

Evaluating the Agreement between the Twin-Block Appliance and a New Low-Cost Arch Development Appliance in Changing the Mandibular Length

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Authors' contributions

This work was carried out in collaboration among all authors. Author LSN designed and supervised the study. Author SPNPN provided the dataset and wrote the protocol. Author AMICKJ managed the literature searches, performed the statistical analysis and wrote the first draft of the manuscript. Authors LSN and SPNPN edited the manuscript. All authors read and approved the final manuscript.

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Abstract

Aim: The main objective of this study is to compare the development of mandibular length by comparing the effectiveness of a new low-cost arch development appliance in increasing the length of the mandible with the twin block appliance (Twin-B).

Methodology: This analysis was performed on patients who attended the clinic in the Division of Orthodontics, Faculty of Dental Sciences, University of Peradeniya. The sample included 60 subjects treated with Twin-B (n=30) and new low-cost arch development (n=30) appliances and each appliance comprised 15 males and females. Intraclass Correlation Coefficient (ICC) and the Concordance Correlation Coefficient (CCC) were calculated to check the agreement between the two methods. A mixed-effects model was fitted to predict mandibular length, and Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC), and log-likelihood were used for selecting the best model.

Results: It was observed that the Concordance Correlation Coefficient (CCC) for after treatment as 0.9172 with a (0.8488, 0.9555) 95% confidence interval. Furthermore, it gives a Pearson correlation of

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0.9609 and bias correlation factor of 0.9545. ICC values after treatment for both single measures and average measures are 0.9499 and 0.9743 with the 95% confidence intervals (0.8976, 0.9758) and (0.9460, 0.9878) respectively.

Conclusion: Besides, both Twin-B and new low-cost arch development appliances have a better agreement and can be used interchangeably. Therefore, the new low-cost arch development appliance is more suitable as a treatment for malocclusion for Sri Lankan patients as it is less expensive, simpler and, less invasive.

Keywords: Agreement; concordance correlation coefficient; intraclass correlation coefficient; mandibular length; twin-block appliance.

1 Introduction

Malocclusion is one of the spectrums of normal variation and is not a disease. No treatment is indicated unless it was beneficial to the patient. Moreover, potential advantages should be listed against possible risks, side effects, including failure to achieve the aims of treatment [1]. In medicine and dentistry, financial constraints should be considered before the commencement of treatment. After working with the general public, dentitions said that the following groups are wishing to undergo treatments, females, higher economic families/groups, and in areas which have a smaller population to orthodontist ratio, presumably because appliances become more accepted [2]. The effectiveness of the appliance, which is used to correct the malocclusion of an individual, is also important [3]. This depends on the compliance of individuals in wearing the given appliance and the growth pattern of the individual. Besides, this considers tooth movement planned attainable.

The chance of success will reduce by the wrong treatment plan or failure to anticipate adverse growth changes. Patient co-operation is also important for the effectiveness of the appliance [4]. Operator factors and patient factors are the factors that are effective to fail the objectives of treatment technique errors, while poor oral hygiene, failure to wear the appliance, and failed appointments are the patient factors [5].

There are three main types of malocclusion patterns in orthodontic namely Class I, Class II and Class III malocclusion. Class II malocclusion is divided into another two divisions called Class II division 1 and Class II division 2. In this study, we focused on treatment for Class II division 1 malocclusion patients in Sri Lanka. As shown in Fig. 1, the Class II division 1 and Class II division 2 are derivatives of the Class II malocclusion.

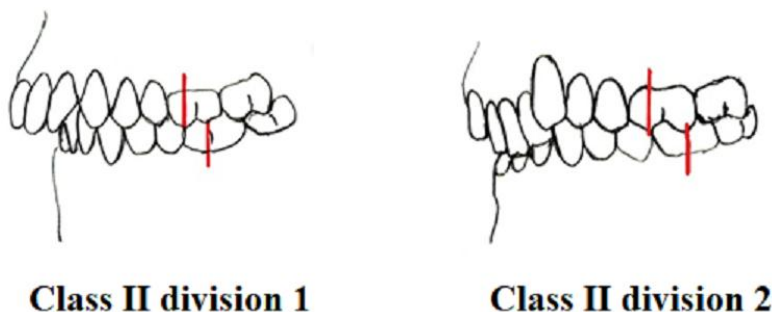


Fig. 1. Types of class II malocclusions

The Twin-block appliance is the most widely used appliance for growth modification in all around the world due to the acceptability by patients [6]. William Clark developed the Twin-Block appliance in the late 1970s and the appliance is simple and designed for full-time wear and achieves rapid functional correction of malocclusion. This also can be modified as another removable orthodontic appliance. Among Class II

division 1 patients, there is a fair percentage of cases which is not selected for treatment using the Twin Block functional appliance in orthodontic clinics. These cases need either combined fixed functional treatment or deferring treatment for orthognathic surgery, but both treatments are costly.

