The Relationship Between Sex and Age on Dental Arch Change in the Reverse Twin Block Appliance on Dental Study Model Measurements: A Randomized Clinical Trial

Osama Bahaa Albajalan[1]*, Nawres Oraibi Alazzawi[2], Nor Ashikeen Mukti[1], A.R. Samsudin[3]

1. Department of Pre-Clinical, International Medical School, Management & Science University, Shah Alam, Selangor, Malaysia.
2. Abu Ghuraib general hospital. Baghdad, Iraq.
3. Department of Oral and Craniofacial Health Sciences, College of Dentistry, University of Sharjah, United Arab Emirates.

Abstract

The human craniofacial skeleton and its associated dental arches undergo visible alterations as they grow. Relatively rapid changes take place during the transitional dentition in the dental arches. The purpose was to evaluate the relationship between sex and age on dental arch change in the reverse twin block appliance on dental study model measurements.This study is a randomized clinical trial consisted of 49 (22 males, 27 females) Malay children with Class III malocclusion were allocated to two groups.The first group which consist of 23 subjects (10 males, 13 females) treated in the early mixed dentition with mean age of was 8.43 (SD=0.20) years and late-treatment group included 26 subjects (12 males, 14 females) treated in the late mixed dentition with mean age of was 10.45 (SD=0.29) years. Upper and lower impressions were taken at the beginning and end of treatment. Multiple regressions were used to analyse the data. Significance level was set at 0.05.

There is no relationship between age and sex affecting the dentoskeletal changes after treatment with reverse twin block appliance. Assessment of post treatment study models showed that both appliances changed the maxillary and mandibular dental arch shape but do not affect the inter-teeth distances.

There are no effects of sex and age on dental arch change measurements after treatment with Reverse Twin Block appliance for the treatment of Class III malocclusion.

Clinical article (J Int Dent Med Res 2020; 13(1): 229-235)

Keywords: Class III malocclusion, Effectiveness, Malay, Reverse twin block.

Received date: 19 June 2019 **Accept date:** 22 October 2019

Introduction

The objective of early Class III malocclusion treatment is to create an environment in which a more favorable dentofacial development can occur[1]. More prominently, early treatment is able to potentially alter the facial profile, leading to a development in the self-esteem of the growing child[2,3]. The malocclusion in children can caused psychological functional[4] and aesthetic[5] concerns. Therefore, it is important to treat these children accordingly. However, the modalities of treatment are varying.

Some orthodontists prefer to introduce the treatment using functional appliances at the early age. Early intervention is believed will reduce the complexity of fixed orthodontic treatment at the later stage[6]. On the other hand, some orthodontists did not practice early stage of treatment because they argued that the growth of mandible cannot be predicted[1].

Several evidences have shown that functional and extra-oral traction appliances treatment effectively causes favourable skeletodental changes[6]. The changes are as follows; redirection of mandibular growth backward and downward, forward growth of maxilla, anterior proclination of upper teeth and posterior proclination of lower teeth. However, in growing children, sex and age are factors that need to be considered in the management of malocclusion[7]. Bishara (2001)[1] showed that Class III malocclusion males and females grow at different rates for different age groups.

The aim of this study is to evaluate relationship between sex and age on dental arch change in the reverse twin block appliance on dental study model measurements.

***Corresponding author:**
Osama B. Albajalan, International Medical School, Management & Science University, section 13, 40100 Shah Alam, Malaysia.
E-mail: drosamabaha77@gmail.com;
osama_bahaa@msu.edu.my

Materials and methods

Subjects

This study is a randomized clinical trial consisted of 49 (22 males, 27 females) Malay children with Class III malocclusion who have been selected from 22 primary schools at Kelantan stat, Malaysia were allocated to two groups.

The first group which consist of 23 subjects (10 males, 13 females) treated in the early mixed dentition with mean age of was 8.43 (SD=0.20) years and late-treatment group included 26 subjects (12 males, 14 females) treated in the late mixed dentition with mean age of was 10.45 (SD=0.29) years. Informed consent was obtained from the parents and patients before starting the treatment. All children were treated with Reverse Twin Block appliance at School of Dental Sciences, Universiti Sains Malaysia, Malaysia. The age ranges of between 8 to 9 years old and 10 to 11 years.

