AJDS LAZHAR Al-Azhar Journal of Dental Science Print ISSN 1110-6751 | online ISSN 2682 - 3314
Vol. 28- No. 1- 177:185- January 2025 https://ajdsm.journals.ekb.eg
Orthodontic & Pediatric Dentistry Issue (Orthodontics and Pediatric Dentistry)

IS THE TWIN ARCH BRACKET SYSTEM DECREASING THE BONDING FAILURE OF ORTHODONTIC BRACKETS? A CONTROLLED CLINICAL TRIAL

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ABSTRACT

Background: It's well known that OTM is a complex process, a plenty of factors play a role in rate of OTM, either patient related factors (age, gender, general health, tooth location etc.) or appliance related factors (bracket's design, archwires size and material, applied force etc.) **Objective:** In the current study, the double slot brackets were used during leveling and alignment phase in comparison with conventional pre-adjusted brackets system in two groups of patients, to clinically assess the bonding failure, patient Preference and time taken for alignment and leveling phase. **Subjects and methods:** The present study was conducted on twenty patients who were divided randomly into two equal groups; Experimental group (group I): that included 10 patients who were treated by using twin arch brackets system. While Control group (group II) included 10 patients who were treated by using the conventional pre- adjusted edgewise brackets system. The primary outcome is evaluation of bonding failure. While secondary outcomes are patient preference and time taken for levelling and alignment. **Results:** An Experimental group recorded (0.5±0.71; median 0), while a control group recorded (3.8±0.92; median 4); with a statistically significant difference between groups (p=0.000). **Conclusion:** The twin arch bracket system decrease number of bonding failure of bracket but it is not accepted to the patients as with conventional fixed orthodontic appliance.

KEYWORDS: Twin arch bracket system, double slot, pain level, Little's irregularity index, oral hygiene index.

INTRODUCTION

The orthodontic bracket plays an important role in the fixed orthodontic treatment course as they used to transmit the force from fixed orthodontic appliance to the tooth structure [(1,2)]. Precise control over the tooth movement becomes possible only when Edgewise has been invented, the feature which makes the Edgewise appliance unique is the presence of horizontal slot that suit a rectangular archwire to be placed[(3)]. Nevertheless, fixed mechano-therapy using the edgewise appliance was complex as it requires more adjustment time and placing many bends into the archwire to achieve the desired position of the teeth[(4)]. Today, it's rarely for an orthodontists to use the edgewise appliance for treatment of malocclusion[(5)].

However, no one can deny Angle contribution as this genius appliance was the backbone for other orthodontic fixed appliance which are no more than a modification of Angle device [(6,7)]. Later on, Joseph

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DOI: *10.21608/ajdsm.2024.307268.1557*

Jonson who introduced the twin wire appliance in 1934 used two light wires simultaneously [8]. After that many scientists modified the design of standard edgewise appliance to increase its versatility [9] . The most influential was the SWA introduced in 1976 by Andrew's, Andrew's appliance has a built in first, second and third order bends, Andrew's work was the basics for today bracket prescription like Roth and MBT systems [10].

More than bracket system utilized two wire simultaneously in the same time to perform orthodontic tooth movement, Johnson twin wire appliance was the first one, twin wire appliance relied on the principle which suppose that inserting two light wires (0.010inch) would be more physiologic and comfortable than one heavy wire as both wires will be inserted in the same channel and hold in place by ligature wire or a cap [8]. The twin wire had the advantage of being more comfortable than other techniques but it lacked precise control over the canines and premolars and was unsuitable for extraction cases [11].

Recently the idea of two wire system was revived in the double slot bracket system; the new feature which the manufacture adds is doubling the slot so each one can perceive a single and heavier archwire[12]. By doing so, the bracket's mesiodistal dimension has been increased; this gives a more control over tooth movements which need rigid force moment such as derotation and mesiodistal angulations or tipping[13]. Furthermore, a wider bracket design can be very helpful in sliding of teeth to close the extraction space where a pure bodily movement of teeth along the archwire and root parallelism is needed[14]. Even so that making the bracket more wider has a certain advantages but in the same time it has it's disadvantages, as these brackets will limit the inter-bracket span which is necessary for making the active archwire more elastic and flexible, as a result in bracket design we should keep balance between these two factors to achieve the desired control over the tooth movement[15-18].