Sri Lanka is a developing country and most of the patients in the middle class or lower-income community refuse to receive treatment with expensive appliances. This restrains a portion of growing children with class II division 1 malocclusion to have proper treatment due to financial conditions. That is not favourable when considering oral health. If these cases are not treated at the optimal time with growth modification techniques, the only alternative available is Orthognathic Surgery at a later stage, which is a major financial burden on the public health sector. Therefore, Sri Lankan dentists developed an appliance named new low-cost arch development appliance to treat these patients. It is the simple plate designed to help normal growth of the child, so that after a child has gone through puberty, protrusion of jaws disappears, but which is used only in the upper arch. This appliance was modified to suit the economic status of the majority of underprivileged children in Sri Lanka. Hence, this study was carried out to examine the effectiveness of the new low-cost arch development appliance with the Twin Block appliance for increasing mandibular length of children. Simply, our intention was to examine the differences between before and after mandibular length (Co-Gn) and check whether they differed significantly from the two treatment protocols. The two appliances used for this study are shown in Fig. 2.

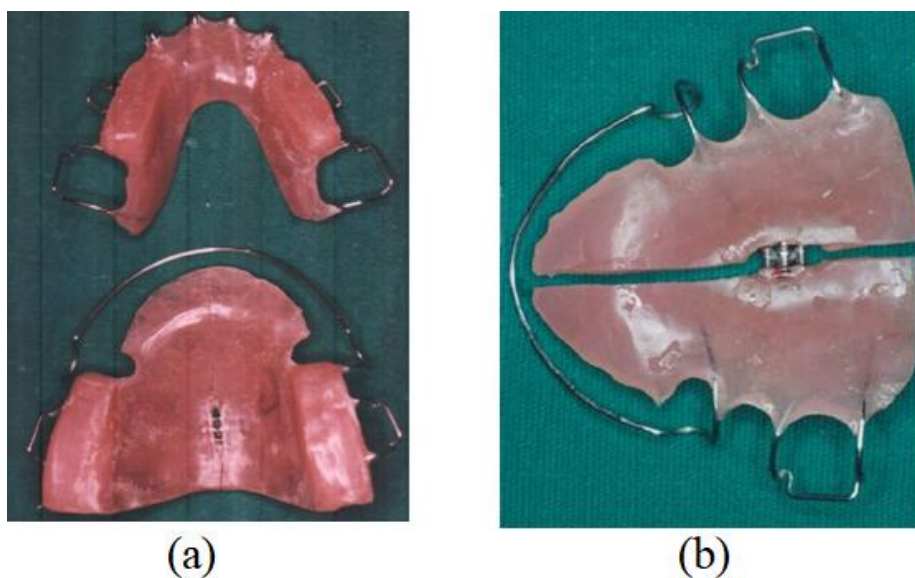


Fig. 2. Appliances that are used to treat patients (a) twin-block appliance, (b) new low-cost arch development appliance

This article is organized as follows. In Section 2, we describe the nature of the data set utilized for analysis and outline the mixed-effects model along with its applicability for the current interest of study. Section 3 expands on the Statistical Analysis conducted with the aid of R statistical software and the key results derived. To sum up, in Section 4, the Discussion states the main findings with direct comparison against the only previous study conducted in Sri Lanka.

2 Materials and Methods

The main aim of this study was to analyze the effectiveness of a new low-cost arch development appliance for increasing mandibular length (Co-Gn) comparing to the Twin Block appliance, the prominence of the upper jaw and lower jaw, and skeletal patterns of class II division 1 treatment modalities. Out of these cases,

60 consecutively treated cases were included for the research. The first group consisted of 30 patients consecutively treated with the Twin-block appliance and the second group included 30 patients consecutively treated with the new low-cost arch development appliance. Criteria for selection of cases for both groups were: (1) skeletal class II assessed clinically (2) average to low angle (3) profile improves when the mandible is postured forward to Canine class I (making an eye estimate of correct class I relationship). The study was conducted according to the prospective study and longitudinal data were collected for the study. Patients were examined over the time and data about them is collected and measurements were taken before and after the treatments. Sella-Nasion-A point (SNA), Sella-Nasion-B point (SNB), A point-Nasion-B point angles (ANB) and, mandibular length (Co-Gn) were the cephalometric variables considered for this study.

Patients were selected during their pubertal growth spurt and this assessment was done in the study using Cervical Vertebral Maturation Stage (CVMS) in X-ray. The treated subjects in both groups had the following features: (1) convex facial profile which improves when mandible postured forward, (2) lips cannot be closed (incompetent), (3) prominent upper incisors, (4) increased overbite (lower teeth bite into palate), (5) increased overjet (protrusion of the upper teeth) and (6) good quality-radiographs with adequate visualization taken before treatment (T_B) and immediately after removal of appliances (T_A). All cases selected by one specialist and manage under strict supervision.

