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Effect Of Rapid Maxillary Expander With Posterior Bite Blocks On Pharyngeal Airway Dimensions in Patients with Adenoid Hypertrophy -A Cephalometric Study.

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ABSTRACT

Objective- Background :To evaluate the effects of Rapid Maxillary Expander(RME) with posterior bite blockson pharyngeal airway dimensions, related soft tissues and Hyoid bone in patients with adenoid hypertrophy and to compare these changes with Control Group.

MATERIAL AND METHODS :32 subjects with adenoid hypertrophy (mean age 11.6 yrs) with a transverse discrepancy were selected for the study. The patients were randomly divided in two groups- Group A: (n=16) RME with posterior bite block group, Group B : (n=16) Control group. In Group A Lateral cephalograms were recorded before start of treatment(T_0), Immediate after expansion (T_1), and after 9 months of retention (T_2). In Group B Lateral cephalograms were recorded at the beginning (T_0), and after 9 months(T_2). Cephalometric measurements in the sagittal dimensions of the pharyngeal airway (Nasopharynx, Oropharynx and Hypopharynx), tongue posture and hyoid bone position were measured and compared using Paired and Un-paired t-test with $p<0.05$ as statistically significant.

RESULTS: In Group A, Nasopharyngeal airways (Depth of Nasopharynx and Height of Nasopharynx), Soft palate thickness (SPT),Tongue height(TGH) was increased significantly and Soft palate length(SPL), Soft palate inclination(SPI) and Tongue Length(TGL) was decreased which was statistically significant, when compared to Group B.

CONCLUSION: Significant increase in the dimensions of the nasopharyngeal airways, upward posture of tongue and upward and forward movement of the hyoid bone was seenin treatment group when compared to control group.

Keywords: Adenoid hypertrophy,Rapid maxillary expander,Posterior bite blocks,Pharyngeal airway dimension.

INTRODUCTION

Adenoids are a masses of lymphoid tissue, located posterior and superior aspect of the soft palate in the nasopharyngeal mucous membrane, at a level parallel to the base of the sphenoid bone.[1]One of the most common pathology causing upper airway obstruction and affecting both maxillofacial and dental development in children is adenoid hypertrophy.[2]Adenoid facies are characterized by long, open mouthed face with an incompetent lip seal, a constricted maxillary arch, retroclined lower incisors,a steep mandibular plane angle, increased anterior face height, and retrognathic mandible.[3]

Rapid maxillary expansion (RME) is a treatment procedure for correcting transverse maxillary deficiency. This technique was

first described by Angel[4]in 1860 and popularized by Haas[5,6]100 years later. The knowledge of RME was extended to nasal cavity,because it was proposed that, with maxillary arch expansion, nasal cavity width and volume was increased.[5] It has been hypothesized that, since half of the nasal cavity's structures are formed by maxillary bones, the nasal cavity's lateral walls are displaced apart with opening of midpalatal suture, resulting in increase in volume and decrease in nasal airway resistance.[7]The bonded rapid maxillary expander is a unique appliance with the incorporation of posterior occlusal coverage, which in turn allows minimal maxillary molar extrusion and tipping as the occlusal forces are directed against the acrylic, resulting in reduced downward and backward rotation of the mandible. Treatment with a bonded RME has been found to have an intrusive effect on maxillary first molars,which favourably contributes to the maintenance of the vertical dimension.[8]

The aim of the present study was to evaluate the effects of RME with posterior bite blocks on pharyngeal airway dimensions and related tissues in patients with adenoid hypertrophy and to compare these changes with controls. Rationale of the study was, if RME increases pharyngeal airway dimensions and improves sagittal relation between the jaws then it will be an important mode of correction for patients suffering from airway obstruction. It may reduce the probability of patients undergoing surgical correction for airway obstruction at a later date.

MATERIALS AND METHODS

This study was conducted in the Department of Orthodontics and Dentofacial Orthopedics in collobration with Department of Otolaryngology. Ethical approval for this clinical trial was obtained from Institutional Committee for scientific ethics. Written informed consent from parents/guardian was obtained prior to the start of study.

