

# A Critical Evaluation of different methods of recording centric jaw relation of completely edentulous individuals - An In Vivo Study \*

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## ABSTRACT

Accurate recording of maxillomandibular relations plays a pivotal role in the success of the complete denture rehabilitation. The centric relation is a repeatable and recordable relation which remains constant throughout life. There are various techniques used to record centric jaw relation namely 1.Intra oral graphic tracing 2.Extra oral gothic arch tracing 3.Nick and Notch method 4.Mush bite technique. This study was attempted to evaluate the efficacy, consistency and relative accuracy of the various methods used to record centric jaw relations.

Keywords: Articulator, Centric relation, Face bow transfer, Split cast technique

## 1 INTRODUCTION

The accurate recording and transfer of jaw relation records<sup>[1]</sup> from the edentulous patient to the articulator is essential for the restoration of function, speech, facial appearance, and maintenance of the comfort to patient's stomatognathic system. The patient's maxillomandibular relationships are dynamic and changes have been observed as age advances. Yoshiyuki Watanabe<sup>[2]</sup> has mentioned that occlusal stability is an important aspect for success of prosthetic treatment, and can only be achieved with an accurate determination of the mandibular position.

There are only approximate guides available to determine where to place the teeth; two of the most important of these are vertical and horizontal relationship<sup>[3]</sup> of the mandible to the maxillae, when constructing a complete denture. In edentulous patients proprioceptive impulses from periodontal ligament guide the mandibular movements. Edentulous patients do not have any proprioceptive guidance from their teeth to guide the mandibular movements. The sources of proprioceptive impulses for an edentulous patient are transferred to the temporomandibular joint.

For the rehabilitation of an edentulous patient, a learnable, repeatable and recordable maxilla to mandible relation is required, which remains constant throughout the life. There is substantial evidence indicating that, when dental influences are eliminated, a healthy elevating musculature will position the condyle in its most anterior and superior bracing position against the eminence. This seated

condylar position has been referred to as *centric relation*.

Centric and eccentric relations of mandible can be recorded through check bites, graphic recordings, functional recordings and cephalometrics. These records are then transferred to a semiadjustable articulator so that it can be set to simulate the various jaw movements<sup>[4]</sup>. This study is an attempt to compare the relative accuracy of the three different methods of recording centric relation using intraoral tracing method as a standard. The comparison of the four registered records of centric relation will be done using SplitCast mounting<sup>[5]</sup> on semiadjustable articulator and by using another modified Ash's free plane articulator.

The methods used for recording centric relation may be classified broadly as static or functional, and each of these may be extraoral and intraoral techniques. The static methods<sup>[3]</sup> are those that involve first placing the mandible in centric relation with the maxillae and then making a record of the relationship of the two occlusion rims to each other. The functional methods<sup>[3]</sup> are those that involve functional activity or movement of the mandible at the time the record is made. Accurate records of centric relation have been made by all the methods in both classes.

The aims and objectives of the study were

- (1) To compare the efficiency of high tracer<sup>[6]</sup>, conventional intraoral tracer<sup>[6]</sup>, mush<sub>5</sub>bite technique<sup>[5]</sup> and Nick and Notch<sup>[5]</sup> method in determining centric relation.
- (2) To evaluate the consistency of centric relation rec-

ords obtained with four different techniques

- (3) To compare the deviation of centric relation records in horizontal plane obtained with three different techniques to those obtained with intraoral tracing technique, and
- (4) To evaluate the deviation of centric relation records obtained with four different techniques using Split Cast technique

## 2 Materials and methods :

Ten edentulous patients who exhibited good health, average neuromuscular coordination, and relatively good ridges were selected at random from Department of Prosthodontics, Tamil Nadu Govt. Dental College & Hospital, Chennai, India. Equal numbers of male and female patients were selected between age group of 50 to 60 years. A total number of 10 edentulous individuals with class I skeletal relationship were subjected to this study. The patients were informed about the study and their written informed consent was obtained before the commencement of this procedure.

Grouping of Samples: The readings taken in this study were broadly grouped in two main groups :

Group 1: Readings evaluated with the help of Split Cast mounting.

Group 2: Readings evaluated with the help of Modified Ash Free plane Articulator.