The inclusion criteria for sample selection were reverse over jet and Class III deciduous canine relationship and/or Class III molar relationship. Subjects with craniofacial anomalies, previous orthodontic appliance therapy and history of facial trauma were excluded from the study. The study models for all the subjects were coded with identification number so that the operator was blinded from identifying the patient group.

Reverse twin block appliance

Reverse twin block appliance developed by Clark (1995) [4] 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 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 (Figures 1 and 2).

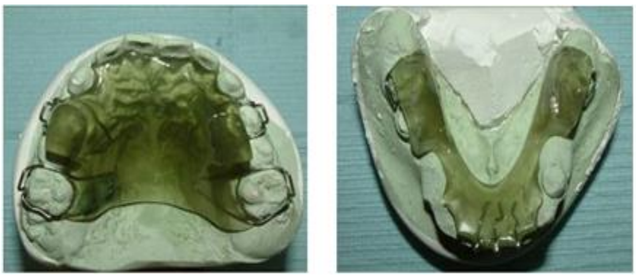

Figure 1. Upper and lower reverse twin block appliance

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 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 over bite during visits and to ensure that the patient complied to wear the appliance without any problem.

Imaging procedure of dental study model

The study models were labelled with 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 colour. 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 image was rotated 180º which makes the anterior at the superior position and the posterior molar at the inferior position. The images were saved in bitmap (bmp) format which is a requirement of MorphoStudio software to import the data into its digitizer program. The images were also saved in JPEG format for arch depth arch analyses using VixWin PRO software.

Digitizer program of dental study model

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 calibration scale determined the distances between the vertical and horizontal points which were constant for all images (60 mm horizontal and 60 mm vertical). Seven homologous landmarks of maxillary dental cast and seven homologous landmarks of mandibular dental cast.

Identification of tooth landmarks was performed according to Ash and Nelson (2003) (Figures 3 and 4). Since, the samples were in a mixed dentition stage, some teeth were missing (exfoliated deciduous molar and unerupted premolar). Therefore, landmarks identification as used by Taner *et al.* (2004)[8] was adapted. The estimated point of cusp tips or mid-incisal points were used for erupted teeth and a point halfway between the adjacent teeth was used for unerupted teeth. After digitization was complete, J-links and triangles were produced, and files were saved as text files.

Landmarks	Definition
0	Left disto-palatal cusp of first permanent molar
1	Left mesio-buccal cusp of first permanent molar
2	Left cusp tip of deciduous canine
3	Left mesio-incisal edge of central incisor
4	Right cusp tip of deciduous canine
5	Right mesio-buccal cusp of first permanent molar
6	Right disto-palatal cusp of first permanent molar

Figure 3. Landmarks of maxillary dental cast

Landmark	Definition
0	Right disto-lingual cusp of first permanent molar
1	Right mesio-buccal cusp of first permanent molar
2	Right cusp tip of deciduous canine
3	Right mesio-incisal edge of central incisor
4	Left cusp tip of deciduous canine
5	Left mesio-buccal cusp of first permanent molar
6	Left disto-lingual cusp of first permanent molar

Figure 4. Landmarks of mandible dental cast

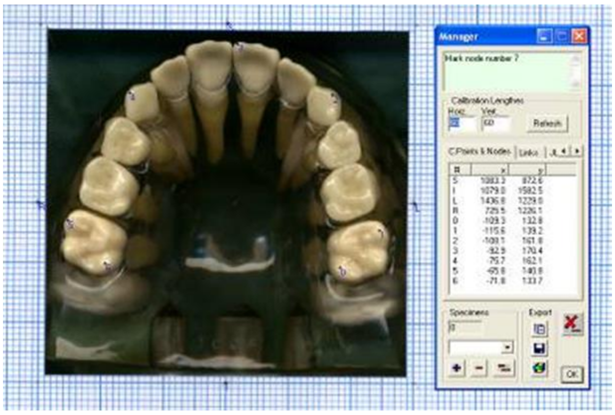

Figure 5. Maxillary dental cast.

