Effectiveness of Treatment with Reverse Twin-Block and Reverse Pull Face Mask on Dental Arches of Class III Malocclusion: A Randomized Clinical Trial

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Abstract

The dental arches undergo visible alterations after orthodontic treatment. It was indicated that significant variation was observed between dentitions in the arch width as well as arch depth.

The aim of this study is comparing the dental arch change after treatment with reverse twin block and reverse pull face mask appliances on dental study model measurements of Class III malocclusion.

A prospective clinical trial consisted of a total of 97 Class III malocclusion Malay children aged from 8 to 11 years enrolled in two treatment groups. The reverse twin block appliance group, which consists of 49 subjects and reverse pull face mask group, consists of 48 subjects. The duration of the treatment period 0.68 (SD=0.25) months. Upper and lower impressions are taken at the beginning and end of treatment. Multiple regressions used to analyze the data. The significance level set at 0.05.

There was showed no significant differences in dental arches change between reverse twin block appliance and reverse pull face mask appliance except for variable Upper arch depth change (UADC) which was showed significant difference and increased in reverse pull face mask appliance group than reverse twin block appliance group (P <0.001).

Both appliances did not affect the inter-teeth distances, except for reverse pull face mask appliance, which increased upper dental arch length.

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Introduction

The options to date for the correction of Class III malocclusions fall into three categories, the first being growth modification. The second option being orthognathic surgery and the third option being camouflage treatment by changing the inclination of maxillary and/or mandibular incisor by using fixed appliances therapy[1].

In growing children, growth modifications by reverse-pull face mask[2,3], chin-cup[4,5], Functional regulator (FR-3) of Fränkel appliance[6] have all widely used for the treatment of Class III malocclusion.

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Reverse pull face mask appliance is one of the management approaches for orthopedic treatment in Class III malocclusion. The early treatment with a reverse pull face mask appliance of Class III malocclusion patients with maxillary deficiency, forward maxillary growth would be a good treatment result and at the same time as in the case of a prognathic mandible, redirecting the anteroposterior growth of the mandible would be the ideal aim of treatment[7].

Functional appliances are considered to be primarily orthopedic tools to influence the facial skeleton of the growing child in the condylar and sutural areas. However, these appliances also exert effects on the dentoalveolar area. The uniqueness of functional appliances lies in their mode of the force application. They do not act on the teeth in a similar manner to other removable appliances, which use mechanical elements such as springs,

elastics, or ligatures, but rather transmit, eliminate and guide natural forces (e.g., muscle activity, growth, tooth eruption)[8].

Early treatment allows the maxillary arch to advance forward as much as possible, to improve occlusal relations, and to obtain improved facial esthetics and a more normal psychosocial development[9,10,3,11,12]. Whenever a jaw discrepancy exists, the ideal solution is to correct it by modifying the child's facial growth. Bishara[13] found that craniofacial changes take place in the periods of 5 to10 years and 10 to 15 years are more significant than in the period of 15 and 25 years. However, it is not clearly understood whether craniofacial changes due to growth modification influenced by appliances would vary between early mixed dentition stage and late mixed dentition stage[14,15,16].

So far, there has not been any randomized clinical trial on Class III malocclusion in Malay. Therefore, this study designed to compare the dental arch change after treatment with reverse twin block and reverse-pull face mask appliances based on dental study model measurements of Class III malocclusion.

Materials and methods

Subjects

This study is a prospective clinical trial consisted of 97 subjects followed prospectively, aged from 8 to 11 years enrolled in two treatment groups. The reverse twin block appliance group, which consists of 49 subjects and a reverse-pull face mask group, consists of 48 subjects.
Informed consent was taken from the parents and patients before starting the treatment. The duration of the treatment period was 0.68 (SD=0.25) months. Upper and lower impressions were taken at the beginning and end of treatment. Multiple regressions were used to analyze the data. The significance level was set at 0.05. This study was approved by the Research and Ethics Committee.

The inclusion criteria for sample selection were reverse overjet and Class III deciduous canine relationship and/or Class III molar relationship. Children with craniofacial anomalies, previous orthodontic treatment, and history of facial trauma were excluded from the study.

Reverse twin block appliance

Reverse twin block appliance developed by Clark[17] was used in this study. The position of bite blocks was reversed compared to twin blocks for Class II treatment. The appliance consisted of maxillary and mandibular removable appliances retained by 0.7 mm stainless steel Adams clasps on the first permanent molars and first permanent premolar or first deciduous molar when the premolar has not yet erupted. For the lower appliance, three 0.9 mm ball clasps were also placed in the mandibular incisors inter-proximal areas. The lower acrylic bite blocks were designed to cover the lower molars, while the upper acrylic bite blocks overlaid the upper first permanent premolars or first deciduous molar and the upper second deciduous molars. The design does not incorporate a labial bow (Figure 1 and 2).