Each group was further subdivided into 4 subgroups, namely

- (1) Intraoral tracing records evaluated with split cast mounting designated as '1A'
- (2) Extraoral tracing records evaluated with split cast mounting designated as '1B'
- (3) Nick and Notch occlusal records evaluated with split cast mounting designated as '1C'
- (4) Mush Bite technique records evaluated with split cast mounting designated as '1D'
- (5) Intraoral records evaluated with modified Ash's free plane articulator designated as '2A'
- (6) Extraoral records evaluated with modified Ash's free plane articulator designated as '2B'
- (7) Nick and Notch records evaluated with modified Ash's free plane articulator designated as '2C'
- (8) Mush Bite technique records evaluated with modified Ash's free plane articulator designated as '2D'

### Methodology

Diagnosis and Impression Making: Edentulous individuals

of age ranging from 51 to 60 years were taken in this study. Primary impression was made with Type II impression compound and primary casts were made. Custom trays on these primary impressions were fabricated with chemically activated denture base resin (DPI, India) with 1.5mm wax spacer. Trays were trimmed and checked for extension in the patient's mouth. Then border molding was done with low fusing tracing compound and secondary impression was made with Zinc Oxide Eugenol impression paste, the impression was poured with Type III dental stone to obtain the master casts. This master cast was then duplicated with reversible hydrocolloid to get two pairs of upper and lower casts. Four pair of record bases having same thickness and extension was made with heat activated acrylic resin.

FaceBow record was made with Dentatus face-bow and transferred to the Dentatus semiadjustable articulator. The upper cast was mounted on the upper member of the articulator by using Split Cast Technique. Intraoral tracing, extraoral tracing, nick and notch method and mush bite technique were repeated 5 times and the most repeated record was accepted.

Evaluation of the centric jaw relation recorded with four different registration methods:

1. Evaluation of extraoral tracing records in split cast technique:

The occlusal rims with extraoral recordings are seated on the mounted upper and lower casts in semiadjustable articulator. Record bases are checked for complete seating on the mounted casts. Three reference points are made on the upper split cast, one anterior to the incisive papilla and two posterolaterally, each made 10 mm anterior to the posterior border of the maxillary tuberosity. After seating, the articulator was closed in centric position according to the interocclusal records obtained. The discrepancy between the cast and the split is measured with the help of a digital Vernier calliper. The readings are noted at all the three reference points; one anterior and two posterolateral which are already marked.

2. Evaluation of Nick and Notch method in split cast technique :

The centric relation records taken with Nick and Notch technique are properly seated on the mounted casts on semiadjustable articulator. After seating, the articulator is closed in centric position according to occlusal obtained and the discrepancy between the cast and the split is measured.

ured with digital Vernier calliper. The readings are noted at all the three reference points; one anterior and two posterolateral.

### 3.Evaluation of Mush bite technique in split cast technique :

The records made with Mush bite technique are placed on casts in the semiadjustable articulator and the discrepancy at the split is noted and measured with digital Vernier calliper on all the three reference points as described above.

### Evaluation of centric jaw relation by modified Ash's free plane articulator:

The centric relation records made with intraoral technique were taken and seated on the other set of duplicated casts, and mounted on the modified Ash's free plane articulator. Care should be taken so that the incisal rod should remain stabilized in the centre of the graph which is fixed on the incisal table. The plaster is allowed to set. Now the centric jaw relation records made with extraoral Gothic arch tracing technique are seated on the mounted cast in the modified Ash free plane articulator. The shift of incisal rod on the graph paper with extraoral records is noted in anteroposterior and lateral directions. The readings were measured with digital Vernier calliper.

The extraoral Gothic arch tracing records were taken out from the modified Ash's free plane articulator and centric jaw relation recordings taken with Nick and notch method were transferred on the mounted casts on Modified Ash's free plane articulator. The shift of the incisal rod is measured on the graph paper with the help of digital Vernier calliper, in anteroposterior and lateral directions. Readings (discrepancies) in anteroposterior direction, i.e., X axis are taken as negative, whereas readings (discrepancies) in lateral direction, i.e., Y axis were taken as positive. Similarly the Nick and Notch method records were removed from the modified Ash's free plane articulator and the centric relation record taken with Mush bite technique were transferred on the mounted casts on modified Ash's free plane articulator. The shift of the incisal rod in the graph paper was measured with the digital Vernier caliper as explained above.



Fig 1 : Face Bow Record



Fig 2 : Extraoral Gothic arch Tracing



Fig 3 : Nick & Notch Record



Fig 4 : Measurement of discrepancy on semi adjustable articulator ( lateral )

### 3 Results :

This clinical study was performed to evaluate the more accurate method of recording centric jaw relation in edentulous individuals.

