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Rapid and slow maxillary expansion: a posteroanterior cephalometric study

ABSTRACT

Aim *The purpose of this study was to evaluate and compare the dental and orthopaedic effects of rapid and slow maxillary expansion in a sample of young patients with transversal maxillary deficiency by using a postero-anterior cephalometric analysis.*
Materials and methods *Two groups of patients were considered: 10 patients (3 males, 7 females) with an average age of 8.9 years were treated with a rapid maxillary expansor (RME); 10 patients (7 males, 3 females) with an average age of 12.2 years were treated with a new slow maxillary expansion appliance (ELA). Postero-anterior cephalometric analyses were made at the beginning of the therapy (T0) and at the end of expansion (T1) using a computerised cephalometric programme. Four parameters were measured: Nasal width, maxillary width, mandibular width, upper molars width.*
Results *Transversal average width increased 5.435 mm (SD 3.31 mm) between the upper molars in the RME group and 5.547 mm (SD 3.49 mm) in the SME group. Maxillary average width increased 4.254 mm in the first group and 2.845 mm in SME group.*
Discussion *An orthopaedic result was reached with both treatments. These results are in agreement with the orthodontic literature.*
Conclusions *This work confirms the effectiveness, efficiency and usefulness of this new ELA appliance in the correction of transversal deficiency with orthopaedic results, if used in growing patients.*

Keywords *Expansion; Interceptive orthodontics; Postero-anterior teleradiograph.*

Introduction

Interest in rapid maxillary expansion (RME) has increased remarkably during the past 2 decades. The correction of transverse discrepancies and the gain in arch perimeter with a non-extraction technique, appear to be the most important reasons underlying this increased interest. Although the major treatment effect is clinically apparent in in terms of teeth alignment, transverse enlargement of the apical bone or the skeletal structures may be considered as an additional result [Melsen, 1972]. Therefore cephalometric studies on posteroanterior (PA) radiographs are needed to quantify the possible changes induced by RME in the various regions of the facial skeleton [Shanker et al., 1996].

Transverse maxillary expansion can be slow or rapid. Rapid maxillary expansion (RME) is a mechanical procedure that utilises great forces and is designed to produce maximum skeletal response with minimum tooth movements [Westwood et al., 2003]. Maxillary expansion is the main treatment in cases of trasversal malocclusion with mono- or bilateral crossbite [McNamara Jr, 2000].

The purpose of this study was to evaluate, by means of PA cephalometric analyses, the dental and orthopaedic changes induced by two different methods of maxillary expansion: rapid expansion with the use of a RME appliance (Fig. 1), and with a new slow maxillary expansion appliance ELA (Fig. 2).

Materials and methods

The study included two groups of subjects: the first consisting of 10 patients (7 females, 3 males) aged between 6 years 8 months and 11 years 1 month, with unilateral crossbite in 6 cases and bilateral crossbite

FIG. 1 R.M.E. – Rapid Maxillary Expander.

FIG. 2 E.L.A.

in 4 cases, who underwent RME; the second group consisted of 10 patients (3 females, 7 males) aged between 8 years 2 months and 15 years 6 months, with a unilateral crossbite in 8 cases and bilateral in 2 cases, who were treated with an ELA appliance (Table 1).

The clinical protocol for the RME group entailed 2 activations of 0.25 mm per day until correction of the crossbite was acieved. The appliance was kept in place for an average of 6 months.

The activation protocol for the ELA included an initial activation followed by another after one month and the following four months to fully compress the spring steel, so that a continuous force can be effectively applied in order to obtain sufficient expansion for the correction of the cross bite. Then the ELA was used as a retainer appliance kept anchored to the first left and right upper molars for 8 months, for a total treatment time of 12 months.

The PA cephalometric radiographs were taken with the same device, whose focus was always at the same distance from the patient.

Cephalometric analyses (Ricketts technique) were performed by the same operator with a dedicated computer programme (OrisCeph ® Elite Computers - Milan, Italy) on the posteroanterior film.

The following landmarks and measurements were considered.

Skeletal landmarks:

- lateronasal (Ln), the most lateral point of the nasal cavity;
- maxillary (Mx), the point located at the depth of the concavity of the lateral maxillary contour, at the junction of the maxilla and the zygomatic process;
- antegonion (Ag), the point located at the antegonial notch.

Dental landmarks:

- upper molar (Um), the most prominent lateral point on the buccal surface of the upper first molar;
- lower molar (Lm) - the most prominent lateral point on the buccal surface of the lower first molar.

