6	101.9	8.30000000000001	96.8	111.2	14.4
Soft Tissues															
Upper Oropharyngeal	15.4	12.1	-3.3	12.7	11.6	-1.1	12.3	12.3	0	9.6	10.7	1.1	11.1	12.7	1.6
Lower Oropharyngeal	9.2	8.1	-1.1	11.2	10.2	-1	10.8	10.9	0.0999999999999996	8.5	9.5	1	9.8	11.2	1.4
Medial Oropharyngeal	4.3	10.8	6.5	11.3	10.3	-1	10.9	11	0.0999999999999996	8.6	9.6	1	9.9	11.3	1.4
Hard Tissues															
Rhinopharyngeal C1 Snp	31	33.8	2.8	46.6	38.6	-8	41.1	37.3	-3.8	30.5	30.4	-0.100000000000001	32	42.2	10.2
Oropharyngeal - C3 Hy	27.2	32.6	5.4	31.3	30.7	-0.600000000000001	34.2	36.2	2	27.8	26.8	-1	28.9	31.9	3
Pharyngeal															
Rhino	365	529	164	731	552.5	-178.5	578.5	572.5	-6	393	421.5	28.5	496.5	666	169.5
Oro	1338	1856	518	2242	1810	-432	2109	2030	-79	1340	1613.5	273.5	1387	1568	181
Area Ororhinopharyngeal	1694	2385	691	2973	2362.5	-610.5	2688	2602	-165	1733	2035	302	1883	2234	351

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- A greater increase in the angle of divergence in cases treated with Andersen activator (Δ Sna.snp-Go.Gn = 1.58 a) compared to cases treated with Frankel (Δ sia. snp-Go.Gn = -1.52°); Student's test in this case showed a statistically significant difference (p = 0.006).

As far as upper airway analysis is concerned, we observe:

A greater increase in the depth of the upper portion of the oropharynx in patients treated with an activator of Andresen (Δ = 2.94 mm) and Frankel (Δ = 3.86 mm) compared to patients treated with obstructive Occlus-O-Guides (Δ = -0.34 mm); The t test student showed statistically significant differences (p = 0.03 in comparison with patients treated with activator and patients treated with Occlus-O-Guide; p = 0.02 in comparison with patients treated with Frankel and patients treated with Occlus- O-Guide.

A general tendency to decrease the length of the C1-Sno segment expressing the depth of the upper portion of the pharynx (rhinopharynx).

A general tendency to increase the length of the C3-Hy segment expressing the depth of the lower tract from the pharynx.

A considerable dispersion of data (excessive standard deviation values) with respect to the rhino-pharyngeal and oro-pharyngeal area (and hence the total pharyngeal area).

Finally, the correlation coefficient of Pearson (r) was calculated and it was shown: A strong correlation between the increase of the mandibular length (Ar-Gn) and the increase of the total pharyngeal area (r = 0.92). A strong correlation between the increase in the anterior upper vertical skeletal dimension (Sor-Sna) and the increase in the rhinopharyngeal area as evidenced in the Kinziger study [13] (r = 0.88). A moderate correlation (r = 0.56) between anterior lower vertical skeletal size (Sna-Me) and increased oropharyngeal area.

Based on the data collected and the statistical analysis conducted, as expected, the effects of the different types of mandibular thrust are overlapping with regard to the stimulation of mandibular growth: The activator seems to favor an increase in SNB angle compared to two other devices and the Occlus-O-Guide have a greater inhibitory effect on the upper jaw. In this regard the maxillo-mandibular divergence parameter should be considered: The RPE and Frankel treated samples are composed of hyperdivergent patients, so mandibular advance is inevitably countered by the increased divergence that tends to keep point B backward. Patients treated with RPE and monoblock showed a statistically significant increase in skeletal divergence compared to patients treated with RPE and Frankel and this data confirms the therapeutic utility of Andresen's activator in the 2nd hypodivergent skeletal classes. The upper part of the oropharynx (OSP-OSA) was more pronounced in the first two patient samples than the third with a statistically significant difference. No statistically significant differences were observed between the 3 samples with regard to the middle oropharyngeal tract (OMP-OMA). Moreover, Frankel would seem more effective than other devices in increasing the depth of the lower oropharynx (OIP-OIA).

Going to analyze correlations with the Pearson coefficient, there is a strong correlation (r = 0.92) between mandibular length increase and total pharyngeal area increase. Therefore the stimulation of mandibular growth has a positive presence on the depths of the UAS.

The patient's skull posture is a factor that greatly influences the numerical values of the angular and linear parameters and of the calculated areas for studying the UAS; In this regard, a great advantage of the CBCT is the ability to orient the acquired volume of the anatomical structure to be studied according to the anatomical plans of interest, regardless of how the head of the patient is placed during the examination [14,15].

The teleradiography of the skull in the latero-lateral projection allows only a sagittal and vertical evaluation of the UAS and must be associated with a teleradiography of the skull in postero-anterior projection, useful for defining, for example, the transverse extension of the nasal pits.

Although the teleradiography of the skull in the latero-lateral position is a simple, inexpensive execution of the diagnostic examination, which involves the patient's reduced exposure to ionizing radiation, it has a large two-dimensional limit that does not allow precise measurements on the three plans of space, as it allows the low dosage CBCT.

Moreover, it is often difficult to locate many cephalometric points of the skull in lateral projection due to the overlapping of numerous bone structures.

Conclusion

Treatment of mandibular skeletal classes II by mandibular thrust entails an increase in the post-operative extension of the posterior-anterior oropharynx that appears to be most affected by the action of these devices.

Effects of the three different types of mandibular thrusters on the oropharynx are substantially overlapping.

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