

Class II subdivision malocclusions treated non extraction with symmetrical forces

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Dedication

To my wife,

Dr. Claudia Bollain Y Goytia

For her encouragement and support that made this all possible.
I couldn't have done it without you.

Abstract

Non-extraction treatment of Class II subdivision malocclusion, with symmetrical forces has not been described in the literature. This study evaluated the use of symmetrical forces with face-bow therapy in conjunction with full fixed appliances of 47 patients (28 females and 19 males) that were treated by the same practitioner. The pretreatment and post-treatment records were taken at an average age of 12.3 and 14.4 years respectively. The results showed that the Caballero index (The distance from the tip of the mesio-buccal cusp of the upper first molar to the mesio-buccal groove of the lower first molar on the class II side.) decreased from 1.86 to 0.12 mm, making this statistically significant. The midline showed a distinctive improvement having a pretreatment value of 1.33 mm and a post treatment value of 0.29 mm. Arch length had a modest gain of 1.15 mm with the left side having the biggest contribution. The maxillary intermolar position remained stable with a 0.3 mm net change. The ANB angle decreased from 3.5 to 2.1 degrees. The upper incisor in relation to S-N and lower incisor inclination increased by 3.3 degrees. Finally, the mandibular plane angle increased in value from 31.2 degrees to 32.2 post treatment. Within the limits of this study and based on the test of equivalence, it is concluded that when symmetrical forces are used in non extraction therapy for Class II subdivision growing patients, the class II malocclusion is corrected, but some asymmetry in the molar position remains.

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Introduction

A Class II subdivision malocclusion is defined as a malocclusion with one side in a Class I molar relationship and the other side in a Class II molar relationship. Class II subdivision is a common malocclusion accounting for more than 50% of all Class II malocclusions (32, 37). The etiology of this malocclusion can be attributed to several dental and skeletal factors such as early exfoliation of a primary tooth and subsequent mesial drift of molars, carious lesions that promote loss of space, ectopic eruption of teeth with drift of adjacent teeth, congenitally missing teeth, and skeletal asymmetries.

A number of different treatment protocols exist to treat this type of malocclusion. The treatment varies depending on the ability and expertise of the orthodontic professional in treating this malocclusion; some of the proposed therapeutics involves the extractions of teeth to restore symmetry, asymmetric mechanics applied by a wide variety of appliances, and surgical intervention.

However no studies have reported a treatment approach where a non-extraction treatment protocol and the application of symmetrical mechanical forces. This treatment protocol was described by Dr. Richard “Wick” Alexander from Arlington, Texas; as part of his treatment philosophy, “The

Alexander Discipline”. The Alexander Discipline is a combination of time proven "truths" learned from past orthodontic experts and over 40 years of trial and error, evaluation, and research. By connecting these experiences, the result is one of the profession's most studied and researched techniques.

Review of the literature

The term subdivision has always been controversial. Molly Siegel (24) surveyed fifty-seven chairs of orthodontic departments around the U.S, and asked them to describe their understanding of the definition of a subdivision malocclusion. To no one’s surprise the responses varied and there was less than 65% agreement on the meaning of “subdivision”. The Class II side, which is determined as the subdivision in question, was identified by 22 departments and the class I by 8. In some departments faculty was split and could not agree on an answer. The American Association of Orthodontists glossary gives the following definition: “Subdivision is used to describe unilateral malocclusion characteristics of the affected posterior segmental relationships”. The original Angle classification describes it as “Occasionally the molar occlusion is Class II on one side and Class I on the other” (32). Siegel (25) concluded that she would teach her dental students

to clarify it by declaring which molar relationship is Class I and which is Class II. Therefore the location of the asymmetry must be identified prior to orthodontic treatment.

Subdivision cases account for 50% of all Class II malocclusions (1, 3). It is important to know the most predictable and stable methods to treat these cases. Patients with Class II subdivision malocclusions have Class I characteristics on one side and Class II characteristics on the other, primarily because of the distal positioning of the mandibular first molar in relation to the maxillary first molar on the Class II side (1-3). This malocclusion can also be produced by the more mesial position of the maxillary first molar in relation to the mandibular first molar on the Class II side. There is evidence that the mandible may account for some of the asymmetry in the subdivision malocclusions. (1, 23)

Williamson and Simmons (23) who used Sub Mental Vertex films to study the mandibular asymmetry, revealed a tendency toward a Class II buccal segment relationship on the shorter side of the mandible. Rose et al. (2) found that the mandibular first molar is located more posteriorly on the class II side of the subdivision malocclusion within a mandible that exhibits no other unusual asymmetry. The resulting asymmetric occlusal relationship

complicates orthodontic treatment.

Possible treatment approaches for Class II subdivision malocclusions

include symmetric extraction of four premolars and asymmetric extractions of three premolars (3-7). The four premolar extraction approach will produce a final occlusion with bilateral Class I molar and canine relationships. With this approach, a Class I molar relationship on the original Class II side and consequent coincidence of the maxillary and mandibular dental midlines depends largely on patient compliance in the use of class II and anterior diagonal elastics (3, 8-12). On the other hand, asymmetric extraction of three premolars (two maxillary premolars and one mandibular premolar on the Class I side) will produce Class I canine and molar relationships on the class I side and Class II molar and Class I canine relationships on the Class II side, along with coincidence of the maxillary and mandibular dental midlines to each other and in relation to the midsagittal plane. (1, 3-7, 13).

Alexander states that all patients with Class II malocclusions present with some asymmetries, both skeletal and dental. He believes that the simplest method to correct these problems is to apply symmetric forces to maxillary

teeth and the maxilla by the use of symmetric facebows and wires that have been coordinated to create occlusal symmetry (26). In the absence of anteroposterior asymmetry in the maxillary arch and with minimal or no crowding in the arches, serious consideration should be given to accepting the asymmetry in the occlusion, including a deviated mandibular midline, and to treating to an ideal overjet and overbite as the primary objectives. All of these different techniques need to be considered when planning the treatment of class II subdivision malocclusions. (2)

As there are currently no reports as a treatment approach where a non-extraction protocol and the application of symmetrical forces have been used for this type of malocclusion, the following study will examine the effects and influence of symmetrical forces in an asymmetrical environment (malocclusion) in a select sample of patients.

Aims of this Study

- 1) To identify a sample of Class II subdivision subjects and to describe their initial dental and skeletal characteristics using study models and lateral cephalometric radiographs.

- 2) To measure pre- and post treatment occlusal asymmetry and maxillary molar asymmetry of these subjects.

- 3) To determine the dental and skeletal changes as a result of the treatment provided to these subjects.

- 4) To determine if the symmetric mechanics used were effective in creating post treatment symmetry.

Null Hypothesis

A) Null Hypothesis (H_0): Following treatment of growing Class II subdivision malocclusion patients, the occlusal relationship will not be restored; proving the treatment method is not successful in restoring symmetry.

B) Alternative Hypothesis (H_A): Following treatment of growing Class II subdivision malocclusion patients, the occlusal relationship will be restored proving the treatment method to be successful in restoring symmetry.