CRITERIA FOR SELECTION OF SUBJECTS

Untreated patients with adenoid hypertrophy were selected with following criteria:

INCLUSION CRITERIA

- Presence of adenoid hypertrophy as diagnosed by an Otolaryngologist.
- Age group between 8-12 years of age.

EXCLUSION CRITERIA

- No previous history of orthodontic treatment.
- No history of upper airway surgeries before or during treatment
- No history of other Respiratory diseases.

For this prospective study, a sample of 32 adenoid hypertrophic patients (7 females and 25 males) were selected. The envelope draw method was used for randomization among groups. Thirty two envelops were prepared and randomly picked each time when a new patient-reported.These patients were divided into two groups, In Group A: (n=16) RME with posterior bite block group and Group B: (n=16) Control group. In Group A, Lateral cephalograms were recorded before start of Treatment(T_0), Immediately after expansion; i.e when the palatal cusps of the maxillary molars were riding up on the buccal cusps of the mandibular molars (T_1), and after 9 months of retention (T_2). In Group B Lateral cephalograms were recorded at the beginning (T_0), and after 9 months(T_2).

DESIGN OF THE RAPID MAXILLARY EXPANSION APPLIANCE WITH POSTERIOR BITE BLOCKS:

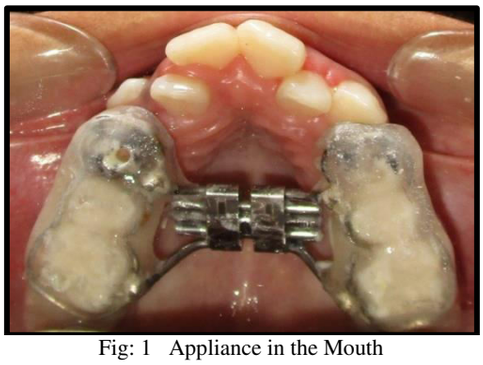

Fig: 1 Appliance in the Mouth

Appliance was constructed by incorporating a hyrax-type screw into a wire framework made from .040 inch stainless steel. The framework extended around the buccal and lingual surfaces of the dentition, with the wire crossing the occlusion between the upper deciduous canines and the first premolar or deciduous first molars. The wire also curved around the distal aspect of the upper first permanent molars.

The screw was positioned in the palate with the midline of the screw aligned with the palatal midline and about 2mm away from the surface of the palate. Approximately 2 to 3 mm of acrylic was bonded to maxillary posterior teeth (Figure 1).

Expansion and Retention Schedule

The appliance was activated one- quarter turn twice daily until the appropriate amount of expansion was produced. Expansion was continued till the palatal cusps of the maxillary molars were riding up on the buccal cusps of the mandibular molars. When the required expansion was achieved, the RME appliance was removed and the screw locked in position with cold cure acrylic and left in place as retention appliance for an additional nine months to allow for adequate re-ossification of the involved sutural system. Oral hygiene of the patients was maintained throughout the treatment.

PHARYNGEAL AIRWAY DIMENSIONS, RELATED SOFT TISSUE AND HYOID BONE POSITION MEASUREMENT

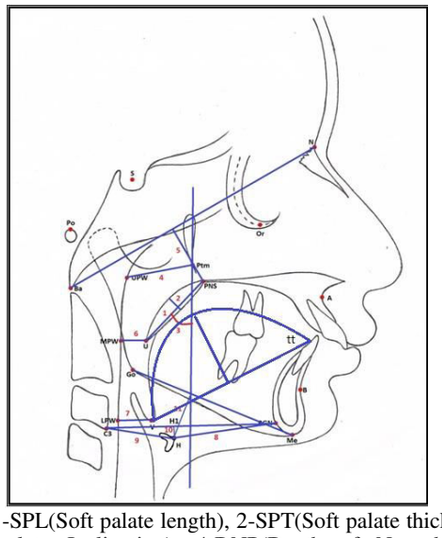

Figure 2: 1-SPL(Soft palate length), 2-SPT(Soft palate thickness), 3-SPI(Soft palate Inclination), 4-DNP(Depth of Nasopharynx),5-HNP(Height of Nasopharynx),6-DOP(Depth of Oropharynx),7-DHP(Depth of Hypopharynx), 8-HRGN(Distance from Hyoid bone to Retrognathion), 9- C_3H(Distance from Hyoid bone to C_3), 10-HH_1(Perpendicular distance from Hyoid bone to line connecting C_3 and RGN), 11-MPH(Perpendicular distance from Hyoid bone to mandibular plane), 12-TGH(Tongue Height), 13-TGL(Tongue length).