As a point of view from orthodontic biomechanics, the new design of double slot brackets has increased mesiodistal dimension, consequently it could affect other aspects of orthodontic treatment; rate of orthodontic tooth movement, quality of controlling orthodontic tooth movement and bonding strength to the tooth surface. So in the current study we will evaluate the previous features of orthodontic treatment, as well as assess the degree of pain sensation during o-tying and untying of the bracket system and efficacy of the twin wire bracket system on oral hygiene.

PATIENTS AND METHODS

Study design

Randomized controlled clinical study.

Study setting and population

The current study was conducted on a sample of 20 orthodontic patients seeking orthodontic treatment from the orthodontic clinic, Department of Orthodontics, Faculty of Dental Medicine, Boys, Al-Azhar University, Cairo.

Sample size calculation

Based on a previous clinical study [19], a sample size calculation was undertaken Using G power statistical power Analysis program (version 3.1.9.7) for sample size determination, A total sample size of 20 patients (10 in each group),100 brackets were bonded in a standardized manner in each group, it will be sufficient to detect a large effect size ranging from 1.36 to 1.37, with an actual power (1-β error) of 0.8(80%) and a significance level (α error) 0.05 (5%) for two- sided hypothesis test [20].

Inclusion criteria

The patients who were included in the current study had the following criteria:

1. Female patients of age ranges from 13 to 18 years.
2. Full set of permanent teeth (the third molars are not considered).

3. Angle class I malocclusion with normal facial proportions.
4. Mild to moderate crowding in both arches that require treatment with fixed appliance using non extraction approach.

Ethical considerations

The present study was approved by the Research ethics committee of Faculty of Dental Medicine, Boys, Cairo. Al-Azhar university, Cairo, Egypt with code (653/253). Also the current study was registered on the clinical trials.gov by ID NCT05071599.

Also, the objectives of the study were discussed with the patients, parents, and \ or guardians and an informed consent form and the orthodontic instructions sheet was signed before the start of orthodontic treatment.

Study groups

The selected patients were divided randomly into two equal groups according to the type of bracket system that was used for leveling and alignment as follows; Experimental group (group I): that included 10 patients who were treated by using twin arch brackets system. While Control group (group II) included 10 patients who were treated by using the conventional pre- adjusted edgewise brackets system.

Groups' randomization

Patient assigned into these two groups through a simple online generated randomization plan by using online software found at the website http://www.graphpad.com/quickcalcs/index.cfm. The allocation ratio is 1:1.

Orthodontic records

The following standardized orthodontic records were taken for each patient for both groups (figure 1):

1. Extra-oral and intra-oral photographs before and after orthodontic treatment.
2. Digital lateral cephalometric radiograph before and after orthodontic treatment.
3. Digital Panoramic radiograph before and after orthodontic treatment.

FIG (1) Pretreatment intra-oral photographs for an experimental group patient.

Interventional steps:

1. Roth buccal tubes (Roth Buccal Tubes: DTC Buccal Tubes – USA) for the first permanent molars were incorporated with pre-adjusted bracket system (Ormco mini 2000 twin TM Roth brackets 0.022-inch slot - USA) for a control group patients, while the double slot brackets kit (Twin arch brackets system: Double Slot Brackets - Sortech Company - Brazil) come included with specific buccal tubes for first and second permanent molars for an experimental group.
2. Bracket kit for both groups was bonded using the same bonding materials and technique according to standardized protocol. The adhesive used to adhere brackets to tooth surfaces is a light cured resin-based composite (Grengloo bracket adhesive system: Ormco Corporation-USA)
3. Leveling and alignment stage for patients in both groups was performed by using the same type and diameter of aligning wires using two wires for an experimental group and a single wire for a control group, the archwire sequences were 0.012-inch (NiTi), followed by 0.014-inch NiTi, 0.016-inch NiTi, 0.016 × 0.022-inch NiTi, 0.017 × 0.025-inch NiTi, and finally, 0.017 × 0.025-in stainless steel on both arches (Figure 2).

Orthodontic outcomes

There are two main outcomes for the current study; the primary outcome is evaluation of bonding failure. While secondary outcomes are patient preference and time taken for levelling and alignment.