Materials and Methods

Pretreatment and post-treatment records of 47 patients were collected from the private practice of Dr. Richard “Wick” Alexander in Arlington, Texas.

The inclusion criteria for the present study were as follows:

1. Patients between 9 and 15 years of age at the start of treatment.
2. Dental casts available pre and post-treatment demonstrating a Class II subdivision malocclusions of at least 1 mm in respect of the mesio-buccal cusp of the upper first molar occluding in the mesio buccal groove of the mandibular first molar.
3. Lateral cephalometric x-rays available pre and post treatment.
4. Non extraction treatment.
5. Treated by the same practitioner with full fixed appliances, and symmetric cervical pull facebow.
6. No missing teeth.
7. Full permanent dentition through first molars.

The final study sample included 47 subjects, 28 females and 19 males. A Post-hoc power study was performed based on the values described above. A computed power of $>.999$ was obtained from our data sample concluding our $N=47$ has sufficient statistical power (table 8).

The initial records were taken before bonding, at a mean age of 12.3 years (T1); post treatment records were taken within 3-5 months of debonding at a median age of 14.4 years (T2).

Treatment Protocol

The same practitioner performed all treatment according to a standard protocol as follows: All subjects were treated with full-fixed orthodontic appliances with prescribed torque and base variation in a .018" slot (Alexander prescription). After the initial wire was placed, all remaining arch wires were bent with omega loops and tied back with .014 ligature wire with a Steiner type ligature tying plier.

In all cases the finishing arch wire was a stainless steel archwire with the dimensions .017 X .025" stainless steel. Each patient was instructed to wear the headgear 12 to 16 hours per day.

The inner bow was placed in the headgear tubes that were occlusally attached to the maxillary first molar bands. The outer bow was maintained parallel to the inner bow and aligned parallel to the occlusal plane.

Approximately 16 ounces (4.5 Newtons) of force was applied.

All maxillary teeth were bonded with brackets and archwires that were tied back to the first molars. Face-bow therapy was discontinued once a Class I molar relationship had been attained. A wrap-around retainer was used for maxillary retention. A canine to canine retainer, constructed with 0.036 wire, was bonded to the lingual surfaces of the mandibular anterior teeth for

mandibular retention. When the retention devices were removed, a small amount of interproximal reduction was performed to better approximate the proximal surfaces. All archwires were preformed and adjusted symmetrically to each patient by the operator. Upper and lower wires were coordinated for symmetry during the treatment, bilateral ¼” 6 oz Class II elastics were used to finalize the occlusion. The average treatment time was 21 months.

Model analysis

The following measurements were taken on the maxillary and mandibular casts at T1 and T2, with digital calipers to the closest 0.001 inches.

- 1. Total Arch length: (AL)** Using a brass wire that follows the arch form, measured as the sum of the right and left distances between the mesial contact points of the first permanent molars to the contact point of the central incisors. The wire is fully extended and measured against a millimetric ruler for a final value. (Fig. 1)



Fig. 1

2. Midline: (ML) Measured as the horizontal distance in mm between the incisal midpoint of maxillary central incisors and the incisal midpoint of the mandibular central incisors. (Fig.2)



Fig. 2

3. Maxillary A-P intermolar position: (MAP) The absolute value distance in mm between the two lines extending from the mesial of the upper first molars perpendicular to a line representing the palatal raphe.

(Fig. 3A, 3B)



Fig. 3A



Fig 3B

4. Caballero Symmetry index: (CI) The distance from the tip of the mesio-buccal cusp of the maxillary first molar to the mesio-buccal groove of the mandibular first molar on the Class II side. (Fig. 4)



(Fig.4)

Cephalometric analysis

The following measurements were taken on lateral cephalograms T1 and T2, by a single operator . Ten landmarks were identified, marked and traced. The following six angular measurements were calculated.

Cephalometric Measurements

1. **SNA angle:** The angle between the SN plane and a line connecting nasion and A point. (Fig.5)

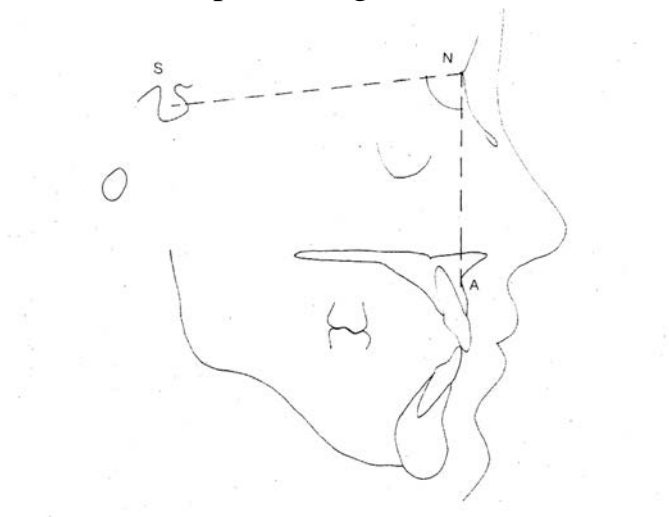


Fig.5

2. **SNB angle:** The angle between the SN plane and a line connecting nasion and B point. (Fig.6)

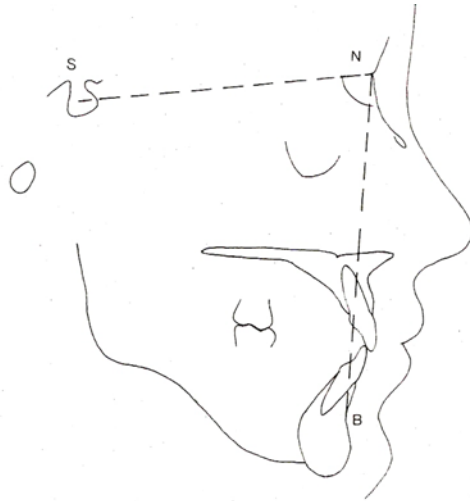


Fig.6

3. **ANB angle:** SNA minus SNB. (Fig. 7)

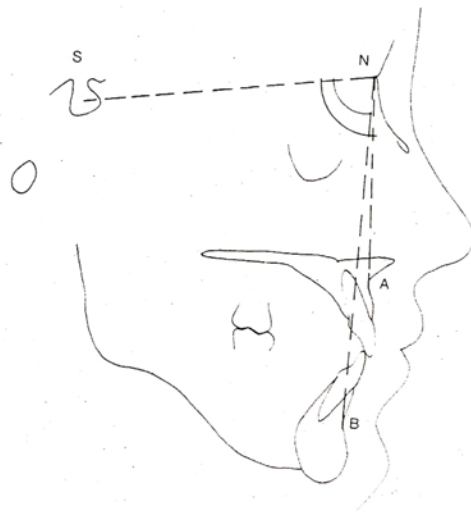


Fig 7

a) **SN- MP:** The angle formed by the intersection of SN and the mandibular plane.(Gonion to Menton) (Fig. 8)