STATISTICAL ANALYSIS

Pre-treatment, post-expansion and post-retention lateral cephalometric values were measured and their significance were compared using the standardized student't' test. Paired t test was used to assess difference in the amount of change in the different variables between the pre-treatment (T0), post-expansion (T1) and post-retention (T2) in Group A (RME with posterior bite block group) and unpaired t test was used to compare the changes in group A (RME with posterior bite block group) and group B (Control group). Significance was determined at p< 0.05 (*significant), p<0.01(**highly significant), and p<0.001 (***very highly significant) level of confidence.Statistical analysis was conducted using EPI INFO STATISTICS(version 7.0).

RESULTS

In treatment Group SPL and SPI was decreased by 1.5±96mm (P<.001) and 2.93±3.8° (P<.001) respectively and the result was Statistically significant. In control group there was no statistically significant change. SPT was increased by 1.25±77mm in Group A which was statistically significant (P<.001) but in Group B the change was insignificant (Table 2).

In Group A, DNP and HNP was increased by 2.4±1.93mm (P<.001) and 2.6±3.2mm (P<.005) respectively and the result was Statistically significant. DOP and DHP was increased by .43±1.8mm (P>.05) and 1±2.5mm (P>.05) but the result was not statistically significant. In Group B there was no significant change in these parameters (Table 2).

In Group A, TGL decreased by 2.12±3mm which was statistically significant (P<.05) while in Group B the change was insignificant. TGH increased by 2.43±1.93mm in treatment group which was highly significant (P<.001) while in Group B there wasn't any significant change(Table 2).

C_3H was increased by 2.1±2.9mm in Group A which was Statistically significant P<.05, HH_1 was decreased by .68±3.0mm which was not significant(P>.05). In Group B, C_3H decreased by .37±1.6mm which was not statistically significant(P>.05), while the HH_1 increased by .81±1.2mm and the result was seen significant (P>.05)(Table 2).

Increase in the pharyngeal airway dimensions was in seen both groups by 2.4±1.9mm and .25±1.6mm in Group A and Group B respectively, but significant increase was seen in treatment group when compared to control. Decreasein the tongue length and increase in tongue height was seen in treatment group significantly while in control group both tongue length and height was increased (Table 3).

DISCUSSION

Maxillary constriction is associated with several problems that include cross bite (dental and/or skeletal), occlusal disharmony, esthetics and functional problems such as narrowing of the pharyngeal airway.[9]It has been hypothesized to play a role in the patho-physiology of Obstructive sleep apnea(OSA) due to its association with low tongue posture that might contribute to narrowing of the oropharynx airway.[10]

Lateral Cephalometric radiography has been broadly used in diagnosis and treatment planning. It is a measurement tool for evaluating the Pharyngeal airway dimension and craniofacial morphology. It also offers considerable advantages over other techniques, including low cost, convenience and reduced exposure to radiation, as well as being able to simultaneously analyze head position, hyoid position and craniofacial morphology.[11]

In treatment Group SPL and SPI was decreased from T0 to T2 by 1.5±96mm (p<.001) and 2.93±3.8° (p<.001) respectively and the result was Statistically significant when compared with Group B and SPT was increased by 1.25±77mm which was also statistically significant (p<.001). An inverse relationship was seen between the soft palate length (SPL) and sagittal mandibular development. It is known that in subjects with adenoid hypertrophy, the tongue position is more backward, with contact to the soft palate resulting in posterior displacement of soft palate and narrowing of oropharyngeal airway.[12]The

increase in the width of the maxilla after RME treatment provide more room to accommodate the upward posture of the tongue. Thus, the base of the tongue moves away from the posterior pharyngeal wall with a resultant decrease in soft palate length, soft palate inclination and increase in soft palate thickness.[13-15]McNamara[16], stated that widening the maxilla led to a spontaneous forward posturing of the mandible during the retention period, in turn correcting the mild Class II relationship. He suggested that the teeth itself act as an endogenous functional appliance, causing a change in mandibular posture and subsequently change in the maxillary-mandibular occlusal relationship which might be the reason for soft palate dimensional changes in this study.

