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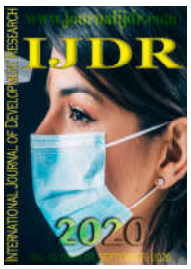

RESEARCH ARTICLE OPEN ACCESS

COMPARATIVE STUDY OF THE ACTIVATORS AND PREFABRICATED FUNCTIONAL APPLIANCES EFFECTS IN INTERCEPTIVE TREATMENT OF CLASS II

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ABSTRACT

The effectiveness of growth activators and functional prefabricated appliances in improving class II and reducing over jet and overbite was proved. However, their dento-skeletel effects have long been controverted. We have proposed to compare, through a prospective clinical study, the skeletal and dento-alveolar effects of growth activators and functional prefabricated appliances and to propose therapeutic guidelines on the choice of the best device according to clinical situations. **Materials and methods**: It is a prospective clinical study of 37 patients with skeletal and dental class II; 20 treated by Andersen activators and 17 by functional prefabricated appliances. Clinical and cephalometric parameters were collected through clinical and radiological examination and statistical analysis was conducted. **Results**: The results of this study showed that statistically the moderation of the skeletal class II obtained by the effect of the activator is similar to that obtained by the prefabricated functional appliances and it is the result of skeletal action. No statistically significant difference was found in terms of overjet and overbite reduction and improvement of the inter-maxillary relationship. **Conclusion**: This study shows that the two appliances are effective in skeletal class II correction and overjet reduction with more important action of activators in promoting mandibular growth.

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INTRODUCTION

The skeletal class II represents the most frequent skeletal discrepancy revealed in orthodontic consultation. There are several therapeutic approaches depending on: the characteristics of class II, the patient's bone age, his cooperation, but also according to the practitioner's concept and training (12). In terms of dento-facial orthopedics, for class II correction, we can use different approaches: either orthopedic growth devices, or traditional functional devices. Orthopedic devices correspond to activators, rigid monoblocks (associated or not with extra-oral forces), or elastic like the Herbst appliance. The classic functional devices like functional regulators of Frankel, lip bumpers, nocturnal lingual envelopes and plates with lapping tracks of Planas are used mainly for cases of class II caused by functional etiology (swallowing, chewing ...) with a low skeletal shift. More recently, other devices have been developed based on the main appliance described in the '50s by Soulet and Besombes (13). Indeed, functional educators stimulate chewing, facial muscles, and more, reeducate the posture of the tongue and bring the cranio-mandibular system into a position of physiological balance. The enthusiasm of orthodontists for these devices from Australian, Finnish and French originshas been more marked for the past fifteen years. Several brands are on the market, including Orthoplus®, MRC® (Myofunctionnal Research Co.) and RMO® (Rocky Mountain Orthodontics). These adaptable devices, of the flexible appliance type, in silicone or polyurethane, incorporate various types. They are

chosen according to the treatment objectives and according to age, malocclusion as well as the size of the arches.

Regardless of the brand, most devices include:

- A molar elevation which allows torelaxthe condylesand to increase mandibular growth,
- Silicone pins at the level of the bumper which reinforce its action,
- Longer or shorter mouth screens,
- Accuform arch shape, to keep lips and cheeks apart,
- A maxillo-mandibular indentation, variable according to the models and according to the age. It corrects the environments, maintains the spaces in eruption phase and guides the final teeth.
- A lingual ramp common to all devices allows the placement of the tongue against the palate with each swallowing. This passive rehabilitation trains the patient to place his tongue correctly and contributes to the transverse development of the palate (13-14).

The effectiveness of functional educators is well established.

Thus, the prospective study of KatriKaski-Nisula et al. **(8)** described a significant increase in the length of the mandible, allowing a class II correction. A second prospective study conducted by KatriKaski-Nisula et al. (**7**), on 271 children with the same age averages revealed,as the previous study,that the use of an eruption guide at the start of mixed dentition is an effective means to treat class II malocclusions, with significant overjet, deep or open bite, or crowding. However, the skeletal, dento-alveolar and cutaneous effects of this appliance have been controversial. To assess these effects, we performed a comparative study between class II activators and functional educators.

