IN VIVO ASSESSMENT OF REPRODUCIBILITY OF MAXIMAL INTERCUSPAL POSITION USING ULTRASONIC AXIOGRAPHY

A Thesis

by

EDWARD ALONZO PALOS

Submitted to the Office of Graduate and Professional Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

Chair of Committee,	William W. Nagy
Committee Members,	Dimitrios I. Kontogiorgos
	Emet D. Schneiderman
Head of Department,	Larry L. Bellinger

May 2019

Major Subject: Oral Biology

ABSTRACT

The maximal intercuspal position (MIP), a maxillomandibular relationship guided by the best fit of opposing teeth, is often used as a treatment position in restorative dentistry. However, there is evidence that the MIP may not be a voluntary easily repeatable intraoral position.

The purpose of this in vivo study was to use axiography to evaluate the reproducibility of the maximal intercuspal position, and to determine the effects that the use of a vinyl polysiloxane (VPS) interocclusal record, a 30 ga interocclusal wax deprogrammer, and the position of the subject, either supine or in the alert feeding position, have on this reproducibility.

Para-occlusal clutches were fabricated for twenty subjects for use with the Axioquick AQR axiographic software, which records the positions of the condyles on X-, Y-, and Z-axes. A bite registration calibration jig was made for each subject to set a reference position "0" at the start of each group of trials, then the subject successively closed in the MIP five times for each group. The data was transferred to Excel and SPSS for analysis.

The results indicated significant differences between successive axiographic recordings of MIP bites on the X-axis and Z-axis in all of the Groups. These differences were skewed anterior and inferior compared to the reference position. The largest differences were found in the groups that used VPS or wax. No significant differences were found between MIP recordings on the Y-axis (medial-lateral direction) for any of the groups.

ACKNOWLEDGEMENTS

I would like to thank my committee chair, Dr. Nagy, and my committee members, Dr. Kontogiorgos and Dr. Schneiderman, for their guidance and support throughout the course of this research.

Thanks also go to my friends and colleagues and the department faculty and staff for making my time at Texas A&M University a great experience and for their participation in the study.

Finally, thanks to my parents, Juan and Gloria Palos; my brother and sister, Aaron and Esmeralda Palos; and all my family for their encouragement, patience and love.

CONTRIBUTORS AND FUNDING SOURCES

Contributors

This work was supervised by a thesis committee consisting of Dr. William W. Nagy and Dr. Dimitrios I. Kontogiorgos of the Department of Restorative Sciences and Dr. Emet D. Schneiderman of the Department of Biomedical Sciences.

The data analyses depicted in Section 3 was conducted in part by Dimitrios I. Kontogiorgos of the Department of Restorative Sciences.

All other work conducted for the thesis was completed by the student independently.

Funding Sources

This work was also made possible in part by a grant from Texas A&M University. The author has no conflicts of interest to report. Its contents are solely the responsibility of the authors and do not necessarily represent the official views of Texas A&M University.

NOMENCLATURE

MIP	Maximal intercuspal position
CR	Centric relation
VPS	Vinyl polysiloxane
PDL	Periodontal ligaments
TMJ	Temporomandibular joint

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1. INTRODUCTION AND LITERATURE REVIEW

The fabrication of dental casts and their mounting in an articulator is a basic procedure in prosthodontics. This seemingly simple process facilitates the production of a dental prosthesis in the laboratory and is an important diagnostic tool in assessing both static and dynamic occlusions. Advances in dentistry have led to developments in instrumentation and protocol in the attempt to produce a model of the patient's occlusion and mandibular movements. Doing so accurately is important for the proper diagnosis of dental conditions as well as for making indirect dental restorations that fit and function correctly when transferred back to the patient's mouth. Done inaccurately it can lead to time-consuming adjustments of restorations in an effort to make them fit, or even a need to redo the procedure, costing both the dentist and the patient time and resources. It is likely not possible to completely reproduce a patient's occlusion and mandibular function using mounted casts in an articulator for a variety of reasons, some of which will be explored in this study.

A common protocol for the mounting of dental casts begins with determining the relationship of the maxilla to the cranial base, and transverse horizontal axis, which is a line that passes through both condyles as they purely rotate in the sagittal plane during a terminal hinge movement [1, 2]. This relationship is transferred to the articulator by mounting the maxillary cast using a facebow transfer. The relationship of the mandible to the maxilla must then be transferred to the articulator. Two common methods for achieving this are by hand articulating and mounting the casts into the maximal intercuspal position (MIP) or by the use of a maxillomandibular record, which is mostly used when mounting the casts in the centric relation (CR) position. The decision on which maxillomandibular relationship to use is determined by the clinician, taking into consideration such factors as the complexity of the reconstruction, the patient's current occlusal stability, and whether a conformative or reconstructive approach is utilized.

The MIP mounting is used when the patient's pretreatment intercuspal relationship and vertical dimension of occlusion are to be maintained. There are an infinite number of intercuspal positions, however, this maxillomandibular relationship is a tooth guided position defined in the Glossary of Prosthodontic Terms as "the complete intercuspation of the opposing teeth independent of condylar position, sometimes referred to as the best fit of the teeth regardless of the condylar position" [2]. The MIP can usually be achieved clinically by asking the patient to "bite down" on their back teeth. In contrast, CR relates the mandible to the maxilla based on the position of the condyles, independent of tooth position. The Glossary of Prosthodontic Terms defines CR as "a maxillomandibular relationship, independent of tooth contact, in which the condyles articulate in the anterior-superior position against the posterior slopes of the articular eminence" [2]. Between 80-90% of patients have a discrepancy between the CR and MIP positions [3,4]. An advantage to the CR position is that it is a stable, reproducible mandibular condyle position in patients with healthy temporomandibular joints (TMJs), and so can serve as a reference position, even in edentulous patients, patients lacking a stable bite, or in patients undergoing extensive dental restorative work in which their bite may be changed. However, locating this position can be difficult for clinicians lacking the proper training [5].