The samples treated with the Twin-block appliance and the new low-cost arch development appliance consisted of 15 females and 15 males. Average age of the sample treated with the Twin-block appliance was 12 years 7 months \pm 1 year. The average age of the sample treated with the new low-cost arch development appliance was 12 years 8 months \pm 1 year. First, a power analysis test was performed to calculate power as it is an important aspect in experimental design and sample size estimation. Power is defined as the probability of avoiding or rejecting type II error. The precision of the results depends on the sample size and if the sample size is too small, the experiment will fail to provide accurate results. Besides, if the sample size is too large it will cause time and resource wastage [7].

Descriptive statistics were calculated for all measurements before and after treatment. Mann-Whitney U test was performed to compare the mean differences with 0.05 significant levels. Also, the Mann-Whitney U test is one of the nonparametric tests which is used as an alternative form of two-sampled paired sample t-test for independent samples. It is a mostly used statistical test to compare ordinal outcomes between two groups of subjects [8,9].

The instruments or methods change from time to time because of the technology development or instruments are developed to suit the country that the instruments are used. In this study, the Twin-block appliance and a new low-cost arch development appliance were used. In 1983, Altman and Bland proposed a method by studying mean differences and constructing limits of agreement to evaluate two different measurements [10]. Bland-Altman plots are also known as Tukey's Mean Difference plots. These plots are well-defined methods to check the retest-reliability of a single measurement method or the agreement of different measurement methods [11].

The prominence of the upper jaw and the prominence of the lower jaw are represented by SNA and SNB respectively. The difference between SNA and SNB, which is measured in degrees, is known as A point-Nasion-B point angle or ANB, which determines the skeletal discrepancy an individual has.

2.1 Mixed-effects models

The mixed effects model contains two types of effects which are fixed effects and random effects [12]. Fixed effects are associated with the entire population or with certain repeatable levels of experimental factors while random effects associated with random units that are drawn at random from the population. One-way classification is one of the classifications in mixed-effects models [13,14]. In one-way classification, observations are grouped according to only one specific characteristic and can be analyzed either using fixed effect model or random fixed-effect model, it depends on the types of inferences. It can be experimented

with in units or populations [15]. When modeling group data, we construct a simple model ignoring the grouping structure of the data. The formula of the mixed-effects model is given below.

$$Y_i = \beta_1 X_{i,1} + \dots + \beta_p X_{i,p} + b_1 Z_{i,1} + \dots + b_q Z_{i,q} + \varepsilon_i$$

where, $\beta_1 \dots \beta_p$ are the unknown parameters of the fixed effects, X_{ij} 's are the known design variables, Y_i 's are the observations, b_{ij} 's are the random coefficients, Z_{ij} 's are the random effect design variables, ε_i 's are the error terms. The errors ε_i 's are assumed to be independently distributed as $N(0, \sigma^2)$ and $\varepsilon_{ij} \sim N(0, \sigma^2)$ $i = 1, 2, 3, \dots, M$ and $j = 1, 2, 3, \dots, n_i$.

There may have been more than one model that may be identified, and need a method to determine which of them is preferred. Because of the above consideration, it is common to have several competing models. Therefore, several methods were used to select the best model among the other models. Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC), and Log-Likelihood methods are the methods usually used to select the best model.

$$AIC = -2\log L + 2m$$

$$BIC = -2\log L + m\log(N)$$

where m is the number of parameters, L is the Likelihood, N is the total number of observations. If AIC is used to compare two or more models, select the model with the lowest AIC value as the best model, and similarly select the model with the smallest BIC. Furthermore, a Bayes factor, cross-validation, Deviance Information Criterion (DIC), false discovery test, Focused Information Criterion (FIC), Hanna-Quinn information criterion can be used for model comparison.

2.2 Interrater agreements

The interrater agreement is mostly used to evaluate the two methods or treatments [16]. Here, interest is in evaluating if raters can be used interchangeably; it means whether the response measured by one rater can be replaced with another rater without leading to any differences. If this satisfies, selects one that is cheaper, less expensive, or easier to use [17,18]. Concordance Correlation (CCC) and Intraclass Correlation Coefficient (ICC) were performed to evaluate the effectiveness of the Twin-block appliance and the new low-cost arch development appliance. "Reproducibility" is one of the names used to call interrater agreement [19,20]. The main aim of this study is to provide a comparative description of the Twin-block appliance and a new low-cost arch development appliance for evaluation. The correlation coefficient is widely used to measure the agreement between the two appliances.

2.2.1 Concordance Correlation Coefficient (CCC)

The Concordance Correlation Coefficient (CCC) is used to assess the agreement between two continuous measurements made by different observers and it is an index [21]. The CCC can be defined as

$$CCC = 1 - \frac{MSD}{MSD'} = \frac{2\rho\sigma_1\sigma_2}{(\mu_1 - \mu_2)^2 + \sigma_1^2 + \sigma_2^2}$$

where ρ is a precision, σ_1, σ_2 are variances of the measurements and μ_1, μ_2 are the means of the measurements. The CCC value ranges between -1 and 1, and high values indicate better agreement and CCC=1 indicates perfect agreement.