The basic data of the results of this study are shown in annexure from Table III to Table IV. Table III depicts the measurements noted by using split cast mounting for various subgroups based on different recording methods. In this table the readings of intraoral subgroup was categorized under subgroup 1A. This was considered as the control group. Each measurement was repeated five times and the mean is taken. The other records taken with other three different techniques were categorized under subgroup1B as reading of extraoral gothic arch tracing ,subgroup1C as reading taken with the help of nick and notch technique and subgroup 1D as the readings taken with the help of mush bite technique. The measurements at all the three points (two lateral points and one anterior) are taken as described earlier and mean values were taken.

#### Statistical Analysis :

Table Ia:

ANOVA Table	SS	df	MS
Treatment (between columns)	111.4	3	37.12
Residual (within columns)	0.3729	35	0.01066
Total	111.7	38	

Table Ib:

Newman-Keuls Multiple Comparison Test	Mean Diff.	q	P Value
SUBGROUP-1A vs SUBGROUP-1D	-4.329	129.1	0.0001***
SUBGROUP-1A vs SUBGROUP-1C	-3.709	110.6	0.0003***
SUBGROUP-1A vs SUBGROUP-1B	-1.661	49.52	0.0001***
SUBGROUP-1B vs SUBGROUP-1D	-2.668	81.73	0.0002***
SUBGROUP-1B vs SUBGROUP-1C	-2.048	62.75	0.0001***
SUBGROUP-1C vs SUBGROUP-1D	-0.6197	18.99	0.0003***

Note: \*\*\* denotes significant at 1% level.

#### Interpretation of results :

In this study, the discrepancy of centric relation recordings was evaluated among four different recordings, taking intraoral records as control, by using split cast technique. Then, the results were analyzed using the following statistical analysis. One way ANOVA test was used to assess the significant difference between different groups based on arc of closure tracing measurements.

Table III depicts the split cast mounting discrepancies for various groups based on different methods and also shows the mean and standard deviation of the various subgroups.

Table IV depicts mean and standard deviation of different measurement among various subgroups evaluated by split cast mounting.

Table Ia shows the statistical evaluation of one way ANOVA test between different groups. ANOVA results show that the treatment between the columns and the residual within the columns were statistically significant at 1% level.

In Table Ib, NEWMAN KEULS multiple comparison test depicts the different groups were statistically significant at 1% level such as

Group 1A vs Group 1D

Group 1A vs Group 1C

Group 1A vs Group 1B Group 1B vs Group 1D Group 1B vs Group 1C Group 1C vs Group 1D



Table II : Measurement taken with different recording techniques with the help of modified Ash's free plane articulator (in mm.)

SUBGROUP S	2AX	2AY	2BX	2BY	2CX	2CY	2DX	2DY
PATIENT 1	0	0	-0.1	0	-1.8	0	-2	2
PATIENT 2	0	0	-0.2	0	-1.7	0.5	-2.5	2.1
PATIENT 3	0	0	-0.2	0.2	-1.9	0.6	-2.3	2.3
PATIENT 4	0	0	0	0	-1.6	0.8	-3.4	3.3
PATIENT 5	0	0	0	0	-1.8	0.1	-2.7	2.1
PATIENT 6	0	0	0	0.3	-1.7	0	-2.3	2
PATIENT 7	0	0	-0.1	0.2	-1.3	0.5	-2.2	2.2
PATIENT 8	0	0	-0.2	0.2	-1.6	0.6	-3.3	2.4
PATIENT 9	0	0	-0.2	0.1	-1.8	0.5	-3.2	2.3
PATIENT 10	0	0	-0.2	0	-1.3	0.5	-3.3	3.1

Table II shows the measurements taken with the help of modified Ash's free plane articulator. In this table 'X' and 'Y' denotes the discrepancy in the anterolateral and lateral directions. -ve sign is taken for only graphical representation which otherwise has no significance.

#### 4 Discussion :

The success of complete denture is determined by correct recording of maxillomandibular relationship. Centric relation is the repeatable position. Patient will be comfortable to perform all the functional and parafunctional movements in this position. Centric relation records can be established by various methods. This study was conducted to evaluate the consistency of various methods of recording centric relation. In this study the methods used to record centric jaw relation were

- (1) Intraoral tracing technique,
- (2) Extraoral Gothic arch tracing technique,
- (3) Nick and Notch technique, and
- (4) Mush bite technique.

First two techniques are most frequently used in measuring centric jaw relation. According to Michman and Langer the intraoral tracing technique gave better results than the commonly used method of an interocclusal record, made with the use of wax rims alone. Krishan K, Kapur and A. Albert Yurkstas also told that intraoral tracing procedure and extraoral tracing procedure were more consistent as compared to wax registration method. Tench also quoted a statement and agreed with the Gysi arrow point technique is the only means that should be used in any practice to establish the most important single measurement taken in construction of full dentures, the centric occlusion relation of mandible to maxilla.