Depth of nasopharynx (DNP) was increased by 2.4±1.93mm (p<.01) and the Height of Nasopharynx was increased by 2.62±3.2mm (p<.01) in group A, and these changes were statistically highly significant when compared with Control Group following Bonded rapid maxillary expansion appliance treatment (Table 3). Aloufi et al[10] have also reported similar observations following rapid maxillary expansion therapy. Tecco et al[17] in his study had significant increase in nasopharyngeal airway dimension (5.3 mm) compared with the control group (1.2 mm). This airway improvement occurred 6 months after RME and remained stable after 12months of follow-up. It was suggested that RME causes a reduction in Nasal airway resistance (NAR), which results in a reduction of head elevation, suggesting improvement in nasal breathing. Monini et al[18] suggested an increase in the posterior nasal space which could be in relation to the reduced nasopharyngeal soft-tissue hypertrophy due to two main reasons: the better nasal breathing and the physiological age-related reduction of lymphatic tissue, which was evidenced in our study.

DOP and DHP was increased from T0 to T2 by .43±1.8mm (P>.05) and 1±2.5mm (P>.05) respectively, but the result was not statistically significant when compared with Group B. Zhao et al [19] evaluated changes in oropharyngeal volume in growing patients after RME treatment in maxillary constricted patients. There was no increase in minimum cross-sectional area and total oropharyngeal airway volume.It is known that in subjects with adenoid hypertrophy, the tongue position is more backward, in

Table 1: Cephalometric measurements of Pharyngeal airway, Related soft tissue and Hyoid bone of Group A (T0),(T1) and (T2) and Group B (T0) and (T2).

S.No.	Variable	GROUP A			GROUP B	
		T0 (Mean±SD)	T1 (Mean±SD)	T2 (Mean±SD)	T0 (Mean±SD)	T2 (Mean±SD)
1.	SPL (mm)	28.94±3.19	28.38±3.0	27.4±2.8	28.13±3.61	28.81±3.35
2.	SPT (mm)	7.06±1.06	8.06±1.18	8.31±1.07	7.19±.655	7.00±,632
3.	SPI (^{o})	40.5±9.07	39.38±8.34	37.56±7.3	42.75±6.76	43.06±6.40
4.	DNP (mm)	5.81±2.48	6.81±2.97	8.25±3.2	7.75±4.56	8.00±3.63
5.	HNP (mm)	18.94±3.33	21.69±1.85	21.56±1.75	18.75±2.32	18.75±2.74
6.	DOP (mm)	9.13±1.7	8.94±1.43	9.56±1.63	7.44±2.80	7.31±2.35
7.	DHP (mm)	13.5±3.42	14.38±2.39	14.5±2.6	11.44±2.55	11.31±2.44
8.	TGL(mm)	64.56±5.0	62.25±4.18	62.44±3.7	60.88±4.01	61.06±4.18
9.	TGH(mm)	24.69±3.4	26.13±2.9	27.13±2.8	23.81±2.58	23.94±1.84
10.	HRGN (mm)	32.44±4.03	30.94±4.34	30.5±5.0	30.19±7.02	31.31±6.29
11.	C3H (mm)	29.5±2.9	30.5±3.6	31.6±3.4	28.25±3.23	27.88±2.82
12.	HH_1 (mm)	6.19±5.6	5.44±6.2	5.5±5.5	3.63±2.18	4.44±2.65
13.	MPH (mm)	15.06±4.5	14.5±5.1	14.31±4.3	13.13±5.60	11.94±5.15

contact with soft palate resulting in posterior displacement of soft palate and narrowing of oropharyngeal airway.[12]The increase in the width of the palate using RME can create more space to accommodate the tongue higher toward the roof of the palate. Thus, the base of the tongue moves away from the posterior pharyngeal wall with a resultant increase in oropharyngeal space.[13-15]