2.2.2 Intraclass Correlation Coefficient (ICC)

The Intraclass Correlation Coefficient (ICC) was originally proposed by Sir Ronald Aylmer Fisher. The ICC prefers when considering a group of coefficients. The value of the ICC ranges between 0 and 1 with higher values indicate excellent reliability [22,23].

ICC is used to measure the relationship between a common class and it is a group of coefficients. Intraclass Coefficient of Correlation is the degree of consistency among measurements. The single measures and average measures estimate the reliability of single ratings and reliability of average of k ratings, respectively.

3 Results

In this study, a full sample size of 60 is divided into two treatment groups such as Twin Block appliance treatment group and the new low-cost appliance treatment group. Each group was consisted of 30 patients. Power analysis was performed using Rstudio and obtained the power for the experiment of 0.8614 and this increases experiment sensitivity to detect significant effects.

Descriptive statistics were calculated for SNA, SNB, Co-GN and, ANB at T_B and T_A for the two treatment groups. The comparison was performed by the Mann-Whitney U test. Statistical significance was evaluated at $P < 0.05$. Nonparametric statistics were applied to between-group comparisons to avoid type II statistical errors due to limited sample size.

Table 1. Comparison of the cephalometric measures before and after treatments

Cephalometric measures	Twin-block (n=30)					New low-cost arch development appliance (n=30)					Mann-Whitney U test	
	Mean	Median	SD	Min	Max	Mean	Median	SD	Min	Max	Z	p-value
Before treatments												
SNA ($^{\circ}$)	82.73	83.00	4.32	74.00	90.00	82.53	83.00	4.01	72.00	90.00	-0.149	0.882
SNB ($^{\circ}$)	75.23	75.00	2.66	70.00	80.00	75.77	76.00	2.89	70.00	86.00	0.530	0.596
Co-Gn (mm)	112.99	113.2	5.07	104.46	123.3	113.3	113.10	4.61	103.2	123.30	0.466	0.641
ANB ($^{\circ}$)	7.50	7.00	2.69	1.00	15.00	6.77	7.50	3.12	-2.00	12.00	-0.314	0.754
After treatments												
SNA ($^{\circ}$)	83.20	83.00	3.12	77.00	89.00	82.27	82.00	2.12	76.00	86.00	-1.121	0.262
SNB ($^{\circ}$)	80.33	79.50	2.60	76.00	86.00	79.37	79.00	2.89	74.00	83.00	-1.062	0.288
Co-Gn (mm)	119.80	118.2	5.75	107.90	132.1	121.2	121.00	4.94	105.3	131.90	1.412	0.158
ANB ($^{\circ}$)	2.90	3.00	1.32	0.00	6.00	2.90	3.00	1.03	1.00	5.00	-	-

The Twin-block group and new low-cost arch development group were similar at the start of the treatments and the end of the treatments. In Table 1, all the mean of the measurements increases after treatment. There is no significant larger increase or decrease in the measurements and no major differences between groups in measures of SNA, SNB, ANB, and Co Gn existed before treatment (Table 1). There is no any significant difference between SNA, SNB, Co Gn and, ANB measurements. All the p-values are greater than 0.05 which indicates there is no significant difference between means. Moreover, the Mann-Whitney U test was performed to check the treatment performance between male and female patients. Table 2 and Table 3 show the results of the test for males and females separately.

Table 2. Comparison on before and after treatment of male patients

Cephalometric measures	Twin-block Appliance (n = 15)					New Low-Cost Arch Development Appliance (n = 15)					Mann-Whitney U test	
	Mean	Median	SD	Min	Max	Mean	Median	SD	Min	Max	Z	p-value
Before treatments (T_B)												
SNA ($^{\circ}$)	83.40	83.00	4.53	74.00	90.00	83.87	84.00	2.90	79.00	90.00	-0.188	0.851
SNB ($^{\circ}$)	75.67	76.00	2.29	72.00	80.00	76.80	76.00	2.96	74.00	86.00	-0.950	0.342
Co-Gn (mm)	115.80	113.80	4.88	109.2	123.30	113.20	113.10	5.37	103.20	123.3	-1.162	0.245
ANB ($^{\circ}$)	7.77	7.00	3.47	1.00	15.00	7.07	8.00	3.35	-2.00	12.00	-0.147	0.884
After treatments (T_A)												
SNA ($^{\circ}$)	83.47	83.00	3.25	77.00	89.00	82.33	82.00	1.54	79.00	85.00	-1.120	0.263
SNB ($^{\circ}$)	80.47	79.00	2.72	77.00	86.00	79.47	79.00	1.25	77.00	82.00	-0.667	0.505
Co-Gn (mm)	122.80	124.10	5.32	115.3	132.10	121.70	122.30	6.13	105.30	131.9	-0.373	0.709
ANB ($^{\circ}$)	3.07	3.00	1.49	0.00	6.00	2.87	3.00	0.99	1.00	5.00	-0.851	0.395