If mounting in CR, an open bite interocclusal record must be used since it is a condylar position and not a tooth position. Meng, et. al. found that mounting casts in CR using a wax interocclusal record was accurate, as determined by evaluation of the occlusal contacts with articulating paper and scanned light transmission through vinyl polysiloxane (VPS) interocclusal records [6]. However, when mounting in MIP, it is possible to either mount the mandibular cast against the maxillary cast using an interocclusal record or by articulating the casts by hand to find "the best fit of the teeth." Peregrina and Reisbick evaluated the mounting of casts in MIP and found that when casts are made from irreversible hydrocolloid impressions, hand articulation without the use of a record was the most accurate [7]. Walls, et al. also found that it was more accurate to mount the dental casts in MIP by "hand articulation" compared to the use a polyether bite registration, unless the patients' occlusal schemes did not allow for an easily established and stable maximal intercuspal position [8]. Elastomeric polyether bite registration material compresses under load during mounting, causing possible distortion, and captures higher surface details intraorally, such as occlusal fissures and embrasures when compared to casts poured from alginate impressions. This prevents complete and intimate adaptation of the polyether interocclusal registrations to the stone casts.

Possible sources of inaccuracy in mounting dental casts in an articulator include distortions in dental impression materials, cast materials, and type or material composition of bite registrations [9,10]. However, there are other reasons that it may not be possible to mount dental casts in MIP. The first reason is a biological one. Dental casts are solid static models of a dynamic biologic system. Intraorally, teeth are supported by the periodontium, which includes periodontal ligaments (PDL). This results in physiologic mobility in which healthy teeth are capable of movement in the range of 56 to 108 microns [11] in a faciolingual direction and 28 microns in an axial direction [12]. Since MIP is guided by teeth, when a patient bites in MIP there may be small movements of the teeth positions depending on the position into which the patient closes and the force with which they bite. For most patients biting in MIP, the condyles are not in their most musculoskeletally stable position, but have translated down the articular eminence in order for their teeth to come together into this best fit of the teeth. However, the majority of the population is able to close into MIP when asked to bite down due to neuromuscular control. The PDL of teeth display a discerning proprioceptive ability, with natural teeth being able to perceive biting down on something as small as 0.02 mm [13]. This proprioception is protective against biting down hard on hard objects while chewing as well as preventing destructive forceful closing on deflective incline planes of the teeth. This PDL, along with proprioceptive inputs from other anatomical structures, gravity, and psychic origins leads to an adaptive muscle response or "muscle memory" [14] which results in an occlusal programming that allows most people to be able to close into MIP. As the patient closes more firmly into MIP, physiologic mobility allows the teeth to shift and settle slightly into a more stable adaptation between opposing teeth. Gurdsapsri, et al. found that the clenching level when biting in MIP was significantly correlated to posterior teeth contact areas with a greater amount of clenching correlating with a greater amount of occlusal contact area [15].

Dental impressions are made with the patient's mouth open with a non-rigid material that may be unlikely to exert enough force on the teeth to cause physiological movement. Therefore, the dental casts may or may not have the teeth in their neutral position, lacking any physiological mobility. If an MIP interocclusal record is made, the patient must bite down, resulting in slight movement of the teeth, and an interocclusal record of teeth in different positions as those found in the dental casts. Additionally, the position of the patient as they close into MIP may make a difference as well, with the mandibular path of closure being in a more posterior position when the patient is reclined in the dental chair compared to sitting upright in the alert feeding position [16]. A stone cast also exhibits linear expansion on setting and is larger than the record.

Dental impressions by necessity must be made with a patient's mouth more open than their vertical dimension of occlusion. This leads to another possible source of inaccuracy from mandibular flexure, in which the mandibular width decreases the more a patient opens their mouth. DeMarco and Paine found that up to 28% of maximal opening does not result in changes in mandibular width, but greater than 28% opening results in an increasing change in mandibular width due to the effects of the muscles of mastication on the mandible [17]. There is also some evidence that the majority of patients do not have a single stable MIP when hand articulating dental casts and that 57% of cases display what Utz et.al. have termed "lateral leeway", or some degree of rotational movement during hand articulation of dental casts. This was further tested with the use of an electronic condymeter on casts mounted in MI, in which the casts were repeatedly hand articulated and the condymeter measured a mean spatial displacement of 0.16 mm in the condylar areas [18].

This evidence suggests that a truly repeatable MIP may not be possible in vivo, much less in mounted casts in an articulator. A number of studies have been published attempting to measure the variability in MIP in patients using various methods. Berry and Singh attempted to find diurnal variations in MIP by measuring occlusal contacts with articulating paper in the mornings and afternoons of 3 separate days. They did note differences in both the intensity and number of occlusal contacts [19]. However, articulating paper has the drawback of producing false contacts, especially with the use of thicker articulating papers, and some contacts may not mark on smooth and moist tooth surfaces. Molligoda, et.al. also looked at diurnal variations in occlusal contacts, using a different method in which they had patients close into regular viscosity Permlastic (a polysulfide, condensation-cure, impression material), over different times of day over 2 days, and measuring variations in the spread of actual and near contacts by the amount of light transmitted through these bite records. They did find variations between the different records, but these were not statistically significant [20].

Gonzalez Sequeros et. al. studied occlusal contact variability using a T-Scan, which is a computerized instrument to record bite length, timing of tooth contacts , and their relative force. In this study they only compared the number of contacts, and they found no significant differences between the numbers of contacts of most teeth within the same individual [21]. However the resolution of the T-Scan is limited due to the thickness and limited flexibility of the sensor, and the grid system that is used in the sensor, in which measurements are only accurate within the center of each grid [22]. Jaschouz evaluated occlusal contact variability using optical bite registration through Cerec buccal scans and a superimposition program. No significant differences were found, although they did find a mean deviation of 42 microns [23].