It has been suggested that the depth of the upper pharyngeal airway increases with age, whereas the depth of lower pharyngeal airway is established in the early life.[17]Johnston and Richardson[20] stated that in the oropharynx, the depth of the airway was found to decrease with age, while the soft palate became longer and thicker. Their findings specify that pharyngeal morphology is not established during childhood and adolescence, but changes throughout adult life. Evaluating the DHP, similar results were reported several other studies with various myofunctional appliance treatment.[20,21] This improvement in hypopharyngeal airway could be due to mandibular repositioning.[13]

Table 2:Intra GroupComparison of Group A and Group B.

		GROUP A						GROUP B	
S.No.	**Variable**	**T0-T1 Difference (Mean±SD)**	**P Value**	**T1-T2 Difference (Mean±SD)**	**P Value**	**T0-T2 Difference (Mean±SD)**	**P Value**	**T0-T2 Difference (Mean±SD)**	**P Value**
1.	SPL (mm)	.563±1.89	.254	.93±1.69	.043*	1.5±.96	.00***	-.68±1.49	.08
2.	SPT (mm)	-1.0±1.03	.002**	-.25±.77	.21	-1.25±.77	.00***	.18±.65	.27
3.	SPI (^{o})	1.12±2.65	.11	1.81±3.5	.06	2.93±3.8	.008**	-.13±3.17	.70
4.	DNP (mm)	-1±1.54	.021*	-1.4±1.4	.001**	-2.4±1.93	.00***	-.25±1.6	.55
5.	HNP (mm)	-2.75±3.06	.003**	.12±.95	.609	-2.62±3.24	.006**	.0±1.15	1.0
6.	DOP (mm)	.188±.98	.45	-.62±1.14	.046*	-.43±1.86	.36	.12±1.2	.68
7.	DHP (mm)	-.87±2.27	.14	-12±1.2	.68	-1.0±2.5	.138	.12±1.2	.69
8.	TGL(mm)	2.31±2.77	.005**	-.18±2.2	.74	2.12±3.05	.014*	-.18±1.3	.59
9..	TGH(mm)	-1.43±3.2	.097	-1±2.9	.19	-2.43±1.93	.00***	-1.2±1.2	.69
10.	HRGN(mm)	1.5±3.09	.072	.37±2.8	.60	1.87±3.9	.08	-1.12±1.9	.04*
11.	C3H (mm)	-1±2.98	.20	-1.1±2	.03*	-2.1±2.9	.01*	.37±1.6	.37
12.	HH_1 (mm)	.75±3.7	.44	-.06±2	.90	.68±3.04	.38	-.81±1.2	.018
13.	MPH (mm)	.56±3.7	.562	.18±3.2	.82	.75±2.7	.28	1.18±2.6	.09

*= p<0.05(statistically significant), ** = p<0.01(statistically highly significant), ***= p<0.001(statistically very highly significant, NS=Not significant

In Group A, TGL decreased by 2.12±3mm which was statistically significant (p<.05) while in Group B the change was insignificant. TGH increased by 2.43±1.93mm in treatment group which was highly significant (p<.001) while in Group B there was no significant change. Reduction in tongue length and increase in tongue height was probably due to higher and forward posture of tongue after rapid maxillary expansion. In a cephalometric study by Ozbek et a[14],RME resulted in a higher tongue posture. Contrarily, Malkoc¸et al[22]found that RME had no significant effect on tongue position or oropharyngeal dimensions. The cephalometric results reported by Usumez et al[23]suggested significantly increased tongue length, whereas tongue height showed a significant decrease after rapid maxillary expansion, conversely to the present study.