MATERIALS AND METHODS

We propose, through a prospective clinical study, to analyze the skeletal and dento-alveolar effects of two class II interceptive treatment modalities: growth activators and functional educators, to compare the results obtained by these two devices and to offer treatment guidelines for the choice of the best device depending on the clinical situation.

Type of study: This is a cohort study also called a "follow-up study": it is a prospective clinical study carried out on two groups of children with skeletal and dental Class II.

Selection criteria: There were included in this study only growing patients, presenting a class II malocclusion, having no craniofacial syndrome, no aplasia, no extraction of permanent teeth, no previous orthodontic treatment, patients and parents motivated and offering a possibility of follow-up.

Description of the study: The different groups were observed and treated by residents in the dento-facial orthopedic department of the dental clinic of Monastir and the military hospital of instruction of Tunis, for a period of 21 months ranging from January 2017 until September 2018.

- Group G1, made up of 20 children who have been treated with Andresen-type growth activators.
- The G2 group, made up of 17 children who have benefited from orthopedic treatment by prefabricated functional educators from the EF line range fromOrthoplus® company.

The groups of treated cases were selected at random and were chosen regardless of results.

Study protocol: After explaining the study protocol to the parents and having them sign an informed consent, each patient benefited from:

- A clinical examination at the start of treatment (T1) and another one at the end of treatment (T2).
- Two lateral cephalograms with 1/1 scale performed before (T1) and after (T2) the interceptive treatment. The same operator performed cephalometric tracingsin order to avoid variations of interpretation.
- Extra-oral and intra-oral photographs taken before (T1) and after (T2) treatment.
- Maxillary and mandibular impressions before (T1) and after (T2) treatment from which casts were made (Figure 1).

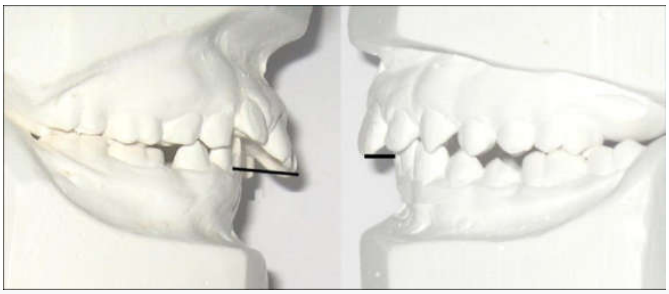

Figure 1. Plaster models showing the decrease in overjet between T1 and T2 in a patient treated with Andresen activator

For each child, the information collected from the clinical examination, dental casts and cephalometric analysis were analyzed and reported on a clinical sheet.

These parameters are divided into 6 groups:

- Clinical: cutaneous, occlusal and functional.
- Cephalometric: cutaneous, skeletal and dento-alveolar.

Skin clinical parameters

Clinical parameters studied are:

- Inter-narinal distance: distance between the wings of the nose measured with a caliper
- Nasogenous grooves: can be normal, erased or marked, clinically estimated or from front view photos.
- Nasolabial angle: angle formed between the columella and the upper lip, clinically estimated on the patient or from the profile view photos, can be normal open or closed.
- Labiomental groove: clinically estimated or on profile photos, may be normal, marked or erased.
- Cervico-chin distance: estimated clinically or on profile view photos.

Occlusal clinical parameters

The following occlusal parameters were noted:

- The canine and molar angle class:
- Overjet: the distance in mm, between the free edge of the upper central incisor and the buccal surface of the lower incisor.
- Overbite: The overlap of the lower incisors by the upper incisors in vertical direction.
- Inter-canine distance: Measured on the casts by positioning the caliper parallel to the occlusal plane placed on the top of the cusp tip of the right and left canines.
- Inter-premolar distance: Measured on the casts in the same way with the points placed on the top of the buccal cuspsof the second right and left premolar.
- Inter-molar distance: The same principle applies with the points placed on the top of the mesio-buccal cusps of the right and left first molars.

Cutaneous cephalometric parameters

Z Angle: is the angle formed by the skin pogonion line - the most protrusive lip and the Frankfurt plane measured from the cephalometric tracing.