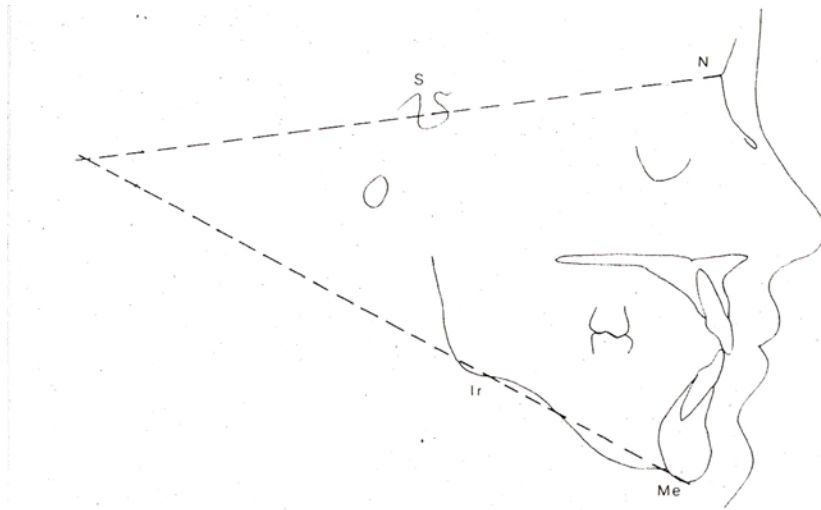


Fig 8

5) Upper 1 to SN: The angle between SN and a line connecting the incisal edge and apex of the maxillary central incisors. (Fig.9)

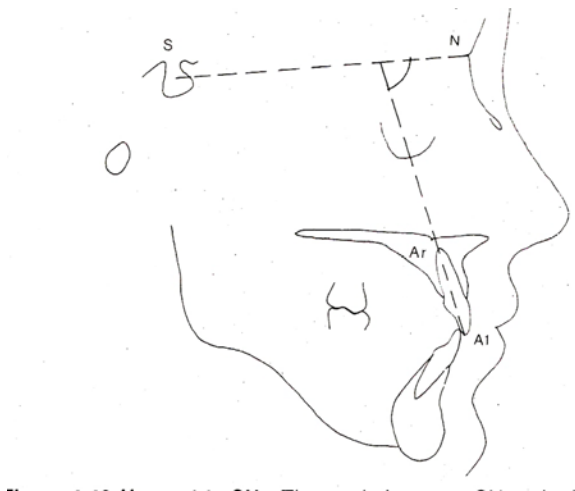


Fig.9

6) IMPA: The angle between the mandibular plane and the long axis of the mandibular central incisor (tip to apex). (Fig.10)

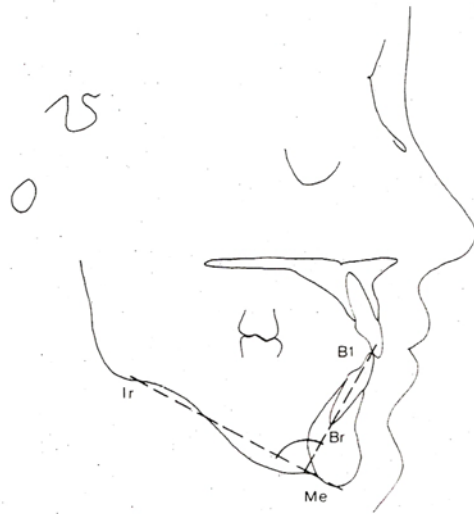


Fig 10

In order to assess the reliability (consistency) of the measurements taken by the principal investigator, a random sample of patients with the same characteristics of the population in the study was collected from the files of the graduate orthodontic clinic at the University of Minnesota. A set of variables were taken twice with an interval of 14 days. From them the variable of interest selected was the Caballero Index. The mean of the deviations (differences) between the two time points for Caballero Index were calculated. The values obtained seem satisfactory having a mean difference of -0.022, concluding that the operator collection is highly reliable. (Figure 11, 12).

Statistical analysis

Mean values, medians and standard deviations were calculated for pretreatment (T1) (Table 1-2) and post treatment (Table 3-4) measurements (T2). The statistical test of equivalence will measure our single group sample using the Caballero symmetry index as main variable.

The equivalence test, tests the null hypothesis that the mean difference is not contained within pre-specified bounds, for the present study, these bounds were set at -1 and 1mm.

Obtaining a 95% P value would mean that the null hypothesis is rejected and conclude that the mean differences are contained within the pre-specified bounds. With equivalence testing we want the confidence interval to be entirely contained within the equivalence bounds. This will lead to a “significant” conclusion.

As stated on the hypothesis, the average symmetry measurement will be close to 0, as the treatment method is successful in restoring symmetry.

What is meant by “close to zero” is inclusion within the equivalence interval, tentatively defined as [-1mm, +1mm] in the population. The sample is intended to represent a population of patients, and we will

decide if the evidence in the sample is strong enough to draw a conclusion with respect to the population, specifically whether we can, as we would like to, reject the H_0 of non-equivalence.

The t-test of equivalence, then, will pertain to these null and alternative

Hypotheses:

$H_0: \mu \leq -1$ or $\mu \geq 1$ (The confidence interval falls entirely outside the bounds. Therefore, we conclude that the mean differences are different)

$H_A: -1 < \mu < 1$ (The confidence interval falls entirely within the bounds. Thus, we conclude that the mean differences are equivalent).