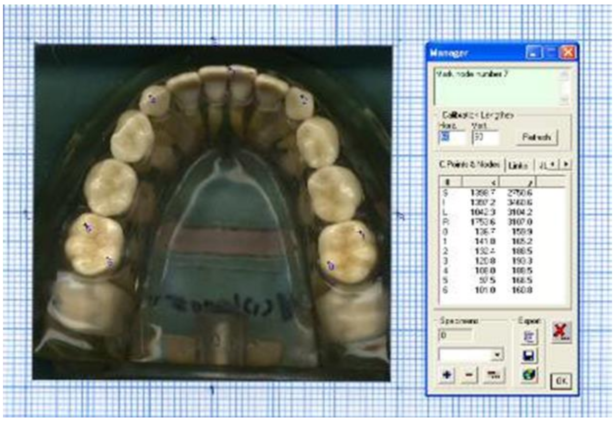

Figure 6. Mandibular dental cast.

Finite element analysis (FEA) of MorphoStudio program for dental study model

The MorphoStudio software receives 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 specimen from a morphometric point of view. With MorphoStudio, a single specimen or groups of specimens can be superimposed in order to obtain a mean specimen after translation, rotation, and scaling of homologous landmarks[9].

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 pseudo colour scale to visualize any change in shape and to determine if these changes are increased or decreased. The colour value of the pseudo colour scale represents the amount of change, where the value ≈ 1 means insignificant difference between both groups, the value <1 indicates decreased in shape and the value >1 indicates increased in shape.

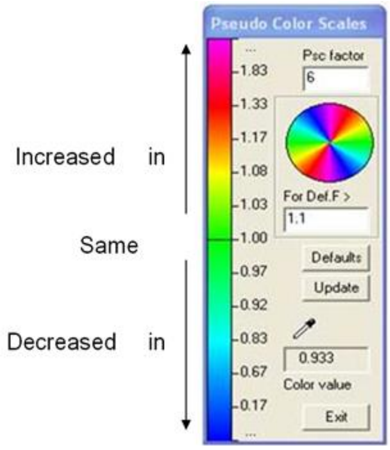

Figure 7. Interpretation of different colours using pseudo colour scale

VixWin PRO software for dental study model

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. Two points on the graphic paper were selected at 10 mm distance between them for calibration to make the measurement ratio of 1:1. The first line was drawn between midpoints of the distal surface of the left first permanent molar and right first permanent molar. A second line was drawn from the midpoint between the central incisors to the inter-molar distance perpendicularly. The arch depth is represented by the perpendicular distance from the midpoint between the central incisors to the inter-molar distance (Figures 8 and 9).

Figure 8. Arch depth of maxillary dental cast.

Figure 9. Arch depth of mandibular dental cast.

Measurement Change (Dependent)	Mean Changes (Post-Pre)	Predictors	Adj.b[a]	95%CI		*t*-stat.	*P* value
				Lower bound	Upper bound		
UICWC (mm)	0.88	UICW (mm)	-0.014	-0.076	0.048	-0.466	0.643
		Sex	0.261	-0.024	0.545	1.843	0.072
		Age	-0.175	-0.482	0.132	-1.151	0.256
UIMWC (mm)	0.86	UIMW (mm)	-0.011	-0.060	0.037	0.470	0.641
		Sex	0.099	-0.181	0.380	0.712	0.480
		Age	-0.039	-0.228	0.307	0.295	0.769
UADC (mm)	0.70	UAD (mm)	0.030	-0.052	0.112	0.728	0.471
		Sex	-0.018	-0.390	0.354	-0.079	0.924
		Age	-0.022	-0.442	0.397	-0.108	0.914
LICWC (mm)	0.98	LICW (mm)	-0.014	-0.084	0.057	-0.392	0.697
		Sex	0.173	-0.109	0.455	1.237	0.222
		Age	0.073	-0.203	0.349	0.530	0.599
LIMWC (mm)	0.93	LIMW (mm)	0.009	-0.045	0.062	0.326	0.746
		Sex	0.189	-0.143	0.522	1.147	0.258
		Age	-0.039	-0.342	0.264	-0.262	0.795
LADC (mm)	1.18	LAD (mm)	-0.082	-0.156	-0.008	-2.246	0.030
		Sex	0.046	-0.221	0.313	0.348	0.730
		Age	0.221	-0.049	0.491	1.650	0.106