Skeletal cephalometric parameters

- **The SNA angle**: determines the sagittal position of the maxilla in relation to the anterior part of the base of the skull.
- **The SNB angle**: defines the sagittal position of the mandible related to the anterior part of the base of the skull.
- **The ANB angle**: measures the maxillo-mandibular sagittal shift.
- **The AoBo distance:** in order to determine the sagittal shift between Ao and Bo, which respectively represent the orthogonal projections of points A and B on the occlusion plane.
- **FMA angle:** formed by the Frankfurt plane and the mandibular plane and it expresses the vertical relationships of the mandible in relation to the base of the skull.
- **The gonial angle**: angle formed by a tangent to the rising branch and a tangent to the horizontal branch, it expresses the degree of rotation of the mandible.
- **GoGn / SN Angle**:determined between the SN line and the GoGn line (Steiner mandibular plane).

Dento-alveolar cephalometric parameters

- **Occlusal plane**: determined between the middle of the incisal overlap and the middle of the molar overlap
- **I/F angle**: formed by the axis of the upper incisor and the Frankfurt plane and expresses the inclination of the upper incisor.
- **I/NA angle:** between the upper incisor axis and the NA line.
- **I / i angle** between the two major axes of the upper and lower incisors.
- **i / NB**: the angle between the lower incisor axis and the NB line.
- **IMPA**: angle formed by the axis of the lower incisor and the mandibular plane and expresses the inclination of the lower incisor
- **FMIA**: angle formed by the Frankfurt plane and the axis of the lower incisor.
- **αAngle:** angle formed by the axis of the upper molar and the occlusion plane, if it increases it expresses a mesial tipping of the upper molar.
- **β Angle**: angle formed by the axis of the lower molar and the occlusion plane, if it increases it expresses a mesial tipping of the lower molar (Figure 2).

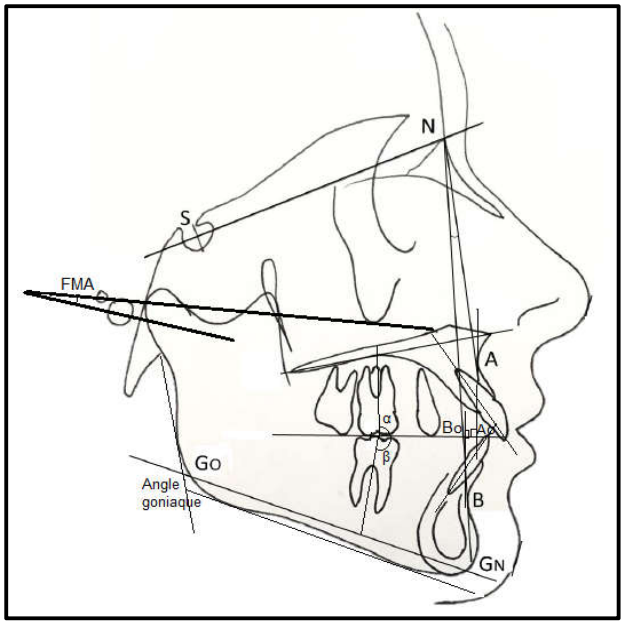

Figure 2. Cephalometric trace

Statistical analysis:

The values of the various variables were entered in data tables, then processed in Microsoft® Excel. The information was analyzed using SPSS (Statistical Package for the Social Sciences) version 22 software. The normality of the quantitative variables was tested by the Shapiro-Wilk test. For those which follow a normal distribution, the correlation between the variables before and after treatment was determined by the student's t test and by testof Wilcoxon for the other quantitative variables. The chi-square test was used for the qualitative variables. The confidence interval was set at 95% so the difference is considered significant if $p < 0.05$.

RESULTS

Bivariate analysis

In order to determine the statistically significant differences between the moments T1 and T2.

- For qualitative variables: the chi-square test was used.
- For quantitative variables: the student's t test and the Wilcoxon test were used (Table 1). The difference is considered significant if $p < 0.05$.