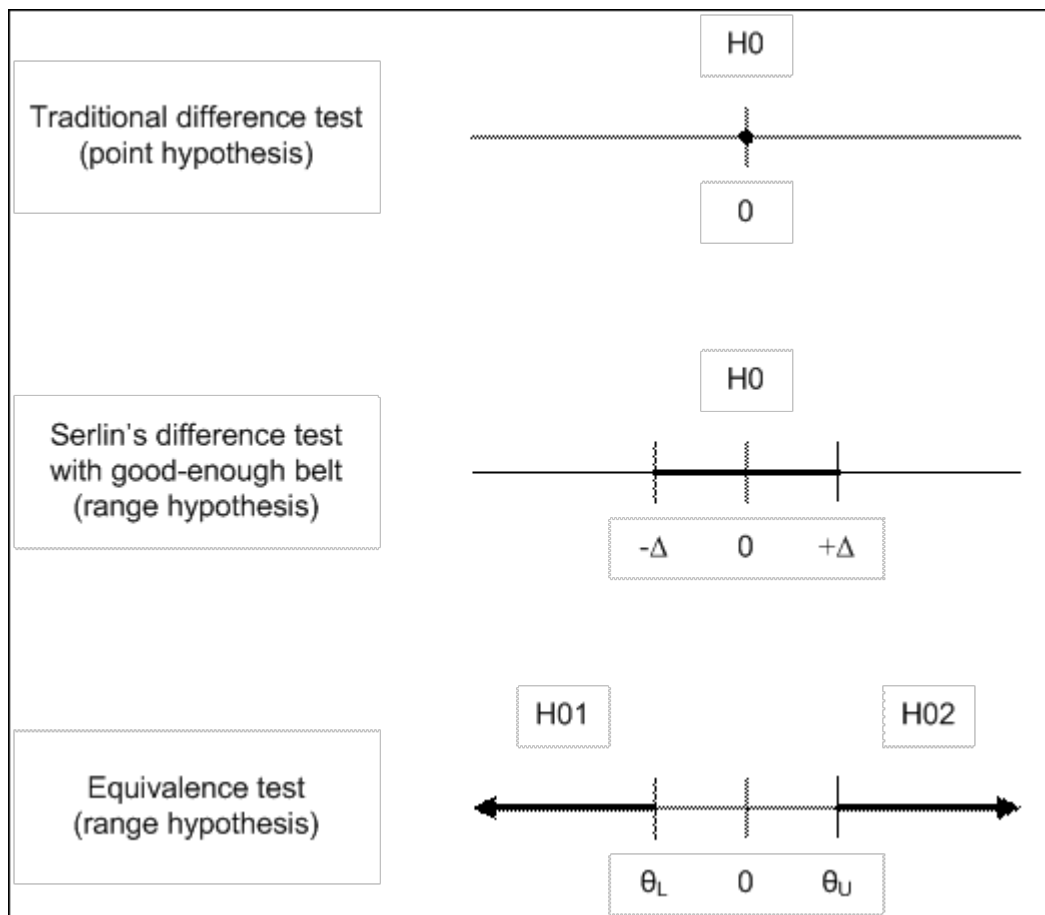


Figure 11. Traditional, Serlin's and Equivalence test

Results

The subdivision distribution in the sample studied showed a tendency towards the right side in both males and females. Five males presented a left side subdivision malocclusion while 14 presented a class II subdivision in the right side; Seven females presented with a left subdivision and 21 with a right subdivision malocclusion (Table 5).

Model Analysis

The variables recorded presented minor clinical and statistical significance with exception of the Caballero Index (CI) and Midline (ML). The mean changes in the Caballero Index from T1 (1.86) to T2 (0.12) was 1.74mm. All of the cases in the sample were corrected from a subdivision into a class I relationship. As the variable to test our hypothesis, the equivalence test with (-1, 1) equivalence interval shows a high P value of $<.0001$ thus rejecting the null hypothesis, proving the treatment method is successful in restoring symmetry based on the Caballero index (Table 6, 7).

As mentioned previously the midline (ML) presented one of the most significant changes, having a pretreatment mean of 1.33 mm at T1 and a posttreatment value (T2) of 0.29 mm with a mean change of 1.04 mm. The total arch length increased by 1.15 mm, with the left side having the biggest contribution to the total length gain (0.74 mm). The maxillary intermolar

position reflected a slight change from pretreatment (T1) 1.88 mm to a 1.51 mm at T2, indicating some anteroposterior asymmetry remains in the molar position. (Table 1, 3).

Cephalometric Analysis

The effect of the treatment in relation to the SNA and SNB angle difference (ANB) was a slight reduction of 1.6 degrees having a pretreatment value of 3.5 degrees in comparison to a 2.1 post-treatment. The inclination of the mandibular incisors increased by 3.3 degrees (92.0 T1 and 95.3 T2). The inclination of the maxillary incisors in relation to the cranial base increased from 102 degrees to 105.3 degrees (3.3 degrees difference). Finally, the mandibular plane increased from 31.2 degrees pretreatment to 32.2 post treatment. (Table 2, 4)

Discussion

The final sample of 47 cases showed sufficient statistical power ($>.999$). From the 47 patients 19 were males and 28 females. In regards to the subdivision distribution 35 presented with a right side subdivision malocclusion and 12 with a left side subdivision. The initial records were taken at a median age of 12 years of age (T1) and post-treatment records were taken at a median age of 14 years (T2). The same practitioner performed all treatment according to a standard protocol involving full fixed appliances and headgear. Six variables were measured in dental models and 6 angular measurements in cephalometric x-rays. Clinically, one of the main goals of any professional in orthodontics is to achieve an Angle class I molar relationship (32), which is the standard of physiologic occlusion (31). All of the cases in the sample were corrected from a subdivision into a Class I relationship. The correction of the Caballero index can be explained by the additive effects of 15 degrees rotation built in the maxillary molars orthodontic bands, which is designed to provide a mesial out rotation couple, thus improving the position of the mesio-buccal cusp in relationship with the lower molar and the orthopedic effects of the headgear, which are consistent with previously published reports (33, 34). Coincident dental midlines are an important component of functional occlusion and provide a useful guide to

the clinician in establishing good buccal interdigitation (30). A symmetrical dental arrangement is thought to be an important component of an attractive smile (27, 28, 29). The midline correction may also be a combination of the elimination of crowding in the dentition, which reestablishes the natural alignment of teeth thus improving the arch symmetry and the effects of elastics; these work by applying additional force in the dentition that causes reciprocal dentoalveolar changes in both the upper and lower arches. The maxillary and mandibular incisors showed minor proinclination mostly due to the elimination of crowding by the straight wire effect and a class II vector of force in intermaxillary elastics. The intermolar position had minimal change, it can be assumed that the 0.3mm of difference was mostly attained by the de-rotation of the molar into a more Class I pattern (mesial out rotation). Also, as the treatment protocol dictates, all wires were bent with omega loops mesially to the molar bands and tied back. This most likely “locks” the molars in place preventing any further change in position, maintaining a consolidated “unit” instead of having independent units within the arch (teeth). In that regard we can say that the total arch length can be explained in the same way. The cephalometric analysis found that the ANB correction was primarily due to the decrease of SNA (33, 34), suggesting that the maxilla was maintained by the orthopedic forces exerted by the

headgear. Previous investigations have demonstrated an opening of the mandibular plane angle associated with maxillary molar extrusion (35, 36) another contributor is the side effects of extrusive forces related to the use of intermaxillary elastics. However this effect is minimal in this study, mainly due to the proper mechanotherapy, (tied back arch wires and properly adjusted face bow) or probably reflects a physiologic “aging” modification with minor vertical growth. The increase of the IMPA angle reflects the flaring of the dentition as the crowding is resolved and/or the effects of Class II elastics used in this type of malocclusion. The increase of the upper incisor inclination (U1-SN) shows the same response to the initial elimination of crowding during the leveling and alignment phase and torque expression, however this is done in a controlled manner by the posterior arch consolidation mechanics.

Conclusion

Non extraction therapy in growing class II subdivision cases treated with symmetrical forces, within the parameters of this study was successful in gaining a Class I molar relationship on the original Class II subdivision side; And an overall satisfactory orthodontic outcome. The attained results can be obtained with proper diagnosis and treatment planning in cooperative

patients with favorable growth patterns. However, it is not to be expected an absolute restoration of symmetry balance of all the variables or clinical characteristics in this type of patients as demonstrated in the existing maxillary molar asymmetry which was not improved as a result of the application of symmetric forces.