Table 1 The relationship of age and sex on the dental arch changes after treatment with reverse twin block appliance.
[a]Adjusted regression coefficient
n=49
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)

Statistical Analysis

The data were entered and analyzed with Statistical Package for the Social Sciences (SPSS , Chicago, Illinois, USA). Before analyses the data was 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 twin block appliance. The level of significance was set at 0.05.
The level of significance was set at 0.05.

Results

There were no significant differences in dental arch changes between males and females after treatment with reverse twin block appliance, and there was no difference between the late and early age groups (Table 1).

The inter-canine and inter-molar distances and arch depth did not show any significant difference in relation to age and sex. Assessment of post treatment study models showed that both appliances changed the maxillary and mandibular dental arch shape but do not affect the inter-teeth distances. Finite Element Analysis (FEA) was used so that the shape changes can be identified after treatment. FEA results indicated non-homogenous shape changes for both arches in early and late mixed dentition stages between the male and female groups. To determine errors associated with dental arch measurements, twenty study model 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).

The intra-class correlation coefficients for inter-examiner were 0.83 to 0.99 and for intra-examiner was 0.99. These values of coefficients were considered good.

Discussion

The result of the present study showed no differences of sex and age on dental arch change between early and late treatment groups in both male and females in the reverse twin block appliance group. This is due to the fact that both groups were in mixed dentition stage and there was no arch dimension variation between early and late mixed dentition stage. In the present study, Finite Element Analysis (FEA) was used so that the shape changes can be identified after treatment. FEA results indicated non-homogenous shape changes for both arches in early and late mixed dentition stages between the male and female groups. These findings point out that there is no difference in treatment shape changes in early and late mixed dentition in males and females. The results of the study demonstrate no relationship between age and sex on the dental arch size treatment response changes. Hence, both groups have similar growth of dental arches. Similar observations were made by Bishara *et al.* (1997)[10]. Moreover, Bishara *et al.* (1997)[10] reported that arch width dimensions were established in the mixed dentition (8 years of age) with a little increase until early permanent dentition (13 years). There were also no sex differences in the treatment response due to the fact that the characteristic features of dental arches were similar in males and females in addition to similar growth of dental arches at the mixed dentition stage. This is supported by Slaj *et al.* (2003)[11] had also reported no difference in width or depth variables at mixed dentition stage.

Most previous studies evaluated dental arch morphology of Class III malocclusion versus Class I malocclusion (Uysal *et al.*, 2005; Kuntz *et al.*, 2008)[12,13,14,15]. Generally clinical studies compared treatment results on lateral cephalogram (Baik, 1995; Ngan *et al.*, 1998)[16,17]. Few studies had assessed the effect of Frankel III functional appliance on the dental arch to correct Class III malocclusion (Miethke *et al.,* 2003; Kalavritinos *et al.,* 2005)[18,19]. Both studies reported significant increase in transverse parameters after treatment with Frankel III functional appliance and did not investigate the relationship between sex and age on dental arch changes. However, our study investigated relationship between sex and age on dental arch changes in the reverse twin block appliance which showed no relationships due to comparable growth at the mixed dentition.

However, the results of the present study indicate that the time to start the treatment of Class III malocclusion can be delayed until late mixed dentition and there is no need to start treatment early in mixed dentition. Moreover, the benefits of delay to start the treatment of Class III malocclusion will minimize the total treatment time to the patient, reduce the cost of treatment, reserve the oral hygiene of the patient and result in better patient compliance and cooperation at late mixed dentition than at early mixed dentition.

Conclusions

The results of the present study holds important clinical implications in that clinicians can delay the treatment of Class III malocclusion until late mixed dentition and there is no urgency to start the treatment at early mixed dentition. Furthermore, no differences were observed in the treatment response between males and females.