C_3H was increased by 2.1±2.9mm in Group A which was Statistically significant (P<.01) in comparison to Control Group ,HH_1 was decreased by .68±3.0mm which was not significant (P>.05). In Group B, C_3H decreased by .37±1.6mm which was not statistically significant(P>.05), while the HH_1 increased by .81±1.2mm and the result was seen significant (P>.05). Gale el al[24]suggested that the hyoid bone presented initial forward movement after surgical advancement of the mandible. Battagel[25] et al stated that a wide variation in both the amount and direction of the response of the hyoid to mandibular protrusion existed. Decrease in HH_1could be explained by the fact that as the bone position. It had been stated earlier that both stability and potency of the pharyngeal airway were primary factors in hyoid bone positioning[24]. On the other hand, upward elevation of the hyoid bone occurs with mandibular advancement and this change is temporary in nature.[24,27]

Hence, Bonded RME with posterior bite block appliance, when used for the treatment of adenoid hypertrophic patients not only improves the transverese discrepancy and facial esthetics but also increases the pharyngeal airway spaces. The increased pharyngeal airway and improved sagittal relation between the jaws due to orthopedic treatment indicates that it is an important

Table 3: Inter Group Comparison of Group A and Group B.

S. No.	Variable	T0-T2 of Group A Difference (Mean±SD)	T0-T2 of Group B Difference (Mean±SD)	Difference Between Group A and Group B (Mean±SD)	Un-Paired t	P Value	Significance
1.	SPL (mm)	1.5±.96	-.68±1.49	2.18±.53	4.92	.000	***
2.	SPT (mm)	-1.25±.77	.18±.65	-1.43±.12	5.67	.000	***
3.	SPI (°)	2.93±3.8	-.13±3.17	3.06±.63	2.47	.02	*
4.	DNP (mm)	-2.4±1.93	-.25±1.6	-2.15±.33	3.43	.002	**
5.	HNP (mm)	-2.62±3.24	.0±1.15	-2.62±2.09	3.04	.005	**
6.	DOP (mm)	-.43±1.86	.12±1.2	-.55±.66	.99	.32	NS
7.	DHP (mm)	-1.0±2.5	.12±1.2	-1.12±1.3	1.61	.12	NS
8.	TGL(mm)	2.12±3.05	-.18±1.3	2.3±1.75	2.77	.009	**
9.	TGH(mm)	-2.43±1.93	-1.2±1.2	-1.23±.73	2.16	.04	*
10.	HRGN (mm)	.16±3.9	.1±1.9	.06±2	.06	.06	NS
11.	C3H (mm)	-2.1±2.9	.37±1.6	-2.47±1.3	2.98	.005	**
12.	HH_1 (mm)	.68±3.04	-.81±1.2	1.49±1.84	1.82	.07	NS
13.	MPH (mm)	.75±2.7	1.18±2.6	-.43±.1	.45	.64	NS

***= p<0.05(statistically significant), ** = p<0.01(statistically highly significant), ***= p<0.001(statistically very highly significant, NS=Not significant.**

hyoid bone is attached to the mandible by geniohyoid, mylohyoid and the anterior belly of digastric muscle which are responsible for downward movement of the mandible, resulting in hyperactivity of these muscles. Therefore, the balance between the suprahyoid and infrahyoid muscle is disturbed, resulting in upward movement of hyoid bone, while forward and upward mandibular displacement occurs with Rapid maxillary expansion appliance treatment.[23] According to Phoenix et al[26]the hyoid bone to mandibular plane distance increased in non-RME subjects and decreased in patients treated with RME. RME treatment tends to normalize hyoid mode of correction for patients suffering from airway obstruction.

The results of the study should be viewed in lights of limitations. Cephalometric evaluation of pharyngeal airway dimensions and related soft tissue is a two-dimensional depiction of a three dimensional structure. Cone beam computed tomography(CBCT) and Magnetic resonance (MR) scans have also been used to provide three dimensional pharyngeal airway measurements, but they are expensive and expose patients to high radiation dose.

CONCLUSION

The following conclusions were drawn:

- The dimensions of the nasopharyngeal airways was increased significantly in treatment group when compared to Control group.
- Soft Palate length and Soft palate inclination decreased significantly and Soft palate thickness increased significantly following treatment by bonded RME.
- In Treatment group upward posture of the tongue was seen with forward and upward movement of the hyoid bone while in control group there wasn't any significant change.

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