The intraoral tracing procedure has also been criticized by many prosthodontists. Their main objections were based on the general disadvantages of a central bearing point device. Trapozzano stated "the use of the central bearing point is based on the fallacious assumption that the central bearing point will produce equalization of pressure. Trapozzano maintained that the wax recording method was the most accurate method because of the greater ability to equalize or centralize pressure with this technique.

In this study the four techniques were taken for evaluation, two are graphic tracing technique and two are wax recording methods, and intraoral tracing technique is taken as control group.

Semi adjustable Dentatus articulator was used in the study for evaluation of the consistency of different records by using split cast mounting.

The methods of evaluation used in this study were

- (1) Split cast mounting and
- (2) Modified Ash's free plane articulator.

The modified articulator concept used in the present study is modification of the instrument used by Krishan K. Kapur in 1957.

In this present study four different techniques for recording centric relation were used; namely,

- (1) Intraoral graphic tracing (subgroup 1A & 2A),
- (2) Extraoral Gothic arch tracing (subgroup 1B & 2B),
- (3) Nick and Notch method (subgroup 1C & 2C) and
- (4) Mush bite technique (subgroup 1D & 2D).

Intraoral recordings were taken as control group.

According to the results, among the other three groups, extraoral groups give the closest reading to the control group, the mush bite records show the maximum deviation, the nick and notch records fall in between the two. Group 1B and 2B show least deviation in the range of 1mm.

Subgroups 1C and 2C show a deviation upto 3mm and subgroups 1D and 2D show maximum deviation upto 4mm in split cast mounting evaluation.

After analysing the data obtained from the study, it was found that when the different subgroups were compared with control subgroup, mush bite technique for registration of centric relation showed maximum discrepancy. The difference was statistically significant with  $p < 0.05$ , among all subgroups evaluated with split cast mounting.

The readings of extraoral Gothic arch technique found to be the closest to the control subgroup. Graph 1 compares discrepancy among different subgroups evaluated with split cast mounting. Subgroup-1A (control) is closest to subgroup-1B (extraoral Gothic arch tracing). And subgroup-1D shows an average discrepancy of more than 4mm.

Table II shows the measurements taken with different recording techniques with the help of modified Ash's free plane articulator. In this table it can be observed that Mush bite record subgroup gave a discrepancy upto a maximum of 3.3mm. And extraoral Gothic arch tracing records showed least discrepancy. These findings are in accordance with the previous literature. Graph 2 showed the representation of discrepancies of four subgroups which are evaluated with modified Ash's free plane articulator. In this graphical representation it can be visualized that the maximum discrepancy is shown by blue and orange colour columns. The positive values describe the discrepancy in lateral direction and the negative values in the anteroposterior direction. Control subgroup columns are not visible because the reading is kept as zero. As described in table II, extraoral Gothic arch tracing subgroups 2BX and 2BY showed least height columns and can be interpreted as least deviated from control.

**5 Summary and conclusion :**

An accurate centric jaw relationship record is important when constructing dentures. It is a three-dimensional record and, to be accurate for a given individual, the relationship, anteroposteriorly and laterally, should be recorded at the occlusal vertical dimension deemed correct for the individual. This study demonstrates a significant statistical difference between the recordings taken with intraoral tracing technique and among other subgroups evaluated by two techniques. The recordings were made with the extraoral Gothic arch tracing technique values were closer to the control as compared with two other subgroups in both the evaluations.

Furthermore this study does not show the superiority of any of method for recording centric jaw relation on one another. This study only shows the deviation of the recordings made with four different techniques among different subgroups.

Accurate records for centric jaw relation can be made with any of these techniques, but the chances of errors are more in tactile methods as compared to graphic methods.