Measurements and observations

1. Evaluation of bonding failure:

The bonding, follow-up and assessment of bond failure rate of the brackets were done by a single operator (investigator). Patients were followed for a period of 5 months. If a bond failed, the following information was recorded: (1) site of bond failure, (2) number of failed brackets (3) date of bond failure, and (4) possible reason for bond failure .The patients were requested to come as soon as possible in case of a bond failure. When the patient was unaware of a bracket failure, the date of the appointment was recorded as the date of failure. Failed brackets were re-bonded with the same adhesive, but not included any further in the study.

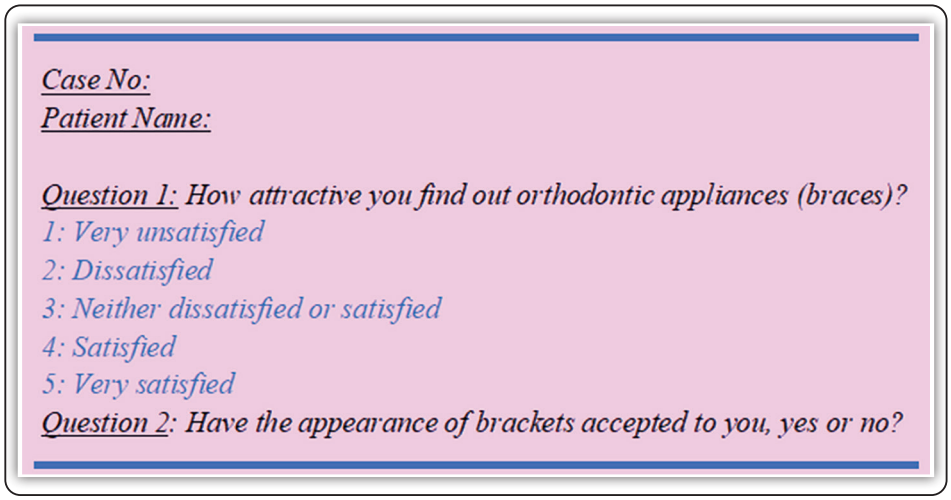
FIG (2) Progressive intra-oral photographs for an experimental group patient.

2- Assessment of Brackets Appearance or Patient Preference.

Each patient had a prepared questioner that contain two questions:

First question: How attractive you find out orthodontic appliances (braces), the patients will be asked to estimate their feelings of attractiveness of brackets(braces) according to Likert scale (1-5 scale), where 1,2,3,4,5 represent for very unsatisfied, dissatisfied, neither dissatisfied or satisfied, satisfied, very satisfied respectively.

Second question: Have the appearance of brackets accepted to you, yes or no?