Declaration of Interest

The authors report no conflict of interest and the article is not funded or supported by any research grant.

References

1. Staley RN, Bishara SE. Textbook of orthodontic. 2001.
2. O'Brien K, Wright J, Conboy F, et al. Effectiveness of early orthodontic treatment with the Twin-block appliance: a multicenter, randomized, controlled trial. Part 2: psychosocial effects. *Am J Orthod Dentofac Orthop*. 2003;124(5):488-494.
3. Uslu O, Akcam MO. Evaluation of long-term satisfaction with orthodontic treatment for skeletal class III individuals. *J Oral Sci*. 2007;49(1):31-39.
4. Clark W. *Twin Block Functional Therapy*. JP Medical Ltd; 2014.
5. Klages U, Bruckner A, Zentner A. Dental aesthetics, self-awareness, and oral health-related quality of life in young adults. *Eur J Orthod*. 2004;26(5):507-514.
6. Baccetti T, Franchi L, McNamara JA. Treatment and posttreatment craniofacial changes after rapid maxillary expansion and facemask therapy. *Am J Orthod Dentofac Orthop*. 2000. doi:10.1067/mod.2000.109840
7. Tollaro I, Baccetti T, Bassarelli V, Franchi L. Class III malocclusion in the deciduous dentition: a morphological and correlation study. *Eur J Orthod*. 1994;16(5):401-408.
8. Taner TU, Ciğer S, El H, Germec D, Es A. Evaluation of dental arch width and form changes after orthodontic treatment and retention with a new computerized method. *Am J Orthod Dentofac Orthop*. 2004;126(4):463-474.
9. Ferrario VF, Sforza C, Miani Jr A, Serrao G. Dental arch asymmetry in young healthy human subjects evaluated by Euclidean distance matrix analysis. *Arch Oral Biol*. 1993;38(3):189-194.
10. Bishara SE, Ortho D, Jakobsen JR, Treder J, Nowak A. Arch width changes from 6 weeks to 45 years of age. *Am J Orthod Dentofac Orthop*. 1997;111(4):401-409.
11. Šlaj M, Ježina MA, Lauc T, Rajić-Meštrović S, Mikšić M. Longitudinal dental arch changes in the mixed dentition. *Angle Orthod*. 2003;73(5):509-514.
12. Uysal T, Usumez S, Memili B, Sari Z. Dental and alveolar arch widths in normal occlusion and Class III malocclusion. *Angle Orthod*. 2005;75(5):809-813.
13. Kuntz TR, Staley RN, Bigelow HF, Kremenak CR, Kohout FJ, Jakobsen JR. Arch widths in adults with Class I crowded and Class III malocclusions compared with normal occlusions. *Angle Orthod*. 2008;78(4):597-603.
14. Attalla SM, Deri NM. Racial identification of head shape by the cephalic index in the malaysian population in section 13 Shah Alam Malaysia. *Int J Med Toxicol Leg Med*. 2018;21(3and4):8-10.
15. El-Bakary AA, Attalla SM, Hammad SM, et al. Age estimation in Egyptian children by measurements of carpals and epiphyses of the ulna and radius. *J Forensic Radiol Imaging*. 2014;2(3):121-125.
16. Baik HS. Clinical results of the maxillary protraction in Korean children. *Am J Orthod Dentofacial Orthop*. 1995. doi:10.1016/S0889-5406(95)70003-X
17. Ngan P, Yiu C, Hu A, Hägg U, Wei SHY, Gunel E. Cephalometric and occlusal changes following maxillary expansion and protraction. *Eur J Orthod*. 1998. doi:10.1093/ejo/20.3.237.
18. Miethke RR, Lindenau S, Dietrich K. The effect of Fränkel's function regulator type III on the apical base. *Eur J Orthod*. 2003. doi:10.1093/ejo/25.3.311.
19. Kalavritinos M, Papadopoulos M a, Nasiopoulos A. Dental arch and cephalometric changes following treatment for class III malocclusion by means of the function regulator (FR-3) appliance. *J Orofac Orthop*. 2005. doi:10.1007/s00056-005-0438-z.