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ORIGINAL ARTICLE

A Positional Analyzer for Measuring Centric Slide

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Abstract Centric relation (CR) has been considered mainly as a position posterior to habitual occlusion or maximum intercuspation (MI). Awareness of the tooth contacts relationship in centric relation position of the mandible and diagnosing the case from this position is essential to consistently select treatment plans that will allow to treat to or very near to centric relation occlusion. Centric slide and other occlusal relationships are conceived of as positions, which can be studied in three dimensions. Clinically, the difference between the two occlusal positions namely CR and MI (centric slide) can easily be determined, but for a more precise evaluation of its length and directions, an occlusal analysis on articulator mounted casts is necessary. Study was under taken on the mounted casts of ten subjects on a semi adjustable articulator to which a stylus and recording table was devised and attached for measurement of CR-MI slide in the three planes namely anterior-posterior, medio-lateral and superior-inferior. It was found that there was a displacement from CR to MI (centric slide) in all the three planes and numerically the mean slide was 0.688 ± 0.623, 0.261 ± 0.627 and 0.127 ± 0.541 mm in the antero-posterior, medio- lateral and superior-inferior directions respectively. The stylus and table attachment may be an accurate indirect method to measure positional changes of the condyle in 3D.

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Introduction

Occlusal contact patterns may be either the "Gnathologic" or freedom-in-centric types. In gnathologic (organic) schemes maximum intercuspation (MI) coincides with the centric contact position (CCP) known as centric relation occlusion (CRO). When centric relation (CR) and MI coincide, no premature tooth contact occurs when closing along a terminal hinge movement, with the result there will be no slide. Conversely Schuyler who proposed the freedom-in-centric occlusion calls for a contact range between CCP and MI (MI being 0.5–1 mm anterior to CR). Centric slide or simply slide is defined as a movement of the mandible from centric occlusion to MI when these two position do not coincide [1]. Changes in the occluding surfaces due to functional adaptation or new restoration may cause premature contacts during closure in CR leading to loss of equilibrium and pathologic occlusion [2].

Understanding the nature of contact of the natural dentition is important for the correct diagnosis and longevity of the natural dentition, for diagnosing and the treatment of mandibular dysfunction, and for planning reconstructive dentistry [3]. When marked discrepancies exist between the interocclusal position and CR, pain in the lateral pterygoid muscle is a common clinical finding that may be confused with an intracapsular TMJ disorder.

The neuromuscular positioning of the mandible to accommodate to these occlusal discrepancies will, many times, hide the true discrepancies from an intra oral examination [4]. Hence, awareness of the maxillo-mandibular relationship in CR position of the mandible and

diagnosing the case from this position is essential to consistently select treatment plans that will allow to treat to or very near to CRO. Hidden discrepancies on intraoral examination require repositioning the patient's mandible into centric and transfer it to an articulator to make the true discrepancy apparent. Once the discrepancies are apparent, it will make the treatment plan to deal with all of the discrepancies present in the case; not just one to cover only those discrepancies seen intraorally.

In order to begin thinking about fitting of teeth together in CR, it is necessary to get the relationships correct in all three planes of space (transversely, horizontally, and vertically). Hence an instrument was devised to evaluate and study the centric slide in three dimensions (i.e. antero-posterior, medio-lateral and superio-inferior displacement) in normal adult dentition in articulated casts by a simple modification of a semi-adjustable articulator.

Materials and Method

The study samples consisted of 10 male and female subjects in an age group of 18–30 years. The sampling frame was made from undergraduate students in Chennai. Only subjects with complete unrestored permanent natural dentition with normal physiologic occlusion were included in the sampling frames [5].

Impressions of the jaws were made with irreversible hydrocolloid (Alginoplast-Heraeus Kulzer, Holland) in perforated stock trays. Casts were made with Type IV dental stone (Ultra Rock Die stone-Kalabhai Karson.Pvt.Ltd.India). Each maxillary cast was mounted on a semi adjustable articulator (Hanau wide vue) after a face bow transfer (Hanau spring Bow) using custom made split-cast mounting plates. The CR records were made as suggested by Lucia using the anterior jig [6, 7].

Determination of CR-MI Slide

The position of initial tooth contact (CR) and MI were measured in 3D. To represent the point of initial tooth contact numerically in CR and MI in 3D, the stylus and recording table assemblies (Fig. 1a) were constructed which were attached to the lateral aspect of the maxillary and mandibular casts respectively. The stylus assembly included two sharpened metal styli (Fig. 1b) perpendicular to each other in which it could be moved without play for which modified screw gauges were used. The recording table assembly included two perpendicular metal receptacles, vertical and horizontal into which machined aluminum slats could be precisely slid.

A mounting rod was attached to the split-cast mounting plate in the maxilla. Using a grooved metal alignment block

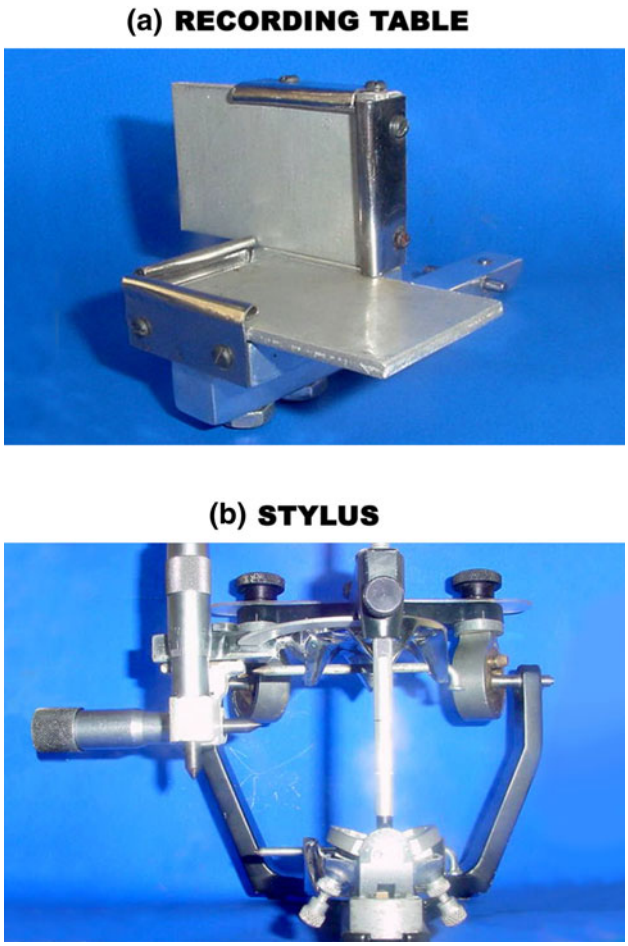


Fig. 1 Table and stylus

(Fig. 2a) and with the casts in CR (confirmed with records) the mandibular mounting rod was embedded in the plaster mounting, parallel to the hinge axis of the articulator (Fig. 4). On completion of the mounting, the alignment block was removed and replaced by the stylus and table assemblies. Adhesive papers were placed on two aluminum slats, which were then slid into their respective holders. The maxillary and mandibular teeth contact was marked with 40 μ articulating paper (Fig 3a) ,which was then confirmed with 13 μ shimstock (Fig 3b). With the casts in initial tooth contact the style were depressed to record two dots on the vertical and horizontal table. The two slats were then removed for measuring and new ones inserted. MI contact markings were made after the casts were brought to MI by loosening the condylar elements. This procedure was repeated for all the 10 subjects with the CR record mounting and MI relation.

A traveling microscopic (Fig. 2b) calibrated to 0.001 cm was used to measure the distance from the edge of each slat, which provided a constant base line, to the center of each dot. On the vertical slat, the distance from the superior edge to the dot established the vertical (Z) coordinate of tooth position. On the horizontal slat, the distance from the posterior (Y) and

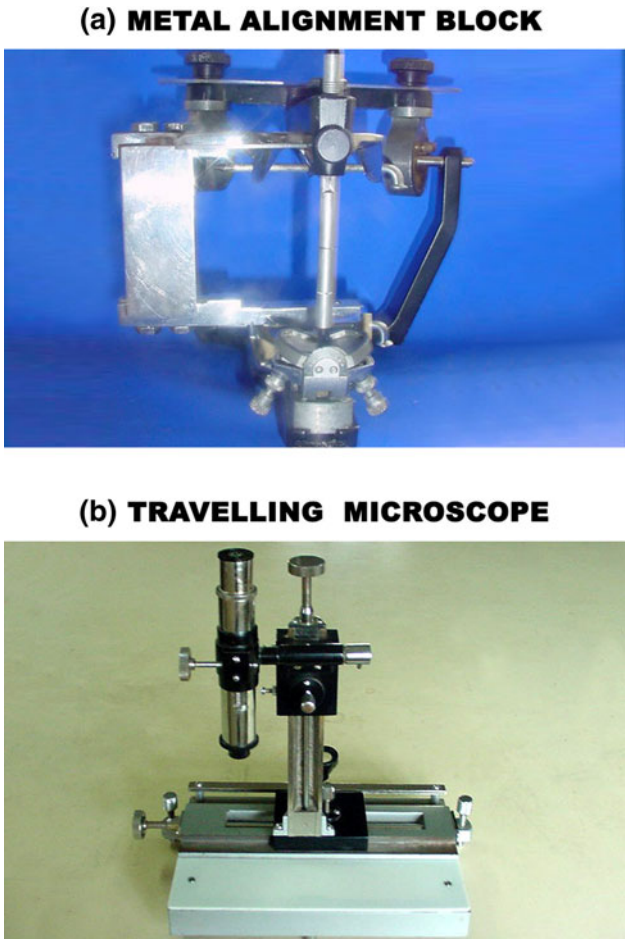
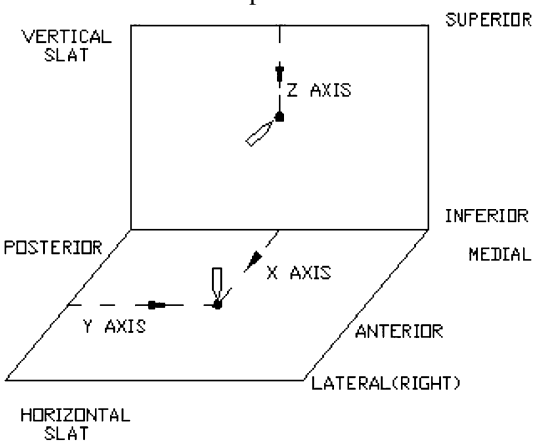


Fig. 2 Aligning block and travelling microscope

medial (*X*) edges established the sagittal and coronal coordinate of tooth contact position.



Statistical Analysis of Data

The statistical package SPSS PC + (Statistical package for social science, version 4.0.1) was used for statistical

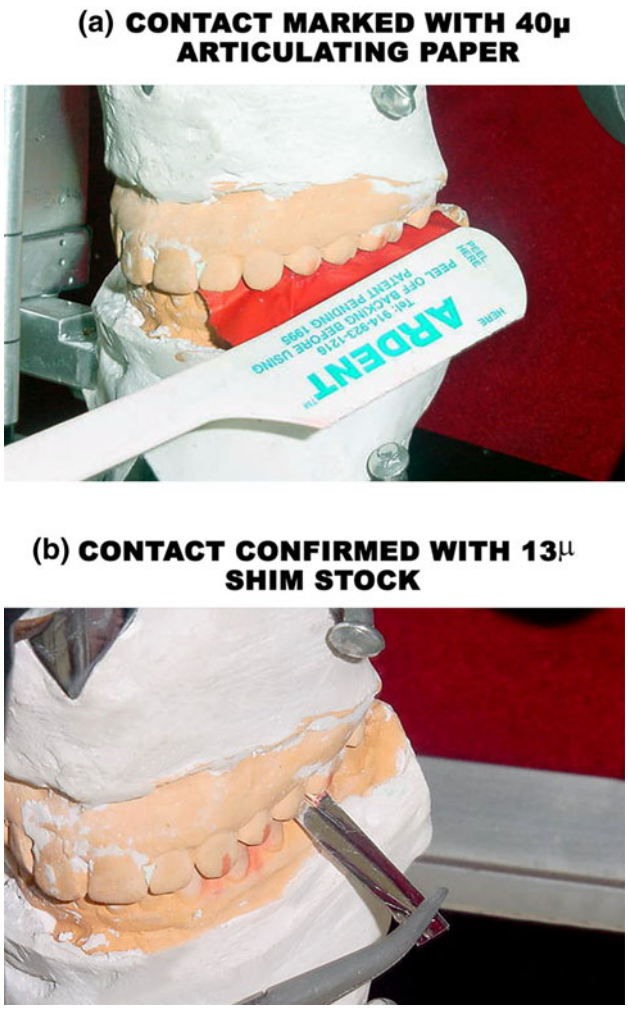


Fig. 3 Contact marking

analysis. Mean and standard deviation (Median and range) were estimated from the sample. The mean values were compared by Wil Coxon's signed rank test. In the present study, $P < \text{O.05}$ was considered as the level of significance. The mean values and standard deviation for the *X*, *Y* and *Z* coordinates for CR and MI methods were calculated.

Results

The profiles of the subjects involved in this study are given in Table 1. The mean age of the subjects was 20.4 years. There were a total of 96 contacts in MI and 20 contacts in CR between the 140 maxillary and 140 mandibular teeth.

The positional displacement (plots) medio-lateral, antero-posterior, superio-inferior direction in CR and MI are given by the *x*-, *y*- and *z*-axis respectively are summarized in Table 2 (Figs. 5, 6). The mean of the centric slide in the medio-lateral, antero-posterior and superio-inferior direction are 0.261, 0.68, 0.127 mm respectively as given in

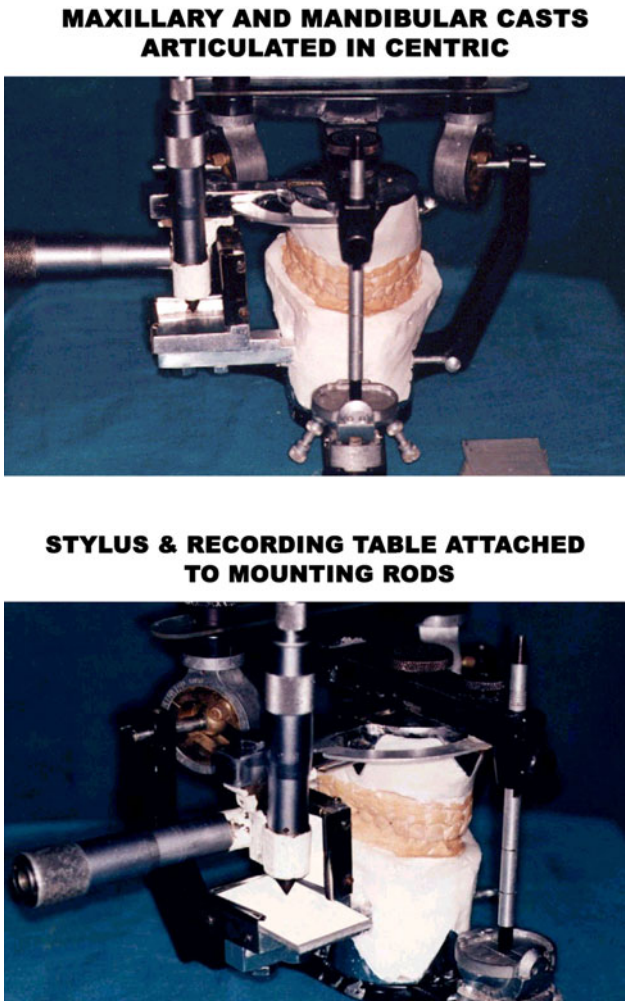


Fig. 4 Articulated casts

Table 3 (Figs. 7, 8). Measurement reliability for intra examiner error was evaluated by repeating RCP-ICP measurements in five randomly selected subjects. The variance between repeated measurements within the five subjects and between the five subjects suggested a strong reproducibility.

Discussion

Historically CR has been considered mainly as a position posterior to habitual occlusion or MI [8, 9]. CR and other occlusal relationships are conceived of as positions, which can be studied in 3D [10]. Clinically, the difference between the two occlusal positions namely CR and MI can easily be determined by closing the mandible in its CR position by manual guidance until the first tooth contact is established. This position used to be called as retruded contact position (RCP) for many years is now called CR contact position. If the patient is then requested to squeeze the teeth together it will permit the mandible to slide towards MI.

This centric slide is easy to observe clinically but for a more precise evaluation of its length and directions an occlusal analysis on articulator mounted casts is necessary. When CR and MI coincide, no premature tooth contacts occur when closing along a terminal hinge movement with the result that there will be no slide. There is a lack of Literature in the methods to determine the extent in space the slide from centric to MI.

Table 1 Profile of the patients included in the trial

Variable	Mean ± S.D	Median (range)
Age (year)	20.4 ± 2.1	20.5(18.0–25.0)
Over jet (mm)	1.5 ± 0.5	1.5(1.0–2.0)
Over bite (mm)	1.9 ± 1.0	2.0(0.0–3.0)
Number of teeth present	29.9 ± 1.7	30.0(28–32)

Ten subjects were included in the study (Male—5, Female—5)

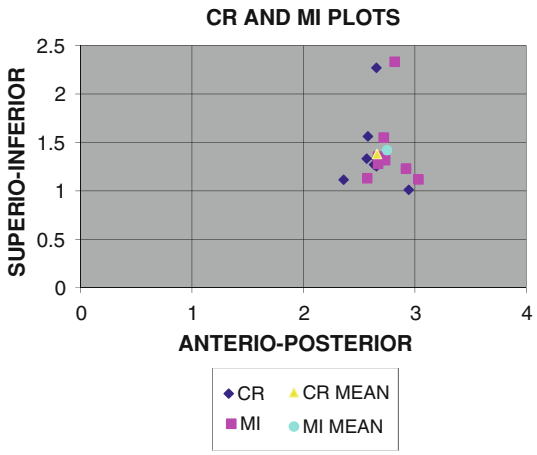


Fig. 5 CR and MI plots in Superio-inferior and Anterio-posterior direction

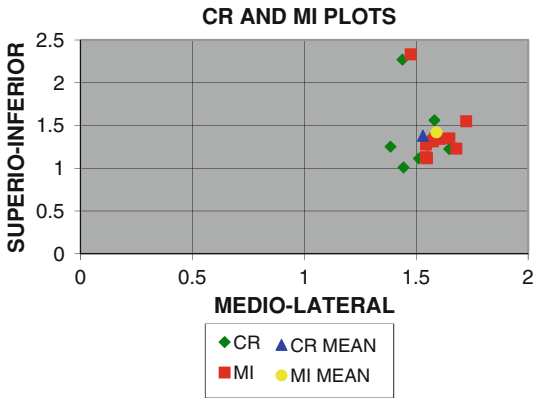


Fig. 6 CR and MI plots in Superio-inferior and medio-lateral direction

Table 2 Mean, S.D. and test of significance Of MI and CR positions

Axis	CR Mean ± SD	MI Mean ± SD	*P* value
X	1.53 ± 0.08	1.59 ± 0.07	0.005(SIG)
Y	2.66 ± 0.17	2.75 ± 0.14	0.008(SIG)
Z	1.38 ± 0.34	1.42 ± 0.35	0.005(SIG)

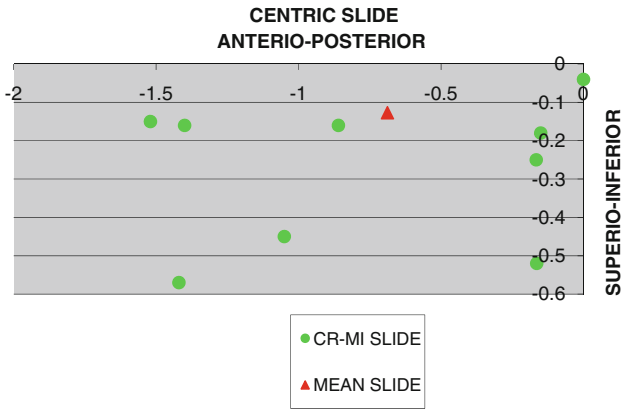


Fig. 7 Centric slide in Anterio-posterior and Superio-inferior direction

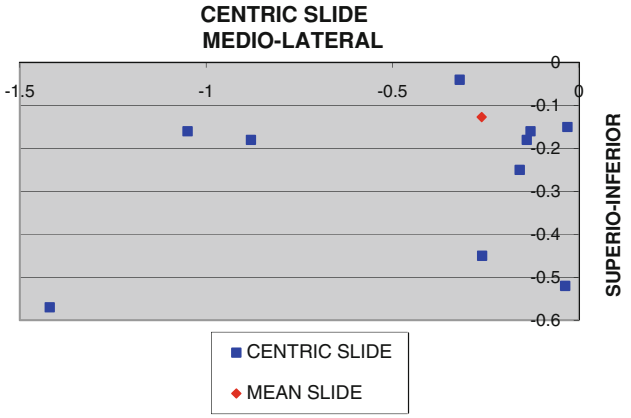


Fig. 8 Centric slide in Medio-lateral and Superio-inferior direction

Table 3 Mean, standard deviation and range of centric slide in mm

Axis	Mean	SD	Median	Range
X	−0.261	0.627	−0.21	(−1.42 to 1.05)
Y	−0.688	0.623	−0.513	(−1.522 to 00)
Z	−0.127	0.541	−0.125	(−1.16 to 1.07)

The objective of this study was to measure the lateral, vertical; and anteroposterior deviation from CRO to MI in the subjects examined using an indigenously designed and fabricated analyser. The study sample was selected from a sampling frame of 50 subjects who had physiologic occlusion as described by Mohl [5]. Physiologic occlusion deviates in one or more ways from the theoretically ideal yet is well adapted to its particular environment, is aesthetically satisfactory to the patient, and has no pathological manifestation or dysfunctional problems. Criteria for physiologic occlusion are occlusal stability, satisfactory mastication, acceptable speech articulation, acceptable aesthetic consideration, freedom from signs or symptoms involving the periodontal attachment, freedom from signs and symptoms of conditions involving the teeth themselves and freedom from signs and symptoms involving the TMJ or musculature.

The mean ranges of overjet (1.5 ± 0.5) and over bite (1.9 ± 1) of this study (Table 1) sample was within the normal range of 1–3 mm. Impressions of the jaws were made with irreversible hydrocolloid and casts were made with type IV dental stone. Split cast mounting plates were machined and used with the Hanau Wide Vue Arcon type semi adjustable articulator. The maxillary casts were mounted on articulator using a Hanau Spring Bow earpiece type face bow. CR records were made as suggested by Lucia using the anterior jig [6, 7]. This technique was followed as it is easy to fabricate and provides stabilization of the mandible during the making of the record.

Since the invention of monograph by Posselt concerning the range of motion of the human mandible, number of statistical studies have described the movement of the mandible from RCP (CR) to MI [10]. Instruments have been categorised as those to measure mandibular movements and those which permit investigation of condylar displacements. Displacement is the difference between the initial position of the body and any other position. These apparatus like Posselts "analyzer for mandibular positions" will not measure movements but it can record positions, the difference between which is then measured [10].

The stylus and recording table by Capp and Clayton (one of those instruments that measure mandibular displacements) is easy to fabricate and does not require major alteration of the articulator and provides an accurate indirect method to measure positional changes [11]. The device used in the study was a similar instrument indigenously devised for the measurements of CR-MI slide.

Assuming the criteria for the selection of normal subjects were the same, the ten subjects in this study had a slide which was significant in the antero-posterior direction (*Y* axis—0.008 *P* value). A possible explanation for the slide found in these subjects is that one given by Lamons and Holmes [12] in their study of upper first molar rotation, stated that the first molar, when rotated takes more space in the dental arch because of it's rhomboid shape. The loss of tooth structure in the primary molars could allow the upper molars to rotate around their lingual roots. This slight

mesial position of the bicuspids could then cause a "prematurity" in centric occlusion with an ensuing slide [12]. The slide was recorded as displacement that occurred in three planes as recorded by the analyzer.

Summary and Conclusion

The position of CR and MI that were determined three dimensionally, using the device showed a definite displacement of the mandible from CR to MI (centric slide). The stylus and table attachment may be used effectively to determine the positional change of the mandible in space.

Acknowledgments Saveetha Dental College, Chennai.

Conflict of interest None.

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