Table 3. Comparison on before and after treatment of female patients

Cephalometric measures	Twin-block Appliance (n = 15)					New Low-Cost Arch Development Appliance (n = 15)					Mann-Whitney U test	
	Mean	Median	SD	Min	Max	Mean	Median	SD	Min	Max	Z	p-value
Before treatments (T_B)												
SNA (°)	82.07	82.00	4.13	76.00	87.00	81.20	81.00	4.60	72.00	88.00	-0.479	0.632
SNB (°)	74.80	75.00	3.00	70.00	80.00	74.73	75.00	2.50	70.00	79.00	-0.104	0.917
Co-Gn (mm)	110.2	108.4	3.49	104.5	116.9	113.50	113.1	3.88	107.9	119.90	-2.095	0.036*
ANB (°)	7.27	7.00	1.67	4.00	11.00	6.47	7.00	2.95	-1.00	10.00	-0.359	0.720
After treatments (T_A)												
SNA (°)	82.93	82.00	3.08	77.00	87.00	82.20	82.00	2.62	76.00	86.00	-0.649	0.516
SNB (°)	80.20	80.00	2.57	76.00	85.00	79.27	79.00	2.79	74.00	83.00	-0.819	0.413
Co-Gn (mm)	116.7	116.4	4.48	107.9	124.0	120.60	120.80	3.51	114.1	128.30	-2.510	0.012*
ANB (°)	2.73	3.00	1.16	0.00	4.00	2.93	2.00	1.09	2.00	5.00	-0.246	0.806

where SD: Standard Deviation; Min: minimum; Max: maximum; A: point A; Gn: gnathion; N: nasion; S: sella; Co: gonion

The overall changes in SNA, SNB, ANB and, Co-Gn measurements from T_B to T_A were similar between two groups of Twin-Block appliance and New Low-Cost Arch Development appliance for male patients. A significantly larger increase in the Co-Gn was detected in the New Low- Cost Arch Development appliance group (3.9°) compared with the Twin-Block appliance group of female patients. According to Table 3 Co-Gn measurements of female patients are significant at 5% significance level both before and after treatments.

Bland-Altman plot is used to explain the agreement between two quantitative measurements. Limits of the agreement are constructed to quantify the agreement between two methods. The mean and standard deviation of the difference between the two measurements were used to calculate the statistical limits. First, data are sorted from smallest to large according to the appliance, and then the mean of the two measurements was calculated for each pair. Next, the differences between appliance 1 and appliance 2 were taken. Finally, the differences were divided by mean to compute the average for each pair. That is possible to build the Bland-Altman plot and to evaluate the agreement.

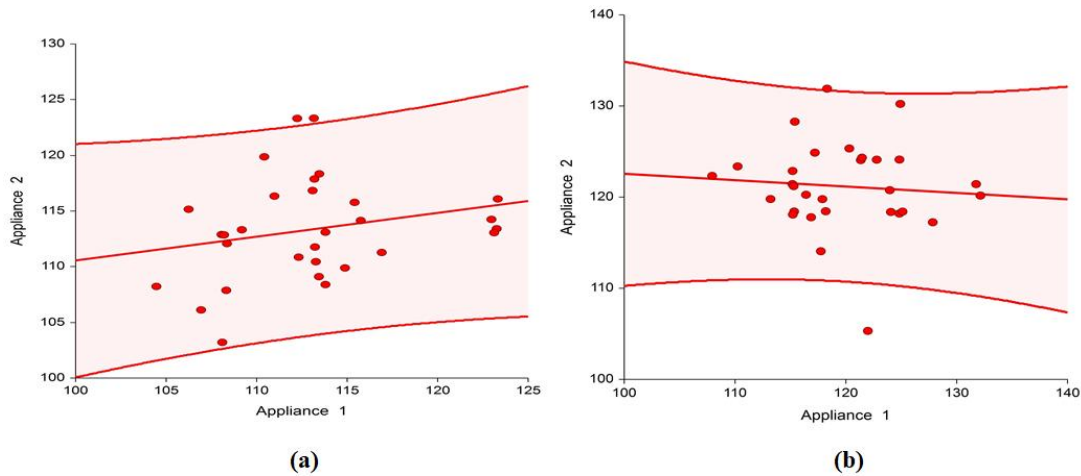


Fig. 3. The regression line between hypothetical measurements done by appliance 1 and appliance 2 (a) Before treatments and (b) After treatments

Fig. 3 shows the regression line between two appliances, the correlation coefficient between two appliances before treatment is 0.9637 and, for after treatment is 0.9609. Moreover, the averages of the differences between before and after treatment are -0.314 and -1.407, respectively. Before the treatments, the mean of

the new low-cost arch development appliance group is greater than the average of the Twin-block appliance group. That indicates the new low-cost arch development appliance measures 0.314 (App1-App2<0; i.e., App1 < App2) units than the Twin block. After treatment, the mean of the new low-cost arch development measures 1.407 units than the Twin block.