The previous studies have evaluated the reproducibility of MIP in vivo using different methods. Another method for recording maxillomandibular relationships is through the use of ultrasonic axiography, which is a double facebow system, in which the lower bow transmits movements of the mandible to the upper facebow sensors. Axiography usually records mandibular movement in 3 axes. Since this is an in vivo procedure, the inaccuracies in making and mounting dental casts are avoided, and the effects of the PDL remain. Another benefit of electronic axiography is that the graphic points and their movements are displayed on a screen, where they can be magnified [24].

The purpose of this study was to evaluate the in-vivo reproducibility of the maximal intercuspal position and to evaluate the effect that the use of a VPS interocclusal record; the use of 30 ga interocclusal wax deprogrammer; and the position of the patient have on the reproducibility of MIP. These measurements will be recorded at successive maximal intercuspal position bites using the SAM Axioquick Recorder (AQR) software. The null hypothesis is that there are no differences between successive maximal intercuspal positions obtained in the alert feeding position; using a VPS interocclusal record; occlusal indicator wax; and with the patient in a supine position.

2. MATERIALS AND METHODS

This study included twenty subjects (11 males and 9 females), ages 25 to 40 and was approved by the Institutional Review Board of Texas A&M University (Protocol number 2014-0653-BCD-EXP). The inclusion criteria for participation in the study required the subjects to be in general good health, fully dentulous to the first molars at minimum, a stable MIP cast position and a resident, student, or staff member at Texas A&M University College of Dentistry. The exclusion criteria included having a history of or existing temporomandibular joint disorder, excessive vertical overlap of anterior teeth preventing the use of a para-occlusal clutch, grossly inadequate dental restorations that may be easily dislodged during study procedures, an inability to execute directions from the operator, or an inability to tolerate an oral exam. The study procedures were completed over two separate appointments for each subject.

2.1 Para-Occlusal Clutch Fabrication

At the beginning of the first appointment, the study project was explained to each subject, and informed consent obtained. Following consent, a clinical dental exam was completed to screen the subjects for compliance with the inclusion and exclusion criteria. If the criteria were met, irreversible hydrocolloid (Jeltrate Alginate Regular Set, Dentsply Caulk, Milford, Delaware) impressions were taken of the subjects’ maxillary and mandibular arches and the subjects were dismissed. The dental casts were poured using ISO Type 3 gypsum stone (Microstone, Whip Mix, Louisville, Kentucky). Once the stone had set, the casts were marked with a code for identification and then were checked for a stable MIP position, as evaluated by hand articulation of the casts. While the casts were articulated, the vertical overlap of the maxillary teeth over the mandibular teeth was recorded on the mandibular cast with a pencil in order to mark the occlusal extent of the para-occlusal clutch (Figure 1).

Figure 1. Maxillary vertical overlap marked on hand articulated casts

The portion of the para-occlusal clutch that surrounded the mandibular teeth was formed using positive pressure thermal forming material in the Ministar S (Great Lakes Orthodontics, Ltd., Tonawanda, New York). A spacer was formed over the mandibular casts using 0.10mm Isofolan (Scheu-Dental GmBH, Iserlohn, Germany) and 1.5mm Clear Splint Biocryl (Great Lakes Orthodontics, Ltd., Tonawanda, New York) was formed over the Isoflan. The occlusal portion of the Biocryl was trimmed to slightly below the previously marked line indicating the vertical overlap of the maxillary teeth. The apical portion of the Biocryl was trimmed 3-4 mm below the marginal gingiva. A brass rod/plate assembly was made using a 0.25" OD X 0.020" W brass tube (McMurry Metal Company, Inc., Dallas, Texas) approximately 5 inches in length and a 0.025" brass plate cut into 0.25" by 3" strips that were perforated. The brass rod was soldered to the middle of the brass plate strip with lead-free solder. The brass rod/plate assembly was attached to the labial portion of the Biocryl with splint resin, and the casts were hand articulated again to verify that the para-occlusal clutch did not interfere with articulating the casts in the MIP.

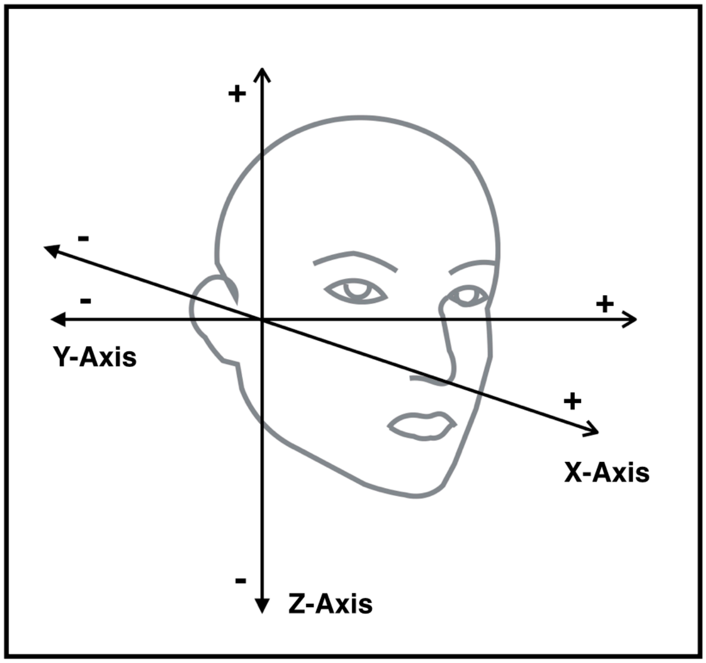
2.2 Axioquick Recorder (AQR)

Following fabrication of the para-occlusal clutches, the subjects were scheduled for a second appointment during which the axiographic recording was completed. The para-occlusal clutches were relined intra-orally to ensure that they were stable enough to provide accurate measurements. This was accomplished by painting tray adhesive on intaglio surface of the para-occlusal clutch and lining it with Futar (Kettenbach GmbH & Co. KG, Eschenburg, Germany) VPS prior to seating the trays in the mouth. After the Futar set, any excess VPS that had flowed onto the occlusal surfaces of the mandibular teeth were trimmed. The para-occlusal trays were seated intra-orally and checked for stability and for a lack of an occlusal interference to MIP. This was completed through visual inspection, having the subjects close on articulating paper, and asking the subjects whether they felt like they were biting on any portion of the para-occlusal clutch. Any portions of the clutch that interfered with occlusion were adjusted (Figure 2).