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**Annexure :**

Table III: The split cast mounting measurements for various groups based on different method

P a t i e n t	Meas- ure- ment i n r e p l i c a t i o n	Gro up1 A mm	Group -1B mm	Group 1C mm	Group 1D mm

n					
t					
1	A	0	Lt Lat=1.2 Rt Lat=1.4 Ant=2.3 Mean=1.63 33	Lt Lat=3.4 Rt Lat=3.5 Ant=4.2 Mean=3.7	Lt Lat=3.9 Rt Lat=3.8 Ant=4.9 Mean=4.2
	B	0	Lt Lat=1.3 Rt Lat=1.3 Ant=2.3 Mean=1.63 33	Lt Lat=3.3 Rt Lat=3.4 Ant=4.1 Mean=3.6	Lt Lat=3.8 Rt Lat=3.9 Ant=4.9 Mean=4.2
	C	0	Lt Lat=1.4 Rt Lat=1.2 Ant=2.2 Mean=1.6	Lt Lat=3.3 Rt Lat=3.5 Ant=4.2 Mean=3.6 666	Lt Lat=3.4 Rt Lat=3.7 Ant=4.8 Mean=3.96666
	D	0	Lt Lat=1.2 Rt Lat=1.3 Ant=2.4 Mean=1.63 333	Lt Lat=3.2 Rt Lat=3.3 Ant=4.2 Mean=3.5 6666	Lt Lat=3.9 Rt Lat=3.7 Ant=4.8 Mean=4.133333
	E	0	Lt Lat=1.3 Rt Lat=1.3 Ant=2.3 Mean=1.63 333	Lt Lat=3.5 Rt Lat=3.5 Ant=4.3 Mean=3.7 6666	Lt Lat=3.8 Rt Lat=3.7 Ant=4.7 Mean=4.06
S		0	0.0148989	0.0795805	0.099713
D			28	72	104
N		0	1.6266	3.6599	4.1119
M					
E					
A					

					3333
	B	0	Lt Lat=1.4 Rt Lat=1.4 Ant=2.5 Mean=1.76 66	Lt Lat=3.5 Rt Lat=3.6 Ant=4.4 Mean=3.8 333	Lt Lat=3.9 Rt Lat=4.2 Ant=5.0 Mean=4.3666
	C	0	Lt Lat=1.3 Rt Lat=1.5 Ant=2.4 Mean=1.73 33	Lt Lat=3.5 Rt Lat=3.7 Ant=4.5 Mean=3.9	Lt Lat=3.7 Rt Lat=4.1 Ant=5.2 Mean=4.33333
	D	0	Lt Lat=1.5 Rt Lat=1.5 Ant=2.4 Mean=1.8	Lt Lat=3.4 Rt Lat=3.7 Ant=4.4 Mean=3.8 333	Lt Lat=3.7 Rt Lat=4.1 Ant=5.1 Mean=4.3
	E	0	Lt Lat=1.4 Rt Lat=1.3 Ant=2.4 Mean=1.7	Lt Lat=3.5 Rt Lat=3.7 Ant=4.5 Mean=3.9	Lt Lat=3.8 Rt Lat=4.2 Ant=5.1 Mean=4.36666
	SD	0	0.0434639	0.0365330	0.027873
	ME				
	AN	0	1.7599	3.85998	4.3398
3	A	0	Lt Lat=1.1 Rt Lat=1.3 Ant=2.2 Mean=1.53 33	Lt Lat=3.5 Rt Lat=3.4 Ant=4.4 Mean=3.7 666	Lt Lat=3.9 Rt Lat=3.8 Ant=5.1 Mean=4.2666
	B	0	Lt Lat=1.2 Rt Lat=1.2 Ant=2.2 Mean=1.53 33	Lt Lat=3.4 Rt Lat=3.5 Ant=4.4 Mean=3.7 666	Lt Lat=3.8 Rt Lat=3.8 Ant=5.0 Mean=4.2
	C	0	Lt Lat=1.2 Rt Lat=1.3 Ant=2.3 Mean=1.6	Lt Lat=3.4 Rt Lat=3.5 Ant=4.5 Mean=3.8	Lt Lat=3.8 Rt Lat=3.9 Ant=5.1 Mean=4.2666

Pa-tient	Meas-ure-ment replica-tion	Gro-up1 A mm	Group -1B mm	Group 1C mm	Group 1D mm
2	A	0	Lt Lat=1.5 Rt Lat=1.4 Ant=2.5 Mean=1.8	Lt Lat=3.4 Rt Lat=3.7 Ant=4.4 Mean=3.8 333	Lt Lat=3.8 Rt Lat=4.1 Ant=5.1 Mean=4.2666