Table 1. Bivariate analysis of the two groups

	Variables	p Value of G1	p Value of G2
	nasolabialAngleT1-T2	.087	.028
Skin and Occlusal clinical parameters	Naso-genous grooves T1-T2	.014	.863
	Nasolabial angle T1-T2	.494	.460
	Cervico-chin distance T1-T2	.000	.026
	Molaire ClasseT1-T2	.019	.582
	Overjet T1-T2	.000	.000
	Overbite T1-T2	.011	.020
	Maxillary inter-canines distance T1-T2	.000	.002
	lower inter-canines distance T1-T2	.015	.045
	Upper inter-premolarsDistance T1-T2	.000	.010
	Lower inter-premolarsDistance T1-T2	.004	.001
	Upper inter-molars distance T1-T2	.012	.013
	Lower inter-molars distance T1-T2	.017	.001
Cutaneous cephalometric parameters	Z T1-T2	.221	.974
Skeletal cephalometric parameters	SNA T1-T2	.197	.053
	SNB T1-T2	.006	.393
	ANB T1-T2	.001	.001
	AoBo T1-T2	.003	.008
	FMA T1-T2	.447	.393
	goniacAngle T1-T2	.003	.778
	GoGn/SN T1-T2	.046	.097
	Inclination of occlusal plane T1-T2	.711	.129
Dento-alveolar cephalometric parameters	I/F T1-T2	.199	.451
	I/NA T1-T2	.107	.231
	i/NB T1-T2	.003	.925
	I/iT1-T2	.178	.535
	IMPA T1-T2	.873	.823
	FMIA T1-T2	.103	.140

Table 2. Results of the multivariate analysis

	ß	Wald	Ddl	Sig	Exp(ß)	IC 95% Exp(ß)	
						Inf	sup
Overjet	-0.879	7.064	1	0.008	0.415	0.217	0.794
I/F	-0.167	4.295	1	0.038	0.846	0.723	0.991
constant	25.944	6.435	1	0.011	185138467243.586		

Multivariate analysis: A multivariate approach to all the parameters studied (clinical and cephalometric) was developed. Variables with p values <0.05 in the bivariate analysis were included in the multivariate regression model. The variables selected were overjet and I / F. These parameters, as well as a calculated constant (Table 2), led to the following equation which provides the practitioner with a score or a test to decide whether the case will be treated by activator or by educator.

Score : 25.944 – (0.879* Overjet) – (0.167* I/F).

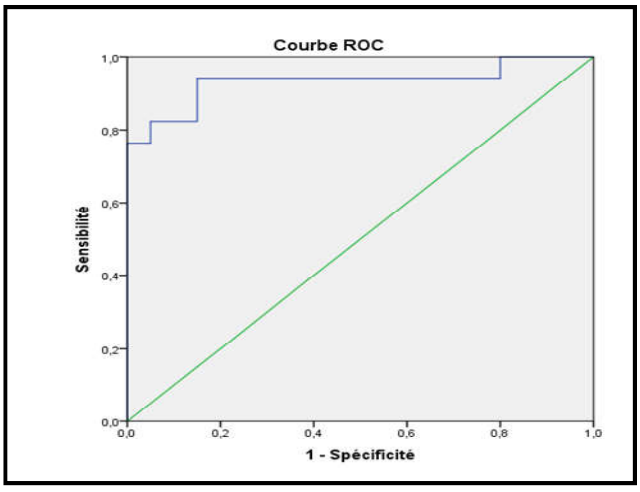

Figure 3. Détermination de la spécificité et de la sensibilité du score selon la courbe Roc

The critical score was 0.18 obtained from the ROC curve. Each new case which will present a score higher than the critical score will probably be treated by activator, on the other hand a lower score will lead us rather towards treatment by educator. The sensitivity of the test is 89% and its specificity 83%. The area under the ROC curve is 0.932> 0.9, indicating that the sensitivity and specificity we get from our equation are favorable. The application of this test on the sample made it possible to establish the percentages for each group (Table 3) which verifies for each patient if the appropriate interceptor device was chosen.

Table 3: Classification of patients included in the study

Observations		Forecasts		
		group		Percentage
		G1	G2	
Groups	G1	17	3	85
	G2	2	15	88.2
GlobalPercentage				86.5

According to the results obtained, 17 cases of the Activators group were well classified according to the formula (85% of cases). Likewise, for the Educators group, 15 patients were well classified with a percentage of 88.2%.