In Fig. 4, the bias of -0.314 and -1.40733 are represented by the gap between the zero difference, and these lines are shown in the red line. In this study, the standard deviation of differences (*s*) and mean difference (\bar{d}) were used to summarize the agreement between two appliances by calculating bias. Also, we expect to see most of the differences to lie between $\bar{d} + 2s$ and $\bar{d} - 2s$ range or 95% confidence interval. In Figure 4, the Bland Altman plot adds confidence intervals for the mean difference (green horizontal bars) and the agreement limits (pink bar). These lines give a visual impression of the precision of the lines. The mean difference lines lie below and above the zero horizontal line and the positions of these lines before treatments and after treatments are -0.314 and -1.407, respectively.

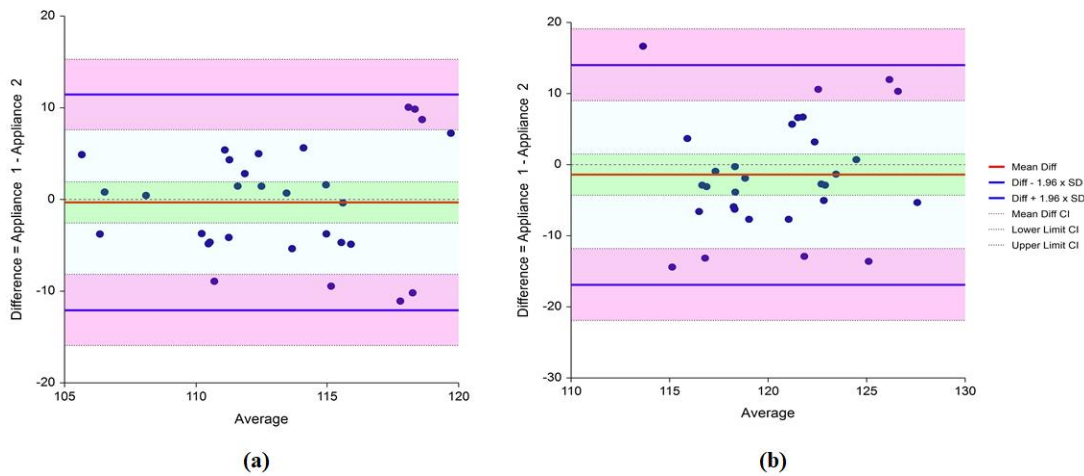


Fig. 4. Bland and Altman plot for data from Table 1, with the representation of the limits of agreement (blue line), from -1.96s to +1.96s. (a) Before and (b) After treatments

Table 4 provides the bias (mean difference) and limits of agreement and their lower and upper confidence intervals which are graphically shown in Fig. 4.

Table 4. Bland-Altman analysis: Bias and limits of agreement for appliance 1 and appliance 2

	Parameter	Value	Std. Dev	95% LCL	95% ULC
Before treatments	Bias (Difference)	-0.314	5.995	-2.553	1.925
	Lower Limit of Agreement	-12.065	1.892	-15.934	-8.196
	Upper Limit of Agreement	11.437	1.892	7.568	15.306
After treatments	Bias (Difference)	-1.407	7.880	-4.350	1.535
	Lower Limit of Agreement	-16.852	2.487	-21.938	-11.767
	Upper Limit of Agreement	14.038	2.487	8.952	19.123

After that, data were used to illustrate agreement evaluation. The dataset has 60 subjects and on subjects, two measurements were taken before and after. Moreover, there are two raters, the Twin-block appliance and, a new low-cost arch development appliance. The mixed effects model was fitted to the data set and agreement evaluation was done using the fitted model.

It was observed that the Concordance Correlation Coefficient (CCC) for after treatment as 0.9172 with a (0.8488, 0.9555) 95% confidence interval. Furthermore, it gives a Pearson correlation of 0.9609 and a bias

correlation factor of 0.9545. ICC values after treatment for both single measures and average measures are 0.9499 and 0.9743 with the 95% confidence intervals (0.8976, 0.9758) and (0.9460, 0.9878) respectively.

In both cases, ICC is greater than 0.90 which indicates both treatments have a better agreement. That shows either the Twin-block appliance or a new low-cost arch development appliance can be used as the treatment of class II division 1 malocclusion with relative mandibular retrognathia. Both appliances have similar effects on growth modification.