	D	0	Lt Lat=1.2 Rt Lat=1.1 Ant=2.3 Mean=1.53 333	Lt Lat=3.5 Rt Lat=3.5 Ant=4.5 Mean=3.8 333	Lt Lat=4.0 Rt Lat=3.7 Ant=5.2 Mean=4. 3
	E	0	Lt Lat=1.4 Rt Lat=1.3 Ant=2.2 Mean=1.63 33	Lt Lat=3.6 Rt Lat=3.4 Ant=4.5 Mean=3.8 333	Lt Lat=4.0 Rt Lat=3.8 Ant=5.1 Mean=4. 3
SD		0	0.0471410 45	0.033350 007	0.040824 845
ME AN		0	1.5666	3.7999	4.266
4	A	0	Lt Lat=1.4 Rt Lat=1.5 Ant=2.5 Mean=1.8	Lt Lat=3.5 Rt Lat=3.6 Ant=4.6 Mean=3.9	Lt Lat=4.1 Rt Lat=4.0 Ant=5.1 Mean=4. 4
	B	0	Lt Lat=1.4 Rt Lat=1.6 Ant=2.5 Mean=1.83 33	Lt Lat=3.5 Rt Lat=3.5 Ant=4.5 Mean=3.8 333	Lt Lat=4.1 Rt Lat=3.9 Ant=5.1 Mean=4. 3666
	C	0	Lt Lat=1.5 Rt Lat=1.5 Ant=2.6 Mean=1.86 66	Lt Lat=3.5 Rt Lat=3.4 Ant=4.5 Mean=3.8	Lt Lat=4.0 Rt Lat=4.0 Ant=5.1 Mean=4. 3666
	D	0	Lt Lat=1.4 Rt Lat=1.5 Ant=2.4 Mean=1.76 66	Lt Lat=3.5 Rt Lat=3.5 Ant=4.4 Mean=3.8	Lt Lat=4.0 Rt Lat=3.9 Ant=5.0 Mean=4. 3
	E	0	Lt Lat=1.5 Rt Lat=1.6 Ant=2.5 Mean=1.86 6	Lt Lat=3.5 Rt Lat=3.5 Ant=4.6 Mean=3.8 666	Lt Lat=4.1 Rt Lat=4.0 Ant=5.0 Mean=4. 3666
SD			0.0433150 09	0.043452 411	0.036505 726

ME AN			1.826	3.83998	4.3596
5	A	0	Lt Lat=1.4 Rt Lat=1.5 Ant=2.2 Mean=1.7	Lt Lat=3.4 Rt Lat=3.4 Ant=4.2 Mean=3.6 66	Lt Lat=4.1 Rt Lat=4.2 Ant=5.2 Mean=4. 5
	B	0	Lt Lat=1.5 Rt Lat=1.4 Ant=2.2 Mean=1.7	Lt Lat=3.4 Rt Lat=3.3 Ant=4.2 Mean=3.6 333	Lt Lat=4.2 Rt Lat=4.1 Ant=5.2 Mean=4. 5
	C	0	Lt Lat=1.4 Rt Lat=1.4 Ant=2.1 Mean=1.63 33	Lt Lat=3.3 Rt Lat=3.4 Ant=4.1 Mean=3.6	Lt Lat=4.2 Rt Lat=4.1 Ant=5.2 Mean=4. 5
	D	0	Lt Lat=1.3 Rt Lat=1.4 Ant=2.1 Mean=1.6	Lt Lat=3.4 Rt Lat=3.3 Ant=4.1 Mean=3.6	Lt Lat=4.1 Rt Lat=4.1 Ant=5.1 Mean=4. 433
	E	0	Lt Lat=1.4 Rt Lat=1.5 Ant=2.2 Mean=1.7	Lt Lat=3.5 Rt Lat=3.4 Ant=4.2 Mean=3.7	Lt Lat=4.1 Rt Lat=4.1 Ant=5.2 Mean=4. 4666
SD		0	0.0471463 47	0.043361 25	0.029952 162
ME AN		0	1.6666	3.6398	4.4799
6	A	0	Lt Lat=1.4 Rt Lat=1.3 Ant=2.3 Mean=1.66 6	Lt Lat=3.4 Rt Lat=3.5 Ant=4.3 Mean=3.7 333	Lt Lat=4.1 Rt Lat=4.2 Ant=5.2 Mean=4. 5
	B	0	Lt Lat=1.4 Rt Lat=1.4 Ant=2.3 Mean=1.7	Lt Lat=3.4 Rt Lat=3.4 Ant=4.3 Mean=3.7	Lt Lat=4.2 Rt Lat=4.2 Ant=5.2 Mean=4.