3. Assessment of time taken for leveling and alignment:

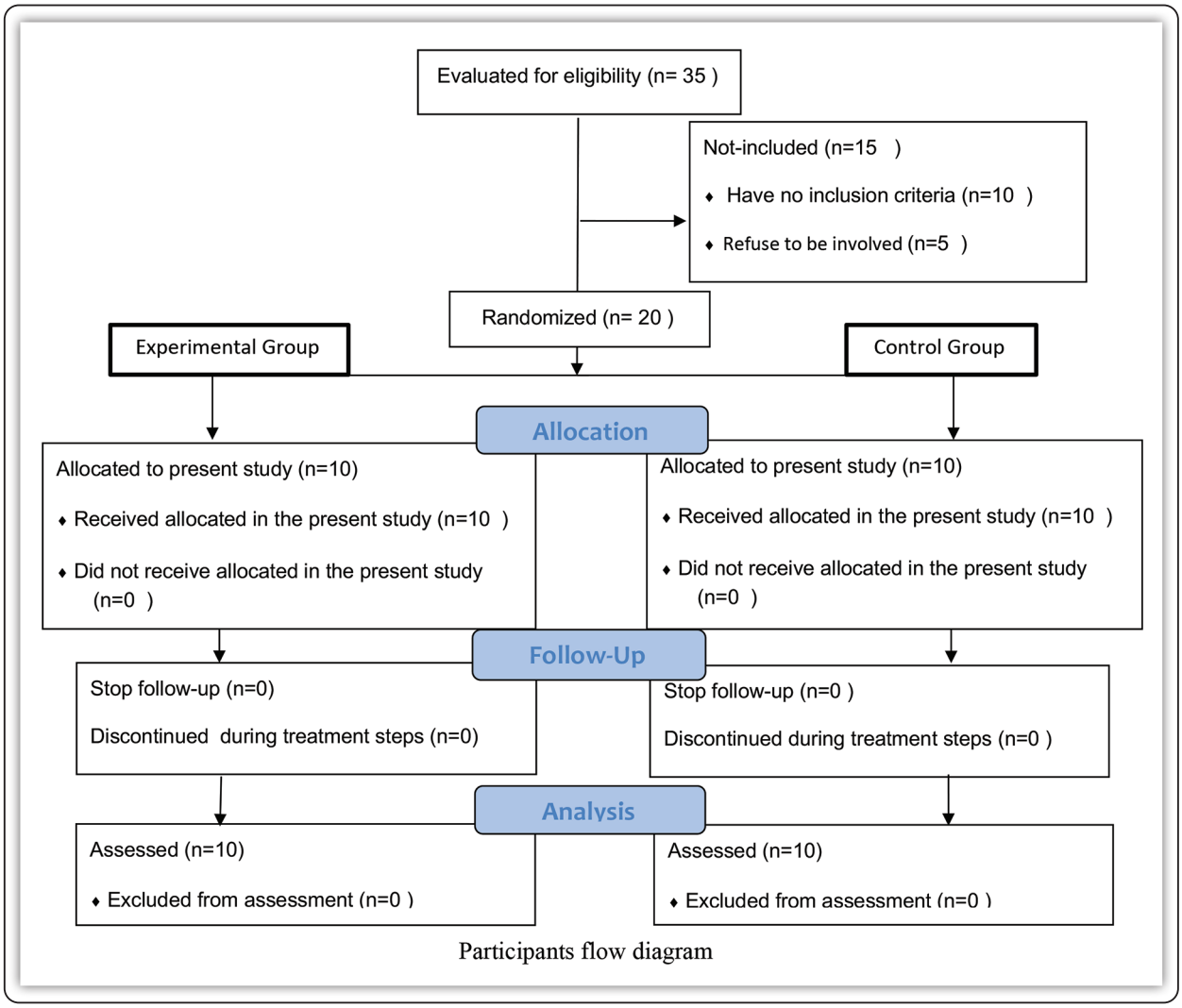
It can be calculated by number of week that had been taken for finishing the leveling and alignment stage for both experimental and control group.

Data management and statistical analysis:

The data was collected, tabulated, and statistically analyzed using Statistical Package for Social Sciences (SPSS program, version 18, Inc., Chicago, IL, USA).

RESULTS

All twenty patients who met inclusion criteria have a complete analysis for Little's Index of irregularity, percentage of crowding correction, pain assessment and evaluation of Oral Hygiene Status at all time intervals (T0 to T10) without any dropping out (see participant flow diagram). Each participant has follow-up every three weeks to the orthodontic clinic.



Participants flow diagram

1. Evaluation of total brackets bonding failure:

An Experimental group recorded (0.5±0.71; median 0), while a control group recorded (3.8±0.92; median 4); with a statistically significant difference between groups (p=0.000), (Table 1)

TABLE (1) Descriptive statistics and comparison of total brackets bonding failure between groups (Mann Whitney U test)

Groups	Mean	Std. Dev.	Median	Difference				P value
				Mean	Std. Dev.	C.I. lower	C.I. lower	
Experimental group	.50	.71	0.00	-3.30	.37	-4.07	-2.53	.000*
Control group	3.80	.92	4.00					

*C.I. 95% confidence interval, p≤0.05, *significant, ns=non-significant*

2. Brackets Appearance or Patient Preference According to Likert Scale:

The Answer was "Yes" in 100% of cases in both groups.

An experimental group recorded (3.2±0.42). This value was significantly lower than that recorded in a control group (3.8±0.42). The difference between groups was statistically significant (p=0.005). (Table 2)

3. Time Taken for Leveling and Alignment:

A control group recorded (4.1±0.74months), while an experimental group recorded (4.11±0.6 months); with no significant difference between groups (p=0.972), (Table 3)

TABLE (2) Descriptive statistics and comparison of Likert scale between groups (independent t test)

Groups	Mean	Std. Dev.	Median	Difference				P value
				Mean	Std. Dev.	C.I. lower	C.I. lower	
Experimental group	3.20	.42	3.00	-.60	.19	-1.00	-.20	.005*
Control group	3.80	.42	4.00					