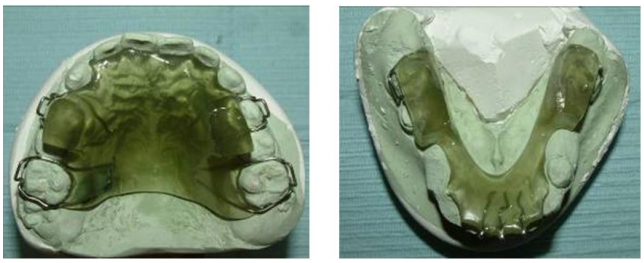

Figure 1. Upper and lower reverse twin block appliance.

Figure 2. Intra-oral photographs of reverse twin block appliance.

Construction of bite registration for twin block appliance

The bite registration was taken with maximum retrusion and 6 mm separation in the buccal segments. A wood tongue depressor stick was used for bite registration to provide separation between upper and lower buccal segments. It provides a suitable 6mm vertical height for the acrylic bite blocks in the buccal segments. The patient was asked to bite on a retruded position as possible.

Fitting reverse twin block appliance for treatment group

The appliance was checked in the mouth, and any needed adjustment was carried out. Each patient was asked to remove and insert the appliance in the mouth in front of a mirror at least

twice before leaving the clinic. Patients were taught how to differentiate between the upper and the lower appliance in order to avoid any unsuccessful trial during appliance fitting in the mouth. This was carried out to ensure that the patients were able to remove it for cleaning and wear it again in the correct way.

During the first few days of wearing the appliance, patients are advised to wear the appliance in front of a mirror to assist him or her where to insert the appliance in the proper place. In the meantime, the parents were also taught to assist their son or daughter to wear the appliance. The patient was asked to wear the appliance for 24 hours/day, including during eating except during tooth brushing, contact sports, and swimming. The patient was asked to attend the clinic every four weeks to ensure that there is intimate contact between the upper distal surface and lower mesial surface, and if not in contact, acrylic was added to reactivate the appliance. Treatment improvement was evaluated by checking the overjet and overbite during the visit.

Treatment progress

An adjustable reverse-pull face mask(Figure 5) (Leone, Italy) was fitted with elastics that delivered approximately 400 g of force on each side. The components of orthopedic face mask therapy included a face mask, a banded maxillary acrylic splint with vestibular hooks, and heavy elastics. Full coverage banded acrylic cap splint type appliance that covered all the maxillary dentition was constructed. The thickness of the acrylic was about 2 to 3 mm of acrylic was constructed on the occlusal and buccal surfaces of the teeth. The acrylic occlusal pads served to control the vertical dimension. Bands fitted to the two permanent maxillary first molars and two deciduous maxillary first molars.

Treatment began with the placement of a banded maxillary acrylic splint to which were attached maxillary vestibular hooks extending anteriorly. These hocks were made from a 1.0 mm wire was attached bilaterally to the buccal aspects of the molar bands and extended anteriorly and superior direction to the canine area.

The direction of elastic traction was forward and downward from the hooks attached to the crossbar of the face mask so that the elastics did not interfere with the function of the lips. Elastics were attached from the hooks to the support bar of the facemask in a downward and forward vector, producing orthopedic force levels of approximately 400 g per side (as measured by a gauge) (Figure 3, 4).

Figure 3. Intra-oral appliance.

Figure 4. Measuring gauge.

Figure 5. Reverse pull face mask.

Patients were instructed to wear the facemask for at least 14 hours per day. Traction was continued for eight months until sufficient clinical movement of the maxilla had been achieved to improve the midface esthetics. Standardized lateral cephalograms were taken at the beginning of treatment at the end of active facemask treatment.

The study models were labeled with the patient's name and registration number. Two-dimensional digital images of the dental cast were obtained using a flat-bed scanner (EPSON GT-1500) at 300 dpi in 24-bit color. During scanning, the study models were placed on the scanner glass plate such that as many of the incisal occlusal edges contact the scanner glass plate as possible. The dental casts were scanned from lingual or palatal to the facial. This provides a sharper edge to the biting surfaces of the teeth. The maxillary and mandibular dental casts were placed on a graphic paper within a square.

The images of the maxillary and mandibular dental casts were processed by the data digitizer, an auxiliary program of the MorphoStudio software. After importing the images into the digitizer program, the images were scaled by marking the superior, inferior, left, and right directions for all maxillary and mandibular dental cast images, which act as a standardized calibration scale.

The MorphoStudio software receives the file according to a specific format, which is the text file. The MorphStudio data can be saved into an MFS (MorphoStudio) document file that can be read later. The model images were analyzed using the MorphoStudio v 3.01 software. This software analyses any 2D or 3D specimens from a morphometric point of view. With MorphoStudio, a single specimen or group of specimens can be superimposed in order to obtain a mean specimen after translation, rotation, and scaling of homologous landmarks.

Finite element analysis is a method of comparison between forms. Using MorphoStudio v 3.01 software, FEA can be used to determine changes in the shape of configurations based upon triangles. FEA is a method for comparison of a reference form representing the initial configuration of a set of landmarks on an object and a target form representing the final configuration of the same set of landmarks on another object. FEA uses a pseudocolor scale to visualize any change in shape and to determine if these changes are increased or decreased (Figure 6). The color value of the pseudocolor scale represents the amount of change, where the value ≈ 1 means the insignificant difference between both groups, the value <1 indicates decreased in shape, and the value >1 indicates increased in shape.

VixWin PRO software (Italy) has been used to measure arch depth of maxillary and mandibular dental casts instead of MorphoStudio software because the MorphoStudio software cannot measure arch depth.

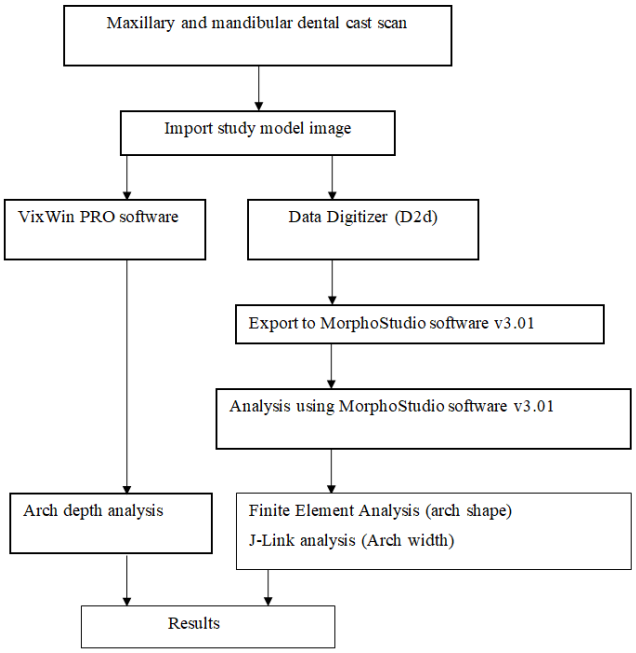

Figure 6. Flow chart for study dental casts.

Study errors

To determine errors associated with cephalometric tracings and measurements, lateral cephalometric x-rays randomly selected and measured. After two weeks the same measurements were repeated. The differences between repeated measurements were tested using a paired *t* test. The degree of reproducibility of measurements was calculated using intraclass correlation coefficient (ICC).

Statistical Analysis

The data were entered and analyzed with Statistical Package for the Social Sciences (SPSS, Chicago, Illinois, USA). Before analyses, the data were checked for any errors in data entry. Each variable was checked for maximum and minimum values to ensure that all numbers were correct and within the normal value of each variable. Both categorical and numerical

variables were checked for any outliers. This was to ensure that the differences were due to biological differences and not due to errors in data entry. Multiple regression analysis was used to evaluate the relationship between age and sex on the skeletal change, and dental arches change after treatment with reverse pull face mask appliance. The level of significance was set at 0.05.

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Results

Multiple linear regression analyses showed no significant differences in dental arches change between reverse twin block appliance and reverse pull face mask appliance except for variable UADC which was showed significant difference and increased in reverse pull face mask appliance group than reverse twin block appliance group (P <0.001) (Table 1).

Measurement Change (Dependent)	Predictors	Adj.b[a]	95%CI		t-stat.	P value
			Lower bound	Upper bound		
UICWC (mm)	UICW (mm)	-0.015	-0.062	0.032	-0.640	0.524
	Appliance	0.158	-0.038	0.353	1.599	0.113
	Sex	0.108	-0.096	0.312	1.051	0.296
	Age	-0.129	-0.338	0.080	-1.225	0.224
UIMWC (mm)	UIMW (mm)	-0.023	-0.064	0.018	-1.109	0.270
	Appliance	-0.020	-0.223	0.183	-0.197	0.845
	Sex	0.045	-0.173	0.263	0.412	0.681
	Age	-0.116	-0.086	0.317	1.140	0.257
UADC (mm)	UAD (mm)	-0.038	-0.102	0.027	-1.154	0.252
	Appliance	0.571	0.283	0.860	3.932	<0.001
	Sex	-0.214	-0.520	0.093	-1.386	0.169
	Age	0.119	-0.195	0.432	0.750	0.455
LICWC (mm)	LICW (mm)	0.003	-0.050	0.057	0.127	0.899
	Appliance	0.053	-0.141	0.247	0.541	0.590
	Sex	0.111	-0.094	0.317	1.074	0.285
	Age	-0.011	-0.205	0.183	-0.112	0.911
LIMWC (mm)	LIMW (mm)	0.032	-0.003	0.067	1.810	0.074
	Appliance	0.202	-0.002	0.406	1.967	0.052
	Sex	-0.051	-0.262	0.159	1.484	0.630
	Age	-0.085	-0.289	0.119	-0.828	0.410
LADC(mm)	LAD(mm)	-0.031	-0.070	0.007	-1.623	0.108
	Appliance	-0.120	-0.033	0.272	1.560	0.122
	Sex	0.120	-0.168	0.138	-0194	0.847
	Age	0.094	-0.060	0.248	1.211	0.229

Table 1. Comparison of dental arches changes after treatment with reverse twin block and reverse pull face mask appliances.

[a]Adjusted regression coefficient

n=97

Upper inter-canine width (UICW), Upper inter-molar width (UIMW), Upper arch depth (UAD), Lower inter-canine width (LICW), Lower inter-molar width (LIMW), Lower arch depth (LAD), Upper inter-canine width change (UICWC), Upper inter-molar width change (UIMWC), Upper arch depth change (UADC), Lower inter-canine width change (LICWC), Lower inter-molar width change (LIMWC), Lower arch depth change (LADC)

Discussion

The results of the study indicate that both appliances are effective in inducing arch shape changes during the treatment of Class III malocclusion. FEA results indicated non-homogenous shape changes for both arches in early and late mixed dentition stages between the male and female groups. In the design of the appliance, no maxillary expansion screw was incorporated in both appliances in order to determine the effect of these appliances on the dental arch. This is supported by Taner *et al.*[18], who reported that orthodontic treatment stimulates maxillary arch shape changes and mandibular arch shape changes in Class II malocclusion treated with headgear without palatal expansion.

The results of the present study showed that both appliances did not produce any changes in the inter-teeth distances of maxillary and mandibular dental arches, except for the increase in the length of the upper dental arch in reverse pull face mask group. This demonstrated that the forward protraction of the maxilla with a reverse pull face mask appliance induced elongation of arch depth due to anterior forward protraction in Class III malocclusion. Kirjavainen *et al.*[19] reported that headgear appliance in Class II malocclusion stimulated an increase in maxillary inter-canine and inter-molar distances. In consideration of the different mechanisms for a reverse-pull face mask in Class III malocclusion and headgear in Class II malocclusion, it was obvious that reverse-pull face mask can increase arch depth in Class III malocclusion due to extra-oral traction.

The results of the study showed that reverse twin block functional appliance does not induce size changes in the upper and lower arches. However, previous studies using the Fränkel functional appliance for the treatment of Class III malocclusion demonstrated changes in the size of the upper and lower arches[20,21,22,6].

The increases in the maxilla and mandibular arch width in the Fränkel functional appliance studies were due to the appliance design. However, all changes in dental arch dimensions must be due to dental changes and not skeletal changes due to the tipping movement of the teeth. Moreover, these studies report that FR-3 encouraged backward and downward rotation of the mandible through small forward growth stimulation on the maxilla, whereas the dentoalveolar effects were mainly due to the linguoversion of the mandibular incisors. Also, they found that the FR-3 appliance

did not affect the ANB angle. On the other hand, a major essential matter that should be taken into account is that the authors compared changes among treated and untreated groups. It would have been more appropriate if the authors compared between different types of functional appliances. In addition, the appliance does not create any effects on the maxilla.

Conclusions

Treatment with Reverse Twin-Block and Reverse Pull Face Mask appliances did not affect the inter-teeth distances, except for reverse pull face mask appliance, which increased upper dental arch length.

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Declaration of Interest

The authors report no conflict of interest.

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