					5333
	C	0	Lt Lat=1.3 Rt Lat=1.3 Ant=2.2 Mean=1.6	Lt Lat=3.3 Rt Lat=3.5 Ant=4.2 Mean=3.6 666	Lt Lat=4.1 Rt Lat=4.3 Ant=5.3 Mean=4.5 666
	D	0	Lt Lat=1.4 Rt Lat=1.2 Ant=2.3 Mean=1.63 3	Lt Lat=3.3 Rt Lat=3.5 Ant=4.2 Mean=3.6 66	Lt Lat=4.3 Rt Lat=4.2 Ant=5.3 Mean=4.6
	E	0	Lt Lat=1.2 Rt Lat=1.3 Ant=2.2 Mean=1.56 66	Lt Lat=3.4 Rt Lat=3.6 Ant=4.3 Mean=3.7 66	Lt Lat=4.3 Rt Lat=4.3 Ant=5.2 Mean=4.6
SD		0	0.0526210 22	0.043396 221	0.043463 916
ME AN		0	1.633	3.705	4.5599
7	A	0	Lt Lat=1.3 Rt Lat=1.6 Ant=2.4 Mean=1.76 6	Lt Lat=3.4 Rt Lat=3.3 Ant=4.2 Mean=3.6 333	Lt Lat=3.8 Rt Lat=3.9 Ant=4.9 Mean=4.2
	B	0	Lt Lat=1.3 Rt Lat=1.5 Ant=2.4 Mean=1.73 33	Lt Lat=3.3 Rt Lat=3.2 Ant=4.2 Mean=3.5 666	Lt Lat=3.7 Rt Lat=3.8 Ant=4.9 Mean=4.1 333
	C	0	Lt Lat=1.4 Rt Lat=1.6 Ant=2.3 Mean=1.76 666	Lt Lat=3.3 Rt Lat=3.4 Ant=4.2 Mean=3.6 333	Lt Lat=3.7 Rt Lat=3.8 Ant=4.8 Mean=4.1
	D	0	Lt Lat=1.3 Rt Lat=1.5 Ant=2.4 Mean=1.73 333	Lt Lat=3.3 Rt Lat=3.4 Ant=4.1 Mean=3.6	Lt Lat=3.6 Rt Lat=3.8 Ant=4.7 Mean=4.1

					0333
	E	0	Lt Lat=1.4 Rt Lat=1.5 Ant=2.4 Mean=1.76 66	Lt Lat=3.4 Rt Lat=3.3 Ant=4.1 Mean=3.6	Lt Lat=3.9 Rt Lat=3.9 Ant=4.9 Mean=4.2 3333
SD		0	0.0181341 95 0.0278966 49 0.0795931 34	0.018134 195 0.027896 649 0.079593 134	0.018134 195 0.027896 649 0.079593 134
ME AN		0	1.7531	3.6065	4.1399
8	A	0	Lt Lat=1.1 Rt Lat=1.2 Ant=2.1 Mean=1.46 6	Lt Lat=3.4 Rt Lat=3.3 Ant=4.2 Mean=3.6 333	Lt Lat=4.0 Rt Lat=4.2 Ant=5.2 Mean=4.4 666
	B	0	Lt Lat=1.1 Rt Lat=1.1 Ant=2.1 Mean=1.43 33	Lt Lat=3.3 Rt Lat=3.3 Ant=4.1 Mean=3.5 6666	Lt Lat=4.0 Rt Lat=4.1 Ant=5.1 Mean=4.4
	C	0	Lt Lat=1.1 Rt Lat=1.2 Ant=2.0 Mean=1.43 33	Lt Lat=3.5 Rt Lat=3.3 Ant=4.1 Mean=3.6 333	Lt Lat=4.1 Rt Lat=4.2 Ant=5.2 Mean=4.5
	D	0	Lt Lat=1.1 Rt Lat=1.1 Ant=2.0 Mean=1.4	Lt Lat=3.4 Rt Lat=3.2 Ant=4.1 Mean=3.5 666	Lt Lat=4.1 Rt Lat=4.2 Ant=5.2 Mean=4.5
	E	0	Lt Lat=1.2 Rt Lat=1.2 Ant=2.1 Mean=1.5	Lt Lat=3.3 Rt Lat=3.2 Ant=4.2 Mean=3.5 666	Lt Lat=4.1 Rt Lat=4.2 Ant=5.1 Mean=4.4 6666
SD		0	0.0379250 18	0.036522 148	0.040824 845