4 Discussion

There are several methods to correct the class II malocclusion. Most of the studies compared the Twin-block appliance with different appliances. Schaefer and co-workers have evaluated Twin-block and stainless steel crown Herbst appliances followed by fixed appliances [24]. These two treatments produced similar changes in class II patients. The active headgear and the Twin-block treatment successfully correct the class II malocclusion [25]. Besides, the Twin-block appliance and Forsus fatigue-resistant device correct class II malocclusion with 80% success rate [26]. This study compared the treatment effects of the Twin-Block appliance and a New Low-Cost Arch Development appliance. Both appliances produced similar results in class II division 1 patients; these changes led to correction of the mandibular length at the end of the overall treatment. Moreover, there is no significant difference between the two appliances, increasing maxillary skeletal SNA, mandibular skeletal SNB Co-Gn, and maxillary ANB before and after treatments. However, there is a significant difference in increasing the length of the mandible (Co-Gn) for female patients. Comparison of Twin-Block and activator treatment on the soft tissue profile, they found the most pronounced effects of the activator and Twin-Block appliances were the significant forward movement of the mandibular length concerning for to the vertical reference line [27].

The Twin-block group and new low-cost arch development group were similar at the beginning of the treatments and after the treatments. There is no significant difference between two appliances increasing maxillary skeletal SNA, mandibular skeletal SNB and Co-Gn and maxillary ANB before and after treatments. Also, there is no significant increase or decrease between the two treatments. A significantly larger increase in the Co-Gn was detected in the New Low- Cost Arch Development appliance group compared with the Twin-Block appliance group of female patients. According to both CCC and ICC values, the Twin Block appliance and new low-cost arch development appliance act in a similar manner.

The correlations between the two treatments were remarkably high for both before and after treatment. The Correlation coefficient between the two appliances is 0.9609 after treatment. That indicates there is a better relationship between the Twin-block appliance and the New Low-Cost Arch Development appliance. After the treatments, the mean of the new low-cost arch development appliance is greater than the average of the Twin-block appliance. That indicates the new low-cost arch development appliance measures 1.4073 (App1-App2<0; i.e, App1 < App2) units than the Twin block. O'Brien was done in the study to check the effectiveness of early orthodontic treatment with the Twin-Block appliance and he found that the Twin-Block appliance resulted in a reduction of overjet, correction of molar relationships, and reduction in the severity of malocclusion [28]. Moreover, there was a study to compare two types of treatment for class II malocclusions assessing mandibular length behaviour in patients who attend for full treatment with standard edgewise and cervical headgear appliances and who used cervical headgear in the first phase and full orthodontic appliances in the second phase. In both groups, the effective treatment to class II malocclusion did not interfere in the direction and amount of growth of mandibular and no influence on the anticlockwise rotation of the mandible [29].

5 Conclusion

The Twin-block group and new low-cost arch development group were similar at the beginning of the treatments and after the treatments. There is no significant difference between two appliances increasing maxillary skeletal SNA, mandibular skeletal SNB Co-Gn, and maxillary ANB before and after treatments.

Also, there is no significant increase or decrease between the two treatments. A significantly larger increase in the Co-Gn was detected in the New Low-Cost Arch Development appliance group compared with the Twin-Block appliance group of female patients. According to both CCC and ICC values, the Twin Block appliance and new low-cost arch development appliance act in a similar manner.

This study compared the treatment effects of the Twin Block appliance and new low-cost appliance. Both appliances produced similar therapeutic changes in Class II division 1 patient; these changes led to the correction of all the parameters at the end of the overall treatment. The new low-cost appliance produced similar results as the Twin Block appliance. Hence, a new low-cost appliance can be used to treat unprivileged Class II division 1 patients in Sri Lanka.

Consent

As per international standard or university standards, patients' written consent has been collected and preserved by the author(s).

Ethical Approval

This study was started as a clinical trial with ethical clearance. Records of 1500 orthodontic patients who attended the orthodontic clinic at the Faculty of Dental, University of Peradeniya were selected for the study, but many cases did not satisfy the selection criteria.

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Competing Interests

Authors have declared that no competing interests exist.

References

- [1] Xie Q, Li X, Xu X. The difficult relationship between occlusal interferences and temporomandibular disorder-insight from animal and human experimental studies. *J Oral Rehabil.* 2013;40:279-295.
- [2] McKernan SC, Kuthy RA, Momany ET, McQuistan MR, Hanley PF, Jones MP, et al. Geographic accessibility and utilization of orthodontic services among medicaid children and adolescents. *J Public Health Dent.* 2013;73(1):56-64.
- [3] Ribeiro GLU, Jacob HB. Understanding the basis of space closure in orthodontics for a more efficient orthodontic treatment. *Dental Press J Orthod.* 2016;21(2):115-125.
- [4] Al-Moghrabi D, Salazar CF. Compliance with removable orthodontic appliance and adjuncts: A systematic review and meta-analysis. *Am J. Orthod and Dentofacial Orthop.* 2017;151(1):17-32.
- [5] Mew M. Orthodontics: Causes of malocclusion. *Br Dent J.* 2015;218(6):319-320.
- [6] Clark W. Design and management of twin blocks: Reflections after 30 years of clinical use. *J Orthod.* 2010;37(3):204-211.