Table 1*Model data T1 measurements.*

Variable	N	Mean	Median	Std Dev	Std Error	Minimum	Maximum
Right_Arch_Length	47	39.1170	39.0000	2.4120	0.3518	34.0000	44.5000
Left_Arch_Length	47	38.3830	38.0000	2.2965	0.3350	34.0000	45.0000
Total Arch Length	47	77.5000	77.0000	4.3289	0.6314	69.0000	89.5000
Midline	47	1.3383	1.3000	0.7657	0.1117	0.0000	3.7000
Intermolar_position	47	1.8872	2.0000	0.8858	0.1292	0.0000	3.5000
Caballero index	47	1.8677	1.7000	0.8237	0.1201	0.5000	4.5000
Age	47	12.3447	12.2000	1.4680	0.2141	9.1100	15.8000
Tx time	47	21.6596	22.0000	4.7332	0.6904	12.0000	34.0000

Table 2*Cephalometric data T1 measurements*

Variable	N	Mean	Median	Std Dev	Std Error	Minimum	Maximum
SNA	47	82.1064	82.0000	3.2786	0.4782	75.0000	92.0000
SNB	47	78.6489	78.0000	3.4937	0.5096	71.0000	89.0000
ANB	47	3.4574	3.0000	2.2909	0.3342	-7.0000	9.0000
IMPA	47	92.0000	94.0000	7.1688	1.0457	72.0000	104.0000
SN_MP	47	31.2553	31.0000	4.2858	0.6251	23.0000	40.0000
U1_SN	47	102.0000	102.0000	8.8244	1.2872	87.0000	129.0000

Table 3*Model data T2 measurements*

Variable	N	Mean	Median	Std Dev	Std Error	Minimum	Maximum
Right arch length	47	39.5319	39.5000	2.0992	0.3062	34.0000	44.0000
Left arch length	47	39.1277	39.0000	2.1378	0.3118	33.0000	43.0000
Total arch length	47	78.6596	78.5000	4.1008	0.5982	67.0000	87.0000
Midline	47	0.2957	0.0000	0.4374	0.0638	0.0000	1.6000
Intermolar position	47	1.5170	1.5000	0.8331	0.1215	0.0000	4.0000
Caballero index	47	0.1230	0.0000	0.8611	0.1256	-1.3000	3.3000

Table 4*Cephalometric data T2 measurements*

Variable	N	Mean	Median	Std Dev	Std Error	Minimum	Maximum
SNA	47	80.9043	81.0000	3.4336	0.5008	73.0000	93.5000
SNB	47	78.6915	78.0000	3.6913	0.5384	71.0000	94.0000
ANB	47	2.1489	2.0000	1.5320	0.2235	-1.0000	6.0000
IMPA	47	95.3085	96.0000	6.7402	0.9832	80.0000	109.0000
SN_MP	47	32.2128	31.0000	6.6755	0.9737	23.0000	68.0000
U1_SN	47	105.1489	105.0000	7.2741	1.0610	91.0000	121.0000

Table 5

Sex distribution by subdivision side

Table of SEX by subside			
SEX	subside		
Frequency Row Pct	L	R	Total
F	7 25.00	21 75.00	28
M	5 26.32	14 73.68	19
Total	12	35	47

Table 6

Equivalence test time 1(-1, 1) equivalence interval.

Variable Caballero Index

N	Mean	Std Dev	Std Err	Minimum	Maximum
47	1.8677	0.8237	0.1201	0.5000	4.5000

Mean	95% CL Mean	Std Dev	95% CL Std Dev
1.8677	1.6258 2.1095	0.8237	0.6845 1.0346

TOST Level 0.05 Equivalence Analysis

Mean	Lower Bound	90% CL Mean	Upper Bound	Assessment
1.8677	-1	< 1.6660 2.0693	> 1	Not equivalent

Test	Null	DF	t Value	P-Value
Upper	-1	46	23.87	<.0001
Lower	1	46	7.22	1.0000
Overall				1.0000

Table 7

Equivalence test Time 2 (-1, 1)

Variable, Caballero Index

N	Mean	Std Dev	Std Err	Minimum	Maximum
47	0.1230	0.8611	0.1256	-1.3000	3.3000

Mean	95% CL Mean	Std Dev	95% CL Std Dev	
0.1230	-0.1299	0.3758	0.8611	
			0.7156	1.0815

TOST Level 0.05 Equivalence Analysis

Mean	Lower Bound		90% CL Mean		Upper Bound	Assessment	
0.1230	-1	<	-0.0879	0.3338	<	1	Equivalent

Test	Null	DF	t Value	P-Value
Upper	-1	46	8.94	<.0001
Lower	1	46	-6.98	<.0001
Overall				<.0001

Table 8

Power hoc test for study sample N=47

Fixed Scenario Elements	
Distribution	Normal
Method	Exact
Lower Equivalence Bound	-1
Upper Equivalence Bound	1
Alpha	0.05
Mean	0.123
Standard Deviation	0.8611
Total Sample Size	47

Computed Power
Power
>.999

Table 9

Model measurements T1 vs. T2

Variable	N	T1	T2	Difference
Right arch length	47	39.117	39.532	-0.415
Left arch length	47	38.383	39.128	-0.745
Total arch length	47	77.500	78.660	-1.160
Midline	47	1.338	0.296	1.043
Intermolar position	47	1.887	1.517	0.370
Caballero index	47	1.868	0.123	1.745

Table 10

Cephalometric measurements T1 VS T2

Variable	N	T1	T2	Difference
SNA	47	82.106	80.904	1.202
SNB	47	78.649	78.692	-0.043
ANB	47	3.457	2.149	1.309
IMPA	47	92.000	95.309	-3.309
SN-MP	47	31.255	32.213	-0.958
U1-SN	47	102.000	105.149	-3.149