ME AN		0	1.4465	3.5932	4.4666						3
9	A	0	Lt Lat=1.3 Rt Lat=1.4 Ant=2.4 Mean=1.7	Lt Lat=3.5 Rt Lat=3.4 Ant=4.3 Mean=3.7 3333	Lt Lat=3.9 Rt Lat=4.1 Ant=5.0 Mean=4.333						Lt Lat=3.9 Rt Lat=3.9 Ant=4.7 Mean=4.16666
	B	0	Lt Lat=1.3 Rt Lat=1.3 Ant=2.4 Mean=1.66 66	Lt Lat=3.4 Rt Lat=3.3 Ant=4.3 Mean=3.6 6666	Lt Lat=3.8 Rt Lat=4.1 Ant=5.0 Mean=4.3						Lt Lat=3.9 Rt Lat=4.1 Ant=4.8 Mean=4.2666
	C	0	Lt Lat=1.2 Rt Lat=1.3 Ant=2.3 Mean=1.6	Lt Lat=3.6 Rt Lat=3.3 Ant=4.2 Mean=3.7	Lt Lat=3.8 Rt Lat=4.0 Ant=5.0 Mean=4.26666						Lt Lat=3.8 Rt Lat=4.0 Ant=4.9 Mean=4.2333
	D	0	Lt Lat=1.3 Rt Lat=1.4 Ant=2.3 Mean=1.66 66	Lt Lat=3.4 Rt Lat=3.4 Ant=4.3 Mean=3.7	Lt Lat=4.0 Rt Lat=4.1 Ant=5.1 Mean=4.4						
	E	0	Lt Lat=1.4 Rt Lat=1.4 Ant=2.4 Mean=1.73 333	Lt Lat=3.4 Rt Lat=3.5 Ant=4.2 Mean=3.7	Lt Lat=3.9 Rt Lat=4.0 Ant=5.0 Mean=4.3						
SD		0	0.0494448 2	0.023571 405	0.050532 496						
ME AN		0	1.673	3.7	4.3199						
10	A	0	Lt Lat=1.3 Rt Lat=1.4 Ant=2.4 Mean=1.7	Lt Lat=3.4 Rt Lat=3.5 Ant=4.3 Mean=3.7 333	Lt Lat=3.9 Rt Lat=4.0 Ant=4.9 Mean=4.2666						
	B	0	Lt Lat=1.3 Rt Lat=1.3 Ant=2.4 Mean=1.66 66	Lt Lat=3.4 Rt Lat=3.4 Ant=4.3 Mean=3.7	Lt Lat=3.9 Rt Lat=4.1 Ant=4.9 Mean=4.						
	C	0	Lt Lat=1.3 Rt Lat=1.3 Ant=2.3 Mean=1.63 33	Lt Lat=3.3 Rt Lat=3.5 Ant=4.2 Mean=3.6 666	Lt Lat=3.9 Rt Lat=3.9 Ant=4.7 Mean=4.16666						
	D	0	Lt Lat=1.2 Rt Lat=1.3 Ant=2.3 Mean=1.6	Lt Lat=3.3 Rt Lat=3.4 Ant=4.3 Mean=3.6 666	Lt Lat=3.9 Rt Lat=4.1 Ant=4.8 Mean=4.2666						
	E	0	Lt Lat=1.3 Rt Lat=1.3 Ant=2.4 Mean=1.66 66	Lt Lat=3.3 Rt Lat=3.4 Ant=4.3 Mean=3.6 666	Lt Lat=3.8 Rt Lat=4.0 Ant=4.9 Mean=4.2333						
SD		0	0.0379985 53	0.029834 745	0.050544 16						
ME AN		0	1.6531	3.6865	4.2466						

Table – IV: Mean and standard deviation of different measurement locations among various groups by split cast mounting.

	GROUP-1A		GROUP-1B		GROUP-1C		GROUP-1D	
	MEAN (mm)	S.D (mm)	MEAN (mm)	S.D (mm)	MEAN (mm)	S.D (mm)	MEAN (mm)	S.D (mm)
PATIENT 1	0	0	1.63	0.01489	3.66	0.079	4.11	0.099
PATIENT 2	0	0	1.76	0.04346	3.86	0.0365	4.33	0.0278 7
PATIENT 3	0	0	1.56	0.047141	3.8	0.17	4.26	0.0408
PATIENT 4	0	0	1.82	0.043315	3.83	0.043	4.35	0.0365
PATIENT 5	0	0	1.66	0.0471	3.63	0.043	4.47	0.299
PATIENT 6	0	0	1.63	0.0526	3.7	0.0433	4.55	0.434
PATIENT 7	0	0	1.75	0.0181	3.6	0.02789	4.13	0.0795
PATIENT 8	0	0	1.44	0.38	3.6	0.365	4.46	0.0408
PATIENT 9	0	0	1.67	0.04944	3.7	0.2357	4.32	0.0505
PATIENT 10	0	0	1.65	0.038	3.68	0.0298	4.24	0.05

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