DISCUSSION

Skin clinical parameters: According to the present study, the two devices allowed an increase in the internarinal distance and the cervico-chin distance with a slight superiority of effect

for the activator, especially in the increase ofthe cervico-chin distance, which indicates an elongation of the mandible with a slightly greater mandibular advancement, confirmed by the analysis of cephalometric parameters. In the same context, the educator contributed to the improvement of skin profile by preventing the worsening of the nasolabial angle's closure. By this, these two modalities of class II malocclusions interceptive treatmentmeet the aesthetic demands of patients.

Skeletal cephalometric parameters: For the activator group, the moderation of skeletal shift marked by the decrease in the ANB angle and the AoBo measurement is done by an increase in the SNB angle. It shows a movement forward ofB point and subsequently a mandibular advancement. Those findings are in agreement with what is reported by the majority of studies (4, 5, 14). These results can be explained by the fact that in addition to the design and the rigidity of the device, which forces the mandible towards a position of propulsion, the average age of patients treated with activators, is close to the growth peak favoring more forward growth of the mandible. Over time, and following treatment by a prefabricated functional educator, this moderation is due to a decrease in the SNA angle andsignifies a retreat ofA point.

According to some studies (9, 2, 3), the anterior facial height manifests an increase following interceptive treatment, mainly with an activator, hence its contraindication for the openbite patients. In our study, the analysis of FMA,GoGn/SN and gonial angle valuesshowed some stability, especially for the G1 group. This may be for the reason that in the present study the educator did not really have a remarkable effect on the mandible.Actually, for the patients treated with activator, changes in facial height are marked by changes due to natural growth, which tends to reduce the anterior facial height of the lower level by anterior rotation of the mandible. This fact outweighs the effect of the activator because of the relatively short duration of treatment (8 months) and probably if this was elongated to reach a year or more as in some studies (10, 11) one would notice a posterior rotation of the mandible.

From these findings, we can therefore say that the skeletal changes essentially boil down to encouraging mandibular growth by the activator and preventing the worsening of maxillary prognathy by the educator.

Dentoalveolar cephalometric parameters

The dentoalveolar parameters did not undergo significant changes in a similar way for the two groups.

On the contrary to what the study by Usha Mohan Das et al (6) reports, neither in the group treated with an educator nor the one treated with an activator, there is a change in the occlusion plane. They also describe an increase in the proclination of the mandibular incisor and a retroversion of the upper one. However,in our study the values of angles IMPA, FMIA, I/F, α and ß did not undergo any significant modifications.Therefore, we can say that these devices, and thanks to their design (the double splint, the indentations and the return of resin on the vestibular surfaces of lower incisors) ensure good control of dental axes. They do not enter into significant side effects of vestibulo-version of the lower incisors nor of palato version of the upper incisors or tilting of the occlusal plane. Hence, the reduction of the overjet is not the result of dentoalveolar compensation.

In the literature, we have not found enough studies similar to our study which compares the dento-skeletal effects of activators and educators and which provides guidelines for the selection of appropriate cases for each treatment. We encountered studies that rather quantify reduction in overjet, improvement in skeletal shift and molar relationship after specific treatment. The literature is limited to suggesting factors that play an important role in treatment with the interceptor system. These factors include patient motivation, facial growth, overjet, overbite, incisor angulation, importance of Class II and tooth alignment (1-3).

Conclusion

Our study made it possible to compare the effects of each device and to draw the following conclusions:

- The two devices allowed a reduction of the overjet, of the overbite, to improve the inter-maxillary relation, a transverse expansion of the arches and modifications on the cutaneous plan comparable to the other therapeutic means cited by the various studies of the literature.
- The moderation of the skeletal shift obtained by the effect of the activator is similar to that obtained by the functional educator and it is the result of a skeletal action.
- The educator prevented the worsening of the maxillary protrusion while the activator encouraged mandibular growth and will better control the correction of the molar class.

Conflict of Interest: The authors declare that they have no conflict of interest in this work.

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