Additional measurements recorded at the beginning (T0) and at the end (T1) of treatment were:

- maxillary width;
- mandibular width;
- lateronasal width;
- maxillary first molar width.

These last four measurements and the average standard deviation in the sample (Table 2, 3, 4) were calculated; then the results of both groups were compared using the Student's t test (Table 5).

To evaluate the error method the Dahlberg's formula was used, repeating the 4 measurements in 5 patients at a distance of 1 week after the first measurement, obtaining a SD of 0.082 (critical value 0.25).

Results

From a clinical point of view, the cross bite was corrected in both groups, RME and ELA, centering the midlines with stable results.

Although the age difference between the two groups (Table 1) present a not entirely irrelevant significance from a clinical point of view, as shown in Table 5, where the two groups are compared (T for unpaired data), there is no statistical significance in differences in age and treatment times.

	T0	T1	T1-T0	M	F
RME	8y9m÷1y6m	9y3m÷1y6m	7m÷3m	30%	70%
ELA	12y2m÷2y4m	13y3m÷2y5m	10m÷1m	70%	30%

TABLE 1

TABLE 2 T0.

R.M.E.					E.L.A.			
Patient	Maxillary first molar width	Lateronasal width	Maxillary width	Mandibular width	Maxillary first molar width	Lateronasal width	Maxillary width	Mandibular width
1	40.7	18.54	43.51	59.71	50.37	25.47	52.49	65.97
2	46.42	23.75	50.5	61.33	43.48	16.03	44.84	55.82
3	50.04	25.2	56.19	72.44	46.46	16.23	47.55	67.07
4	40.93	19.59	45.94	61.76	45.16	23.82	51.44	68.97
5	53.66	24.02	57.93	73.84	47.47	24.94	48.03	65.47
6	44.42	19.6	52.72	68.36	46.47	21.49	53.73	71.45
7	43.46	14.4	47.69	59.32	41.24	23.92	45.2	66.48
8	44.62	17.73	49.61	66.21	47.93	20.7	53.1	73.32
9	43,12	21.46	50.06	68.11	44.27	25.04	53.17	74.28
10	39.38	18.44	47.36	65.12	48.81	20.79	53.12	68.72
Average	44.675	20.273	50.151	65.62	46.166	21.843	50.267	67.755
Sd	4.4018	3.3343	4.4682	5.1241	2.7027	3.4805	3.5026	5.1914

R.M.E.					E.L.A.			
Patient	Maxillary first molar width	Lateronasal width	Maxillary width	Mandibular width	Maxillary first molar width	Lateronasal width	Maxillary width	Mandibular width
1	54.02	25.7	57.68	73.72	53.13	25.77	52.6	67.32
2	55.67	28.25	54.51	66.5	47.86	18.39	50.22	57.19
3	54.47	25.4	58.02	72.74	50.83	18.32	48.76	67.17
4	43.19	23.49	47.82	64.78	49.17	23.99	51.74	69
5	57.38	24.02	61.41	75.06	50.79	24.95	48.73	67.49
6	47.75	19.71	57.47	68.58	58.59	22.11	59.57	76.04
7	47.61	20.44	50.01	65.19	49.3	26.48	51.25	69.73
8	49.47	21.11	52.37	68.26	56.88	23.7	60.04	77.71
9	47.41	21.49	54.36	66.55	51.54	26.18	55.01	76.85
10	44.14	20.2	50.3	67.45	49.04	23.11	53.2	68.72
Average	50.111	22.981	54.395	68.883	51.713	23.3	53.112	69.722
Sd	4.9566	2.8472	4.2939	3.6599	3.5267	2.9482	4.0198	6.0587

TABLE 3 T1.

R.M.E.					E.L.A.			
Patient	Maxillary first molar width	Lateronasal width	Maxillary width	Mandibular width	Maxillary first molar width	Lateronasal width	Maxillary width	Mandibular width
1	13.32	7.16	14.17	14.01	2.76	0.3	0.11	1.35
2	9.25	4.5	4.01	5.17	4.38	2.36	5.38	1.37
3	4.43	0.2	1.83	0.3	4.37	2.09	1.21	0.1
4	2.26	3.9	1.98	3.02	4.01	0.17	0.3	0.03
5	3.72	0	3.48	1.21	3.32	0.01	0.7	2.02
6	3.33	0.11	4.75	0.22	12.12	0.62	5.84	4.59
7	4.14	6.04	2.32	5.67	8.06	2.56	6.05	3.25
8	4.85	3.38	2.76	2.05	8.95	3	6.94	4.39
9	4.29	0.03	4.3	-1.56	7.27	1.14	1.84	2.57
10	4.76	1.76	2.94	2.33	0.23	2.32	0.08	0
Average	5.435	2.708	4.254	3.242	5.547	1.457	2.845	1.967
Sd	3.316227	2.676016	3.620614	4.38229	3.498819	1.12784	2.834785	1.719412