*C.I. 95% confidence interval, p≤0.05, *significant, ns=non-significant*

TABLE (3) Descriptive statistics and comparison of time of complete correction of LII (months) between groups (independent t test)

Groups	Mean	Std. Dev.	Median	Difference				P value
				Mean	Std. Dev.	C.I. lower	C.I. upper	
Control group	4.10	.74	4.00	-.01	.31	-.66	.64	.972 ns
Experimental group	4.11	.60	4.00					

*C.I. 95% confidence interval, p≤0.05, *significant, ns=non-significant*

DISCUSSION

Concisely speaking, the rate of O.T.M influenced by many variables, so to accurately estimate the rate of O.T.M in vivo, it's advisable to neutralize these variables. For this reason, the subjects under study were female patients aging from to 14 to 18 years with the mean age 16 years, to minimize introducing any confounders which may interfere with measurements and observational procedures.

Patient compliance and attitude toward orthodontic treatment vary with age, even if adults showed more cooperation, self-motivated adolescents have been showed excellent oral hygiene status especially if home care instructions were given and stressed at the beginning of treatment, studies also revealed that 16 to 18 years old adolescents were more often brush their teeth than other age groups [19-20].

Patient acceptance and perceptions toward fixed orthodontic appliance are strongly age and sex related as most studies indicated, adults and females are seeking a more esthetics devices, also adult's social status or patient gender may interfere with patient reaction toward orthodontic treatment, for instance commitment toward visits schedule as well as their satisfaction for appearance of fixed labial orthodontic appliance [21-22].

Time taken for alignment in upper arch (an experimental group recorded (4.1±0.74months), while a control recorded (4.11±0.6 months), statistically no significant difference between two groups, while in lower arch a group recorded (4.3±0.95 months), while an experimental group recorded (4.11±1.05 months), with no significant difference between two groups. With no statistical significant difference between the both groups, this result can be attributed to that the mild crowding can be relieved after short time.

Brackets bonding strength one of the major concerns for every orthodontist during treatment, as brackets bonding strength play a significant role in achieving the ideal outcome of treatment, additionally brackets detachment could cause a prolonged course of treatment, harm to enamel surface, increase cost of treatment and chairside time. However, a previous systematic review showed a high rate of brackets bonding failure (detachment) during orthodontic treatment [23-24].

Many factors play a role in bonding strength of orthodontic brackets, factors related to materials etching type and concentration, adhesive etc., type of brackets, bracket base design and size, adherent's surface and the bonding technique. In the current study we estimated the rate of bracket bonding failure clinically for two brackets system with different design in the first 5 months of treatment[25].

In the current study the data demonstrated a higher bonding failure rate in a control group than an experimental group, which was statistically significant. The higher bonding strength of DSBs may attributed to their base design or size, as their size is large relative to other conventional bracket systems, these findings confirmed by a previous two studies which claimed brackets with large mesh size have a higher SBS values compared to brackets with smaller mesh size [26, 27].

Regarding metallic brackets, studies have shown that the bracket's size and shape have an influence bracket's appearance and acceptance by patients. Date from previous research confirmed that adults usually prefer less metal show of brackets. Interestingly, it was found that colored o-ties markedly participate in acceptance of standard metallic brackets in relation to children and adolescent age groups [28].

In the present study, the acceptance for appearance of brackets in a control group was slightly higher than in experimental group, with most patients in both groups accepting the overall appearance of the appliance. Increased bracket's size and double wire installment may be attributed to the decreased bracket's appearance acceptance for group I patients. Similar findings were reported by Ziuchkovski and Moshkelgosha who concluded that patients show less attractiveness toward large metallic brackets than the smaller one [29, 30].

CONCLUSION

The twin arch bracket system decrease number of bonding failure of bracket but not accepted to the patients as with conventional fixed orthodontic appliance.

RECOMMENDATIONS

1. Application of the twin arch bracket system for orthodontic extraction cases.
2. For doubling the qualification we can use one of methods of acceleration of orthodontic tooth movement with the twin arch bracket system.
3. Avoid to use the twin arch bracket system with adult orthodontic patients.

Ethical statement: this study was approved by the Ethical committee of the faculty of dental medicine, Cairo, Boys, Al-Azhar University with ethical code 653/253.

Patient consent: the objectives of the study were discussed with the patients, parents, and \ or guardians and an informed consent form and the orthodontic instructions sheet was signed before the start of orthodontic treatment.

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