Figure 2. Relined para-occlusal clutch

The upper facebow of the SAM Axioquick Recorder was secured. The lower facebow was attached to the brass rod of the para-occlusal clutch, aligning the ultrasonic sensors of the lower and upper facebows. The MIP was reviewed with each subject, and they were informed that they would be repeatedly closing into the MIP during this appointment. An interocclusal bite registration in MIP was taken using Luxabite (DMG America, Englewood, New Jersey) bisacryl material. This hard bite registration was trimmed to have only the cusp tips indexed and tried in the mouth to verify that the subjects could close into the MIP without interference from the bite registration material. This bite registration calibration jig served to set the reference position by setting the zeros on the X-, Y-, and Z-axes on the SAM Axioquick AQR software during calibration at the start of each experimental group (Figure 3).

Figure 3. X-, Y-, and Z-Axes at the condyle



Four different groups of recordings were completed for each subject, and each group consisted of seven consecutive recordings of the bite position. For the first recording of each group, the subject closed into the Luxabite MIP bite registration calibration jig in order to set the reference position (0,0,0) in the AQR software, and the next recorded bite was into the same bite registration again, in order to gather data confirming the repeatability of the reference "0" when using a bite registration. Then five successive bites were recorded according to the parameters of the group being measured. In Group 1 (Alert), the subjects closed successively into the MIP in an alert feeding position five times. In Group 2 (Supine), the subjects closed successively into the MIP in a reclined position at 180°, parallel to the floor, five times. In Group 3 (VPS), the subjects closed successively into the MIP in an alert feeding position while a full arch VPS bite registration was taken, and the position was recorded after the VPS set, five times. In Group 4 (Wax), the subjects closed successively into the MIP in an alert feeding position after tapping approximately five times in the MIP while using a 30 ga occlusal indicator wax deprogrammer (Dow Corning). In order to minimize bias from repeated closure in MIP affecting its repeatability, the order in which these groups were tested and recorded was randomized. For all trials, the subjects were asked to bite with medium pressure.

2.3 Data Analysis

The data was measured and recorded for each subject for each bite in the X-, Y-, and Z-axes to an accuracy of 0.01mm. Analysis was completed using statistical software (SPSS 19.0, SPSS Inc., Chicago, IL). After setting the reference bite as (0, 0, and 0) for (X, Y, and Z), the next measurement in each trial was having each subject bite again into the bite registration. This data was analyzed to validate the repeatability of using the bite registration as a reference position using descriptive statistics.

The data for each of the groups tested were also evaluated with descriptive statistics to explore if the mean values for each group in the X-, Y-, and Z-axes were statistically different from 0. If the 95% confidence interval (CI) for the mean for each data set included 0, then there was no statistically significant difference to the reference bite. If the 95% CI did not include 0 then the data was determined to be skewed on either the positive or negative side of the axis.

3. RESULTS

The first data analyzed was on whether a hard MIP bite registration could be reliably used to set the reference position (0,0,0) at the start of each trial. As shown in Table 1, the mean values for all of the MIP bite registration jig recordings were 0.002 mm for the X-axis, 0.000 mm for the Y-axis, and 0.018 mm for the Z-axis. The 95% confidence intervals in each axis included 0, demonstrating no statistically significant differences between bites when using the MIP bite registration as a calibration reference.

Table 1. Descriptive statistics for bite registration calibration jig (mm)

	X-axis (Anterior-Posterior)	Y-axis (Medial-Lateral)	Z-axis (Superior-Inferior)
Mean	0.002	0.000	0.018
Upper*	0.017	0.016	0.042
Lower*	-0.013	-0.016	-0.006
Standard Deviation	0.094	0.105	0.154
Median	0.000	0.000	0.000
Minimum	-0.3	-0.3	-0.4
Maximum	0.2	0.3	0.4
IQ Range	0.1	0.2	0.1

* 95% Confidence Interval of Mean

The descriptive statistics on the data for each test Group show that the mean values for MIP bite recordings in the X-axis (anterior-posterior) and the Z-axis (superior-inferior) showed significant differences when compared to the reference position for all Groups, whereas mean values of MIP bite recording in the Y-axis (medial-lateral) did not (Table 2).

Table 2. Descriptive statistics for test groups (mm)

Groups	Alert	Supine	VPS	Wax
X-Axis				
Mean	0.159	0.154	0.353	0.434
Upper*	0.207	0.189	0.408	0.478
Lower*	0.111	0.119	0.297	0.390
Std. Deviation	0.343	0.252	0.398	0.314
Median	0.200	0.100	0.300	0.400
Minimum	-0.6	-0.5	-0.5	-0.4
Maximum	1.0	0.9	1.5	1.3
IQ Range	0.5	0.3	0.5	0.5
Y-Axis				
Mean	0.000	0.001	0.000	0.001
Upper*	0.018	0.026	0.018	0.024
Lower*	-0.018	-0.024	-0.017	-0.022
Std. Deviation	0.128	0.178	0.122	0.167
Median	0.000	0.000	0.000	0.000
Minimum	-0.3	-0.5	-0.4	-0.4
Maximum	0.3	0.5	0.4	0.4
IQ Range	0.2	0.2	0.2	0.2
Z-Axis				
Mean	-0.284	-0.075	-0.515	-0.459
Upper*	-0.236	-0.014	-0.457	-0.391
Lower*	-0.332	-0.135	-0.573	-0.527
Std. Deviation	0.341	0.435	0.416	0.486
Median	-0.200	-0.100	-0.500	-0.450
Minimum	-1.6	-1.3	-2.0	-1.6
Maximum	0.5	1.3	0.4	2.0
IQ Range	0.4	0.5	0.4	0.6