Figure 12

Scatter plot intra-rater reliability study

Time 1 Vs Time 2 for Caballero Index

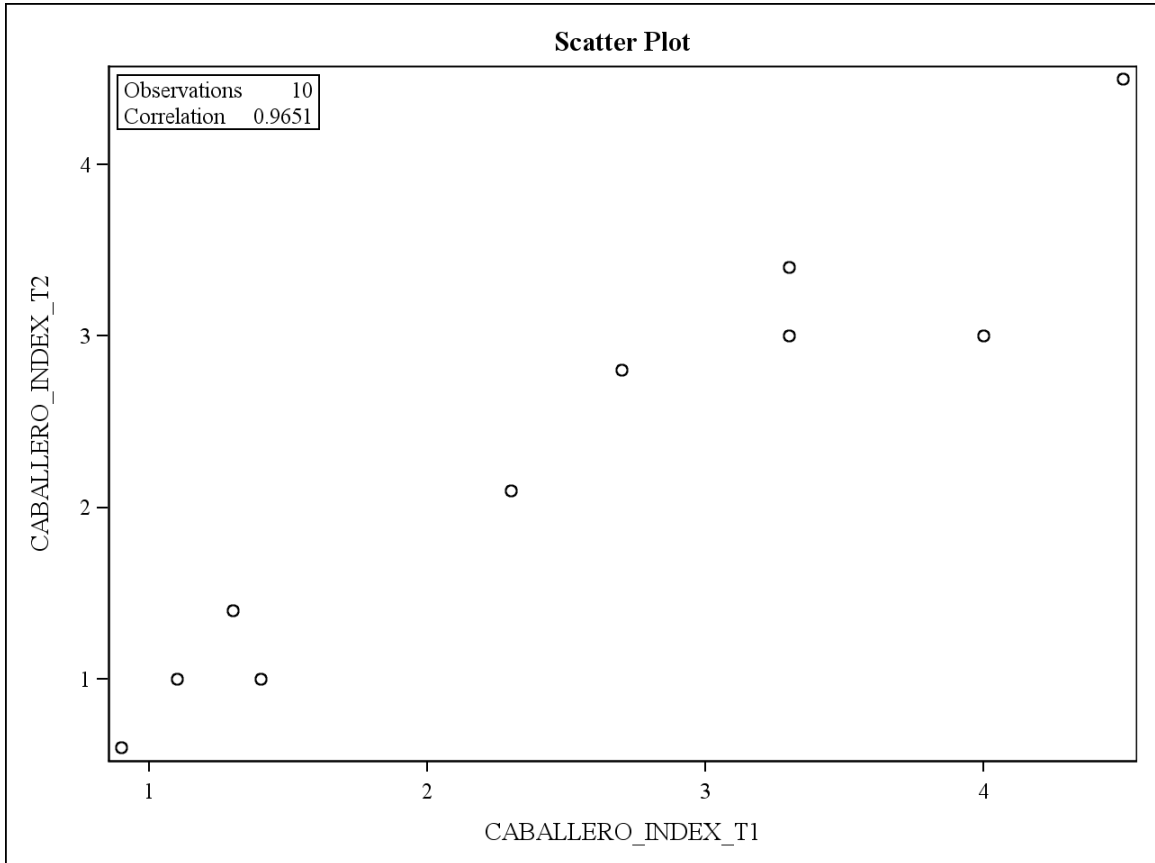


Figure 13

Histogram intra-rater reliability study

Time 1 Vs Time 2 for Caballero Index

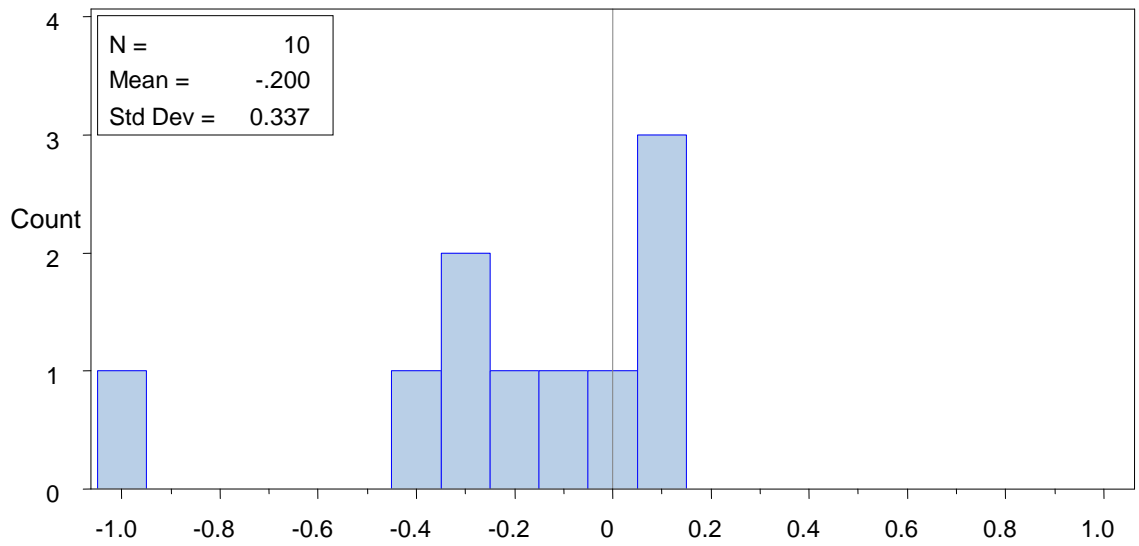


Figure 14

Distribution of sex by subsidy

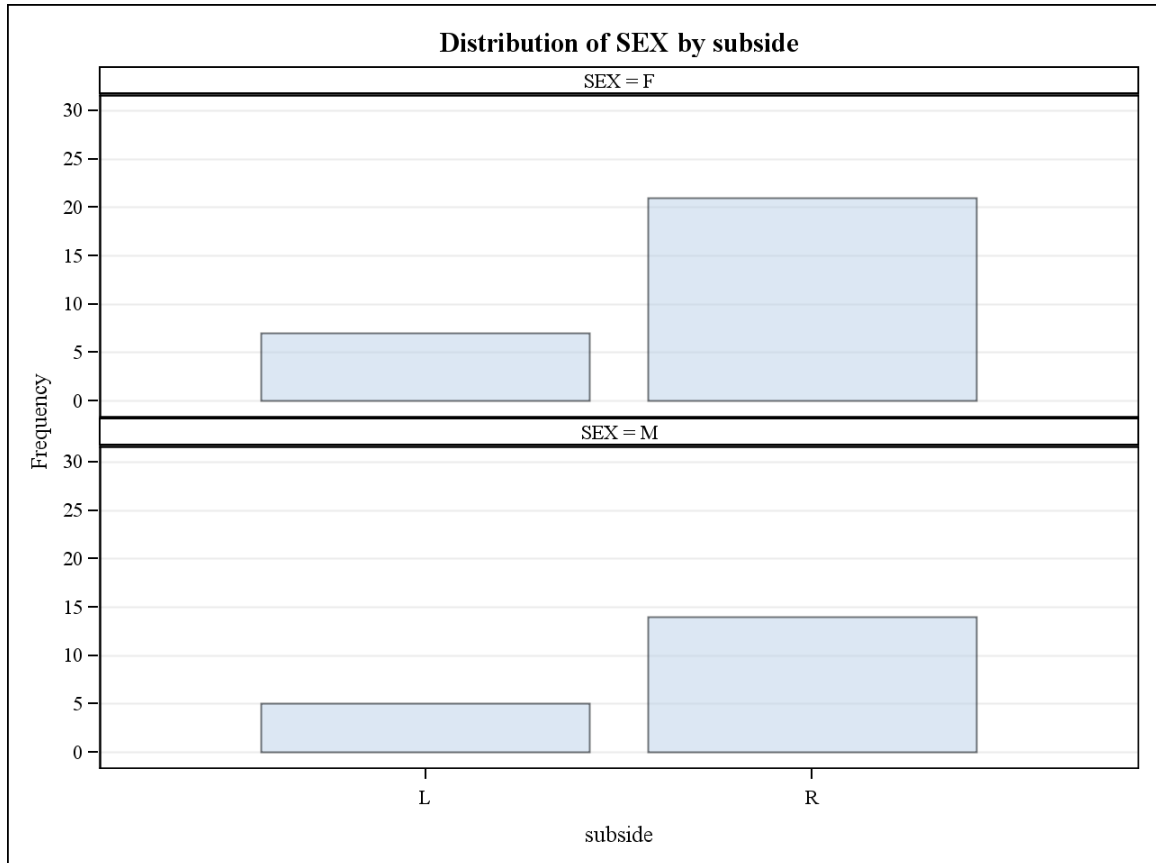


Figure 15

Histogram for data set for Caballero Index

T1

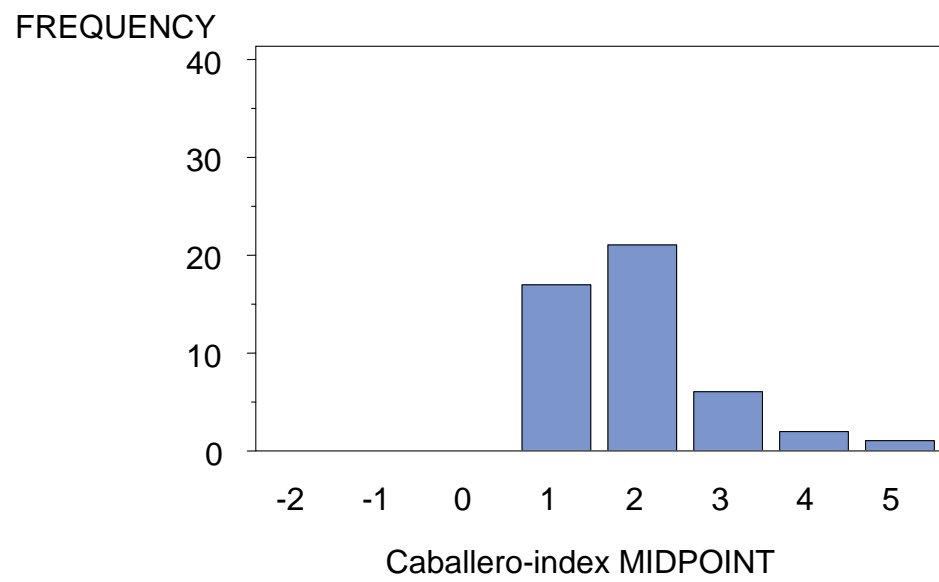


Figure 16

Mean of Caballero Index time 1

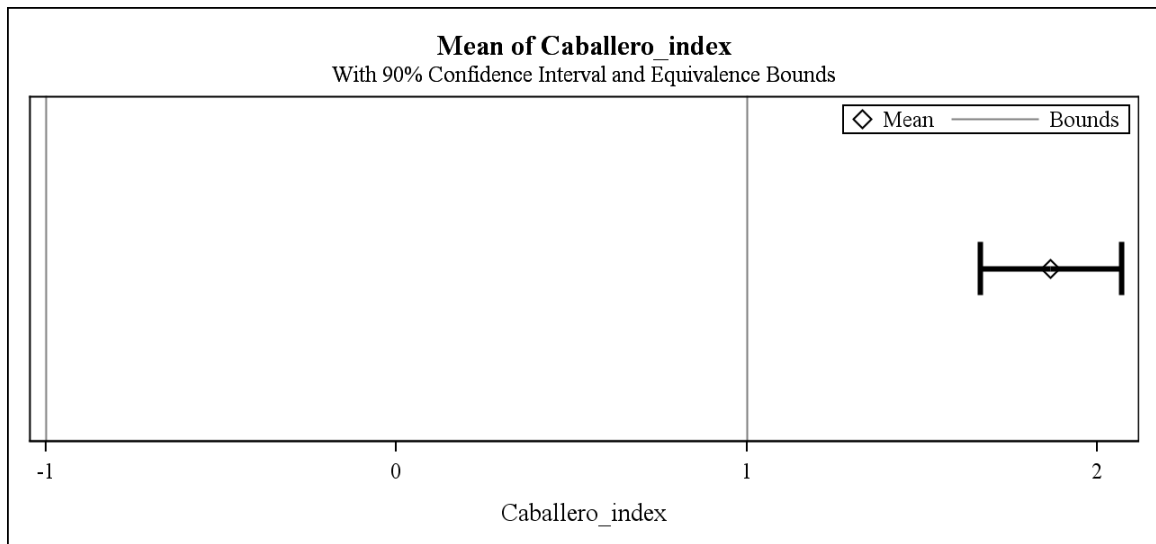


Figure 17

Histogram for Caballero index T2

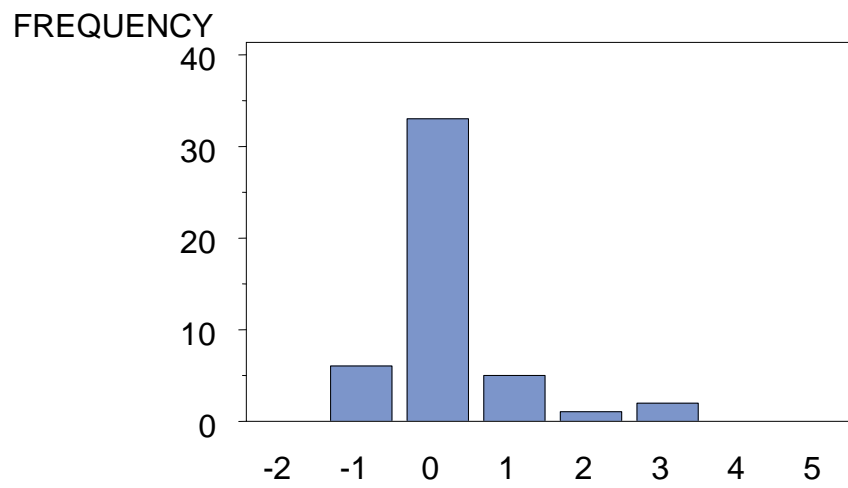


Figure 18

Mean for Caballero Index Time 2

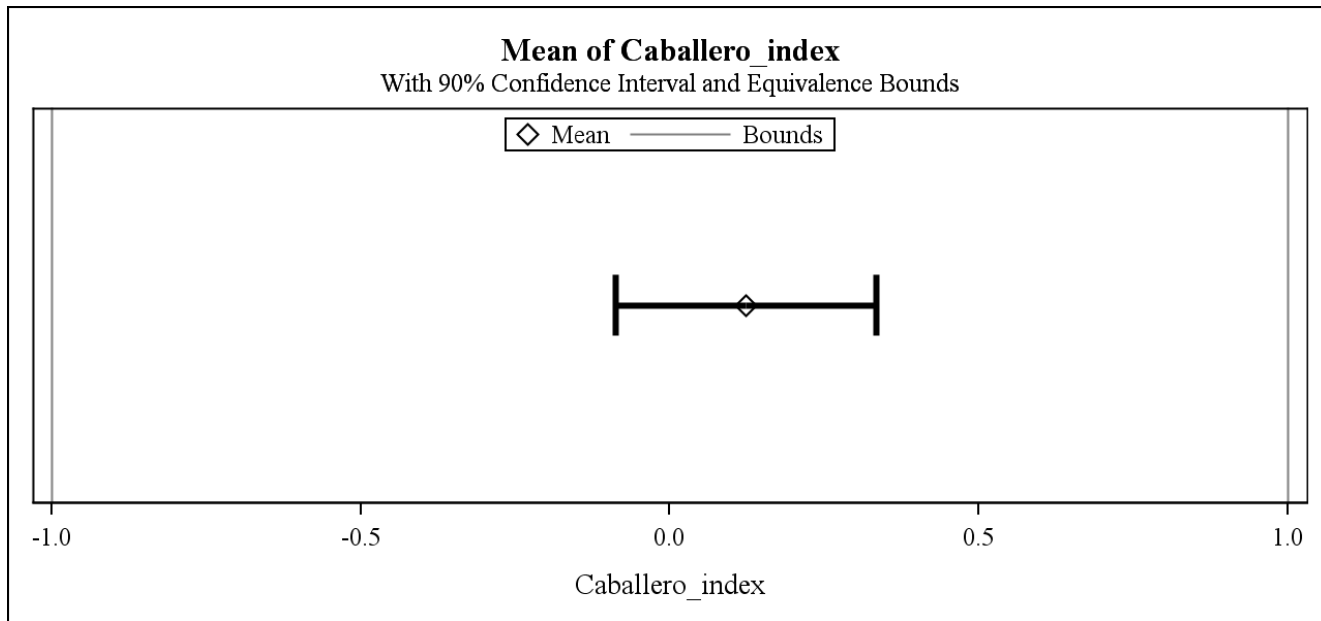


Figure 19

Histogram for Caballero Index data T1-

T2

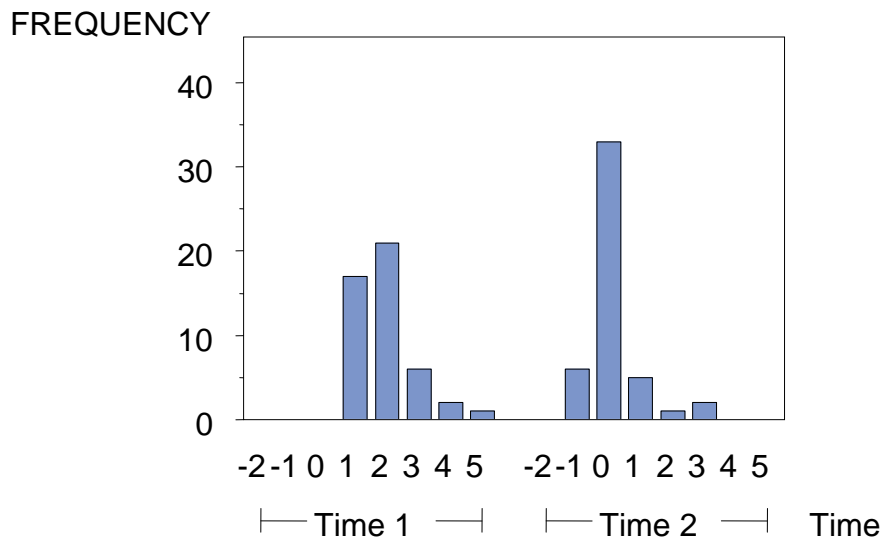


Figure 20

Histogram Caballero Index by Time T1 and T2

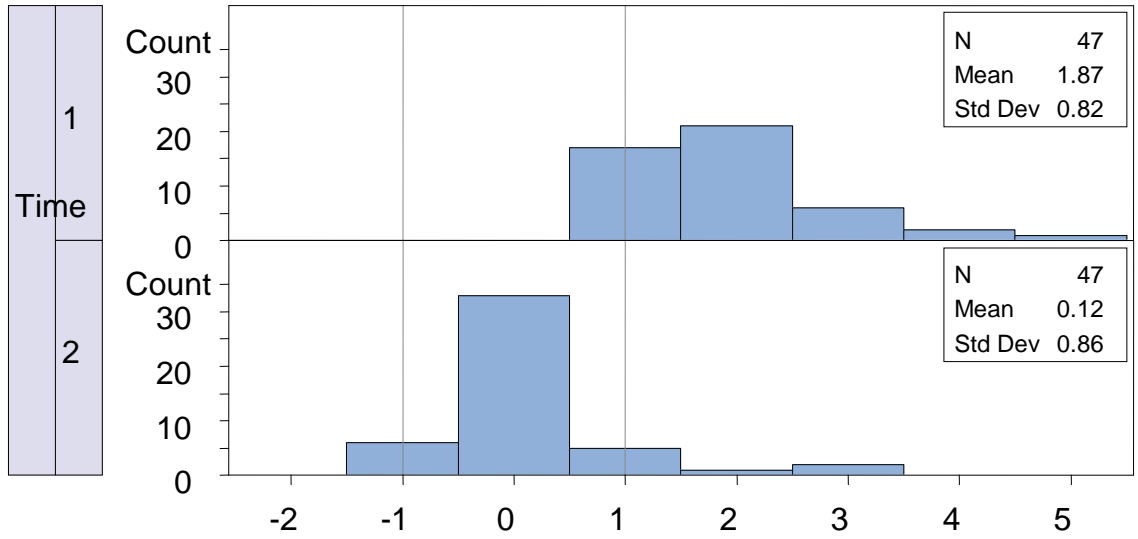
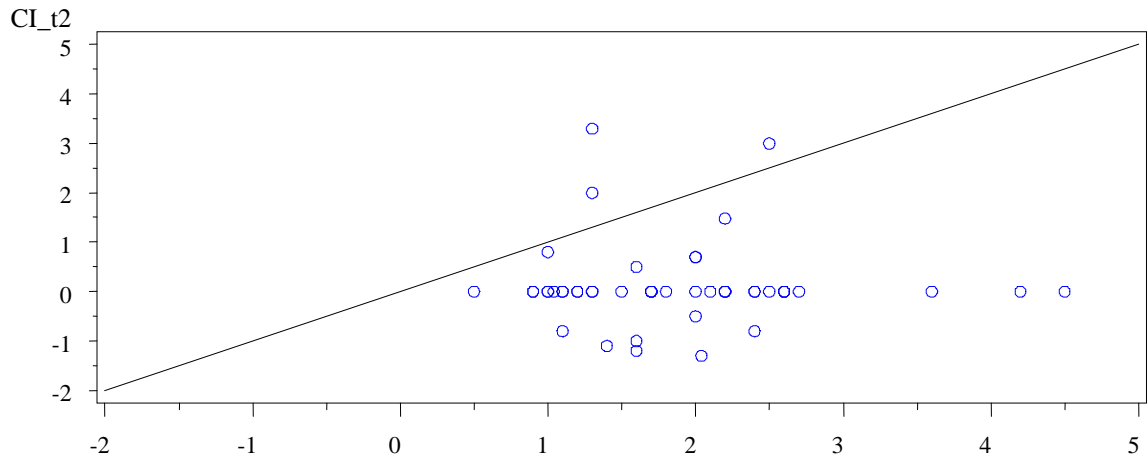


Figure 21

Scatterplot Caballero Index T1 and T2



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