- [7] Schaefer AT, McNamara JA, Franchi L, Baccetti T. A cephalometric comparison of treatment with the twin-block and stainless steel crown herbst appliances followed by fixed appliance therapy. *Am J Orthod Dentofacial Orthop.* 2004;126(1):7-15.
- [8] Spalji S, Tranesen KM, Bikeland K, Katic V, Pavlic A, Vandevska-Radunovic V. Comparison of activator-headgear and twin-block treatment approaches in class II division 1 malocclusion. *Biomed Res Int.* 2017;1-9.
- [9] Giuntini V, Vangelisti A, Masucci C, Defraia E, MaNamara JA, Franchi L. Treatment effects produced by the twin-block appliances vs the forsus fatigue resistant device in growing class II patients. *Angle Orthod.* 2015;85(5):784-789.
- [10] Uttley J. Power analysis, sample size and assessment of statistical assumptions-improving the evidential value of lighting research. *JIES.* 2019;15(3):143-162.
- [11] Storjord HP, Teodorsen MM, Bergdahl J, Johnsen JK. Dental anxiety: A comparison of students of dentistry, biology and psychology. *J Multidiscip Healthc.* 2014;7:413-418.
- [12] Nachar N. The Mann-Whitney U: A test for assessing whether two independent samples come. *Tutor Quant Methods Psychol.* 2008;4(1):13-20.
- [13] David G. Understanding Bland Altman analysis. *Biochemia Medica.* 2015;25(2):141-150.
- [14] Martin CB, Ma X, McIntyre GT, Wang W, Lin P, Chalmers EV, et al. The validity and reliability of an automated method of scoring dental arch relationships in unilateral cleft lip and palate using the modified Huddart-Bodenham scoring system. *Eur J. Orthod.* 2016;38(4):353-358.
- [15] Pinhero JC, Bates DM. *S and S-plus.* New York: Springer-Verlag Publishing; 2002.
- [16] Magezi DA. Linear mixed-effects models for within-participant psychology experiments: Tutorial and free graphical user interface (LMMgui). *Frontiers in Psychology.* 2015;6(2). DOI: <https://doi.org/10.3389/fpsyg.2015.00002>
- [17] Harrison XA, Donaldson L, Correa-Cano ME, Evans J, Fisher DN, et al. A brief introduction to mixed-effects modeling and multi-model inference in ecology. *PeerJ- Life & Environment.* 2018;6. DOI: [10.7717/peerj.4794](https://doi.org/10.7717/peerj.4794)
- [18] Bukoski JJ, Broadhead JS, Donato DC, Murdiyarso D, Gregoire TG. The use of mixed-effects models for obtaining low-cost ecosystem carbon stock estimate in mangroves of the Asia-Pacific. *PLoS ONE.* 2017;12(1):1-15.
- [19] Lin LI. Measuring agreement. In *Encyclopedia of Biopharmaceutical Statistics*, 2nd Ed New York, Marcel Dekker. 2003;561-567.
- [20] King TS, Chinchilli VM. A generalized concordance correlation coefficient for continuous and categorical data. *Stat Med.* 2001;20(14): 673-684.
- [21] Barnhart HX, Williamson JM. Modeling concordance correlation via GEE to evaluate reproducibility. *Biometrics.* 2001;57(3):931-940.
- [22] Lin LI. A concordance correlation coefficient to evaluate reproducibility. *Biometrics.* 1989;45(1):255-268. Corrections. 2000;56:324-325.

- [23] Carrasco JL, Jover L, King TS, Chinchilli VM. Comparison of concordance correlation coefficient estimating approaches with skewed data. *J Biopharm Stat.* 2007;17:673-684.
- [24] Lin LI. Assay validation using the concordance correlation coefficient. *Biometrics.* 1992;48(2):599-604.
- [25] Muller R, Buttner PA. A critical discussion of intraclass correlation coefficient. *Stat Med.* 1994;13(23-24):2465-2476.
- [26] Bujang MA, Baharum N. A simplified guide to determine of sample size requirements for estimating the value of intraclass correlation coefficient: A review. *J. Dent Sci.* 2017;12(1):1-11.
- [27] Varlik SK, Gultan A, Tumer N. Comparison of the effects of twin-block and activator treatment on the soft tissue profile. *Eur J Orthod.* 2008;30(2):128-134.
- [28] O'Brien K, Wright J, Conboy F, Sanjie Y, et al. Effectiveness of early orthodontic treatment with the twin-block appliance: A multicenter, randomized, controlled trial. Part 1: Dental and skeletal effects. *Am J Orthod Dentofacial Orthop.* 2003;124(3):234-243.
- [29] Lira ADS, Souza MMG, Bolognese AM, Nojima M. Comparison of 2 types of treatment of skeletal class II malocclusions: A 5-year post-retention analysis. *Braz J Oral Sci.* 2014;13(4).
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