* 95% Confidence Interval of Mean

On the X-axis, the data for each Group were skewed to the positive, or anterior, side of the axis. The greatest mean difference on the X-axis from the reference position was in Group 4 (Wax) (0.434 mm, 95% CI=0.390-0.478 mm), followed by Group 3 (VPS) (0.353 mm, 95% CI=0.297-0.408 mm), Group 1 (Alert) (0.159 mm, 95% CI=0.111-0.207 mm), and Group 2 (Supine) (0.154 mm, 95% CI=0.119-0.189 mm). On the Z-axis, the data for each Group were skewed to the negative, or inferior, side of the axis. The largest mean difference on the Z-axis was in Group 3 (VPS) (-0.515 mm, 95% CI=-0.573- -0.457 mm), followed by Group 4 (Wax) (-0.459 mm, 95% CI=-0.527- -0.391 mm), Alert (-0.284 mm, 95% CI=-0.332- -0.236 mm), and Group 2 (Supine) (-0.075, 95% CI=-0.135- -0.014 mm). Box plots of the data are presented in Figure 4.

Figure 4. Box plots of data

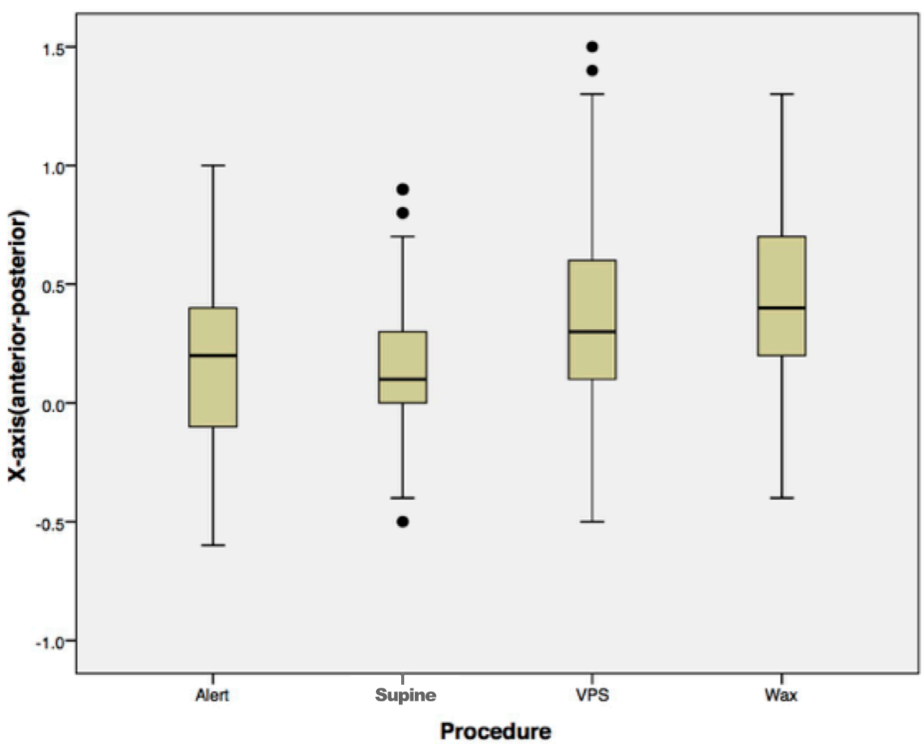
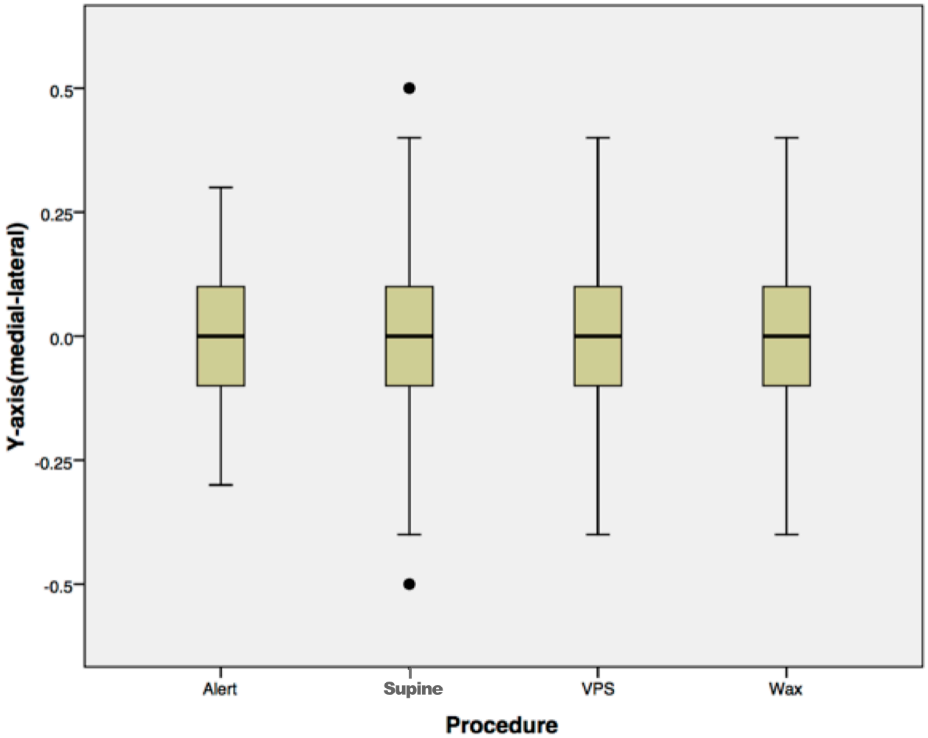
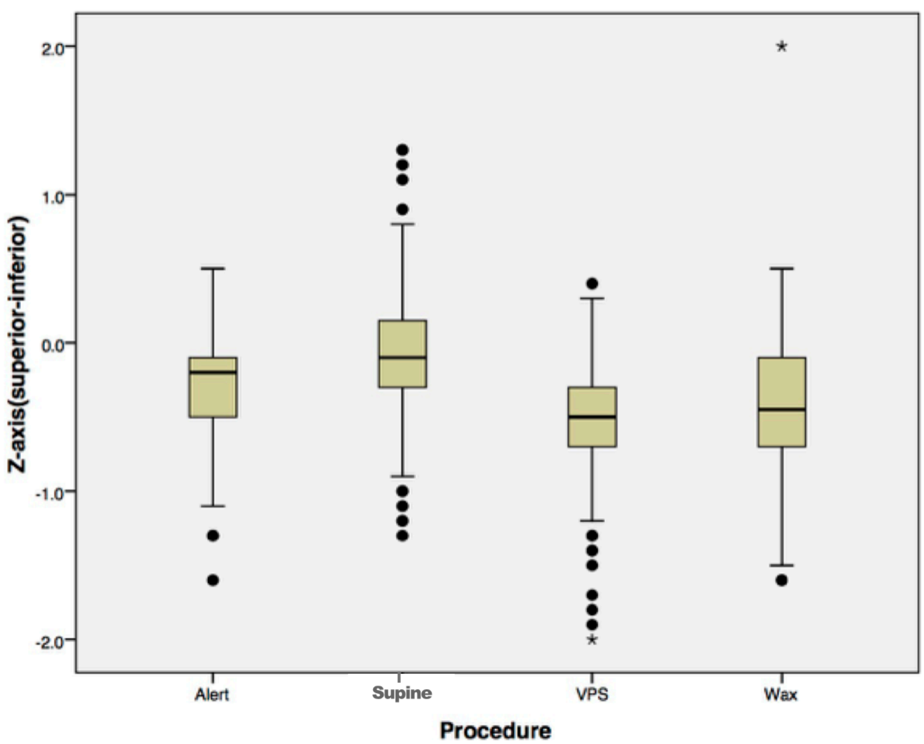