TABLE 4 T1-T0

T FOR DATA CONTROLS				
	Maxillary first molar width	Lateronasal width	Maxillary width	Mandibular width
START TX	0.375837	0.316649	0.949236	0.366909
	ns	ns	ns	ns
END TX	0.41704	0.808374	0.499169	0.713108
	ns	ns	ns	ns
T1-T0	0.942245	0.197933	0.346131	0.408922
	ns	ns	ns	ns

TABLE 5 Comparison between the two groups (T for data controls).

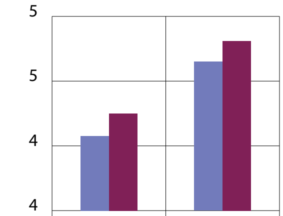
Figures 3 and 4 (maxillary first molar width, maxillary width) show the difference between the minimum values obtained with the two devices.

Discussion

The expansion treatment in patients with narrow bone base, can sometimes avoid the extraction of permanent teeth [Chang et al., 1997]. Thus, the comparison of dental or skeletal changes determined by the use of a rapid rather than a slow expansion appliance are useful data in planning an orthodontic treatment.

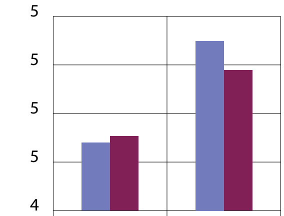
Our clinical results, obtained with RME and ELA, in growing patients are generally positive.

PA teleradiographs are an excellent method to assess the entity and proportion of the orthodontic and orthopaedic effects determined by RME and ELA in order to compare the respective results. As shown in Table 4, the orthodontic changes, appreciable by measuring maxillary first molar width, are 5.435 mm (SD 3.31 mm) in the RME group and 5.547 mm (SD



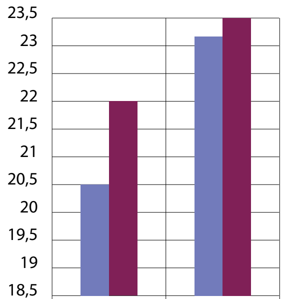
	T	T
R.M.E	44,67	50,11
E.L.A.	46,16	51,71

FIG. 3 Maxillary first molar width.



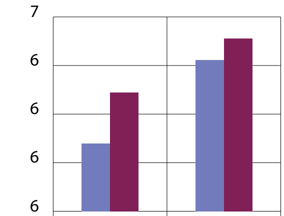
	T	T
R.M.E	50,15	54,39
E.L.A.	50,26	53,11

FIG. 4 Maxillary width.



	T0	T1
R.M.E	20,273	22,981
E.L.A.	21,843	23,3

FIG. 5 Lateronasal width.



	T	T
R.M.E	65,6	68,88
E.L.A.	67,75	69,72

FIG. 6 Mandibular width.

3.49 mm) in the ELA group. From an orthopaedic point of view, in the RME group maxillary width increased of 4.254 mm and in the ELA group of 2.845 mm, highlighting the effects of both orthopaedic devices, even if the ELA justifies the expansion for the dental buccal inclination of upper molars. These results are in agreement with those reported by other authors [Haas, 1980; Wertz, 1977; Krebs, 1964; Cameron, 2002 ; Baccetti et al., 1998]. The average mandibular width increase was 3.242 mm with the RME and 1.967 mm with the ELA. In the literature Lima et al. [2004] reported spontaneous mandibular increases after RME due to purely orthodontic changes.

The measurement of Nasal width, the average value was 2.708 mm in the RME group, while in the ELA group it was 1.457 mm. These results are consistent with those reported in the literature [Silva Filho et al., 1995; Haas, 1980; Krebs, 1964] showing a triangular jaw with the centre of rotation near the frontal maxillary suture. Krebs [1964] showed an increase in molar, maxillary and nasal cavity width after RME treatment.

Conclusion

The results of our research validate the effectiveness of ELA in the correction of transversal deficiency in growing patients. The advantages of this device are ease of use, unnecessary compliance from the patient and the possibility of obtaining a predominant bodily tooth movement with the use of predetermined and constant forces. The effects are similar to those reached with the RME both clinically and radiographically, therefore it can be a good therapeutic option in the case of poor patient compliance or conditions that prevent the use of RME.

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