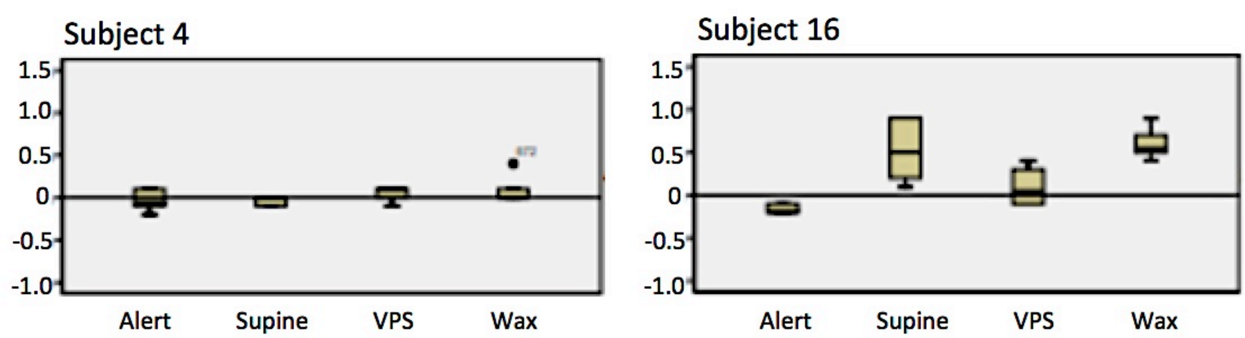
Figure 4. Box plots of data Continued





These were mean measurements, and there was considerable variation between subjects as exemplified in Figure 5, which depicts box plots for the measurements for Subjects 4 and 16 on the X-axis. Subject 4's measurements were similar to each other and close to the reference position in all Groups compared to Subject 16 whose measurements showed a larger interquartile range and deviation from the reference position.

Figure 5. X-Axis box plots showing variablity between 2 subjects



4. DISCUSSION

Dental casts may be mounted in the MIP when treating patients in whom that position is physiologic, which according to Parker meet the criteria of painless and unrestricted TMJs that manipulate easily into CR with a minimal CR to MIP discrepancy (less than 0.5 mm) and no evidence of occlusal trauma. Another factor is the extent of restoration and whether the patient's occlusal contacts are sufficiently maintained during treatment to provide them with the proprioceptive references needed to have a repeatable MIP [25]. If MIP is utilized as the treatment position, then when mounting casts in an articulator the relationship between the maxillary and mandibular casts can be established through hand articulation of the casts as long as the patient's occlusion allows for a stable MIP. In a stable MIP the anatomy and position of the teeth can capture and transfer the patient's MIP bite to the articulator without the need for a bite registration. Alternatively, an interocclusal bite registration may be used to mount casts, especially in patients lacking a stable MIP. However, sources of inaccuracy in mounting casts can arise from distortions in the materials used for the impressions and casts, and if a bite registration is used, another possible source of error is the patient's ability to reliably close into the MIP while taking the bite registration.

The present study evaluated the repeatability of closing into the MIP in vivo through the use of the Axioquick Recorder software in several different clinical scenarios, with the patient in the alert feeding position (Group 1), supine (Group 2), biting into a VPS bite registration material (Group 3), and biting into 30 ga interocclusal wax deprogrammer (Group 4). Changes in the X-, Y-, and Z- axes were measured, with statistically significant differences found between the reference and MIP bite recordings in the X-axis (anterior-posterior) and Z-axis (superior-inferior) in all of the Groups and no differences found between the reference and MIP bite recordings in the Y-axis (medial-lateral) between any of the Groups.

The AQR axiography protocol begins with a calibration, setting the origin of the 3 axes at (0,0,0), usually with the TMJs in CR. In this study the MIP was being measured. Therefore, an MIP bite registration reference jig was created with bisacryl because, interestingly, a constant “0” could not be obtained without it. This position was considered MIP, because the subjects’ actual MIP position could not be repeated without significant differences. This reference jig was used to calibrate the axes to 0 at the start of each Group being recorded. The accuracy and repeatability of using this bite registration jig was confirmed by having the subjects bite into the MIP reference jig again as the first recording in each Group of trials. No statistical differences were found between this first bite recording and the calibrated zero in any of the axes.

On the Z-axis, or superior-inferior direction, the mean MIP bite recordings for all Groups were in a more inferior position compared to the reference. The largest mean differences were found in Group 3 (VPS) (-0.515 mm) and Group 4 (Wax) (-0.459 mm). For the X-axis, or anterior-posterior direction, all Groups had mean MIP bite measurements that were statistically different and anterior to the reference jig position. The largest differences were also in Group 4 (Wax) (0.434 mm) and Group 3 (VPS)(0.353 mm). These findings indicate that the use of a bite registration material, whether VPS or wax, resulted in a more inferior and anterior position of the condyles compared to the reference MIP position. The use of a bite registration material also resulted in a more inferior and anterior position compared to MIP recordings without bite registrations, as in Group 1 (Alert) (X-axis = 0.159 mm, Z-axis = -0.284 mm) and Group 2 (Supine) (X-axis = 0.154 mm, Z-axis = -0.075 mm)

These results are similar to those reported by Berry and Singh, who did find in vivo variations in MIP, measured by the intensity and number of occlusal contacts as marked by articulating paper [19]. However, they did not measure the differences as changes in distance and direction like in the present study. Also the occlusal contacts were only marked with the patients seated. There were several studies with results not in agreement with the present study in that they generally did not find differences between MIP bites. Molligoda, et. al. utilized multiple Permlastic MIP bite registrations taken over two days and measured for diurnal variations in the spread of occlusal contacts. They did find variations around the means for the locations of contacts in different bite registrations, though theses differences were not statistically significant. In that study, occlusal contacts between firm contacts to 0.2 mm near contacts were considered the same, so perhaps their method of measurement was not able to discern small changes in MIP bites, which in this study were in the tenths of a millimeter [20]. Gonzales Sequeros, et. al. used a T-Scan to compare the number of MIP occlusal contacts on each tooth over 4 successive bites and generally found no significant differences, except for on three of the teeth. However, they were looking at the number of occlusal contacts per tooth, not changes in the location of the contacts, and the T-scan can have a limited resolution due to the thickness and stiffness of the sensors [21]. Jaschouz and Mehl used an intra-oral scanner to evaluate four MIP bites in a reclined and four MIP bites in a seated position in the morning and afternoon and found no significant differences, although a possible limitation is that they compared superimposed buccal scans of only the few teeth captured in the scan and they did not check for differences in MIP bites in subjects biting into a bite registration, which in this study were the bites with the largest differences [23].

An interesting finding in this study was that the mean measurements on the Y-axis, or medial-lateral direction, for all the Groups were not found to be statistically different from the reference MIP. Mean MIP bite measurements on the Y-axis were 0.000 mm, 0.001 mm, 0.000 mm, and 0.001 mm for Group 1 (Alert), Group 2 (Supine), Group 3 (VPS), and Group 4 (Wax) respectively. There has been some evidence in the literature of mediolateral movement being possible at the condyles while a patient is biting, usually measured as starting from the CR position. Known as immediate side shift or Bennett shift, a 2016 review by Taylor on the subject found inconsistent reports on its definition, occurrence on the working or non-working condyles, or whether it's only seen in assisted jaw movements where it may be induced by the operator [26]. Although this study was recording MIP bites and not CR, the lack of differences in MIP bite recordings in any of the Groups in a medial-lateral direction indicates the stability of the condyles in the MIP in this axis. This may also be due to the selection criteria used to select patients for this study, e.g. dentulous arches and no history of TMD.

The null hypothesis was partially rejected with statistically significant differences found between the different groups and the reference jig position in the X- and Z- axes, but not the Y-axis. These findings appear to have clinical significance in that the largest mean differences of MIP bite recordings were found in the groups that used a bite registration, either VPS or wax. In Group 3 (VPS) the mean difference in the X-axis was 0.353 mm anterior and 0.515 mm inferior to the reference position. If VPS bite registrations with these differences were used to mount casts to fabricate an indirect restoration that resulted in an occlusal interference of 0.3 to 0.5 mm, this could lead to patient discomfort when biting and possibly to occlusal trauma if the interference were not adjusted. As stated in the introduction, Enkling found that the PDLs of teeth could discern interferences as small as 0.02 mm. These occlusal interferences on restorations are routinely adjusted clinically with the patient in the chair. If the interferences are extensive, adjusting them can expend the clinician's time and resources as well as affect the restoration's anatomy and possibly its structural integrity. Even in the groups without a bite registration there were differences of up to 0.159 mm on the X-axis and 0.284 mm on the Z-axis, indicating the need to check occlusal contacts multiple times when adjusting restorations chairside to verify that there are no occlusal interferences in potentially different MIP bites and supporting the recommendation to check occlusion in both the supine and alert feeding positions.

Some limitations of the study include the potential bias of the subjects reinforcing their muscle memory to close into the MIP as the recordings progressed, thereby improving the repeatability of the recordings through the repeated closures. To try to minimize this influence, after fabricating the MIP reference jig, the order in which the different experimental Groups were recorded were varied randomly for each of the subjects. Another consideration is the level of stability of the upper and lower facebows throughout the recordings. Several straps secured the upper facebow and the lower facebow was attached to paraocclusal clutch which was relined with Futar to aid in stability. The differences observed in this study were in the tenths of a mm, which could conceivably be due to changes in the position of either the upper or lower facebow. However the MIP reference jig recordings and the Y-axis recordings did not show significant differences, suggesting that this was not an issue in this study.

Another limitation of the study is that the reference position for the MIP was based on a bisacryl MIP bite registration jig that was used to calibrate the axes at the start of each Group of trials. The results of this study indicate that the greatest differences on the X- and Z-axis were when the subjects were closing into bite registration materials, Group 3 (VPS) and Group 4 (Wax). This calls into question whether the MIP reference jig and resulting MIP reference position is the subject's true MIP bite or whether a true MIP bite is even possible in vivo. Even so, if an intraoral MIP record was made it probably would not fit the stone cast because of stone expansion and "artifact interferences" [6]. However, these results were generally consistent in finding no differences in recordings in the medial-lateral direction (Y-axis) for any of the Groups and a positive skew (anterior) and negative skew (inferior) for the X- and Z-axes, respectively, for all Groups. These results indicate that the MIP is not repeatable on the X- and Z-axis and is repeatable on the Y-axis, regardless of where the reference point is set.

Future studies could evaluate how differences in AQR recordings translate to differences in occlusal contacts TMD. The following cases could also be explored: patients with a history TMD, a large number of occlusal restorations, more dental wear, and different Angle class occlusions.

5. CONCLUSION

Within the limitations of this in vivo study, the following conclusions can be drawn:

1. No differences were found between successive axiographic recordings of MIP bites for any of the Groups as measured in the Y-axis (medial-lateral)
2. Differences were found between successive axiographic recordings of MIP bites for all of the Groups as measured in the X- (anterior-posterior) and Z-axes (superior-inferior)
3. The use of either a wax or VPS bite registration material resulted in greater MIP bite differences than in Group 1 (Alert) and Group 2 (Supine) in the X- and Z-axes.
4. The differences in the bites in Group 3 (VPS) and Group 4 (Wax) were in an inferior and anterior direction when compared to the reference and when compared to Group 1 (Alert) and Group 2(Supine)
5. The study suggests the MIP bite was not repeatable in vivo without the use of the calibration jig
6. When mounting casts in MIP, if the casts are stable through hand articulation, then mounting them without the use of a bite registration may be more accurate

REFERENCES

1. Winstanley RB. The hinge-axis: a review of the literature. J Oral Rehabil 1985;12:135-159

2. The Glossary of Prosthodontic Terms: Ninth Edition. J Prosthet Dent 2017;117:e1-e105.

3. Posselt U. Movement areas of the mandible. J Prosthet Dent 1957;7:375-385.

4. Crawford SD. Condylar axis position, as determined by the occlusion and measured by the CPI instrument, and signs and symptoms of temporomandibular dysfunction. Angle Orthod 1999;69:103-115; discussion 115-106.

5. Dawson P. Evaluation, diagnosis and treatment of occlusal problems. St. Louis: Mosby; 1974.

6. Meng JC, Nagy WW, Wirth CG, Buschnag PH. The effect of equilibrating mounted dental stone casts on the occlusal harmony of cast metal complete crowns. J Prosthet Dent 2010;104:122-132.

7. Peregrina A, Reisbick MH. Occlusal accuracy of casts made and articulated differently. J Prosthet Dent 1990;63:422–425.

8. Walls AWG, Wassell RW, Steele JG. A comparison of two methods for locating the intercuspal position (ICP) whilst mounting casts on an articulator. J Oral Rehabil 1991;18:43-48.

9. Thongthammachat S, Moore BK, Barco MT 2nd, Hovijitra S, Brown DT, Andres CJ. Dimensional accuracy of dental casts: influence of tray material, impression material,and time. J Prosthodont 2002;11:98-108.

10. Muller J, Gotz G, Horz W, Kraft E. Study of the accuracy of different recording materials. J Prosthet Dent 1990;63:41-46.

11. Rudd KD, O'Leary TJ, and Stumpf AJ, Jr. Horizontal tooth mobility in carefully

screened subjects. Periodontics 1964;2

12. Parfitt GJ. Measurement of physiological mobility of individual teeth in an axial direction. J Dent Res 1960;39:608–618.
13. Enkling N, Nicolay C, Utz KH, Jöhren P, Wahl G, Mericske-Stern R. Tactile sensibility of single-tooth implants and natural teeth. Clin Oral Implants Res 2007;18:231–236
14. Guichet NF. Occlusion 2nd ed. 1977, Anaheim: The Denar Corporation; 1977. p. 19-24.
15. Gurdsapsri W, Ai M, Baba K, Fueki K. Influence of clenching level on intercuspal contact area in various regions of the dental arch. J Oral Rehabil 2000; 27: 239-244
16. Okeson JP: Management of temporomandibular disorders and occlusion. St. Louis: Mosby, 1993. p. 87-88
17. De Marco TJ, Paine S. Mandibular dimensional change. J Prosthet Dent 1974;31:482-485
18. Utz, KH, et. al. The lateral leeway in the habitual intercuspation: experimental studies and literature review. J Oral Rehabil 2007;34:406-413.
19. Berry DC, Singh BP. Daily variations in occlusal contacts. J Prosthet Dent 1983;50:386–91.
20. Molligoda MA, Abuzar M, Berry DC. Measuring diurnal variations in the dispersion of occlusal contacts. J Prosthet Dent1988;60:235-238.
21. González Sequeros O, Garrido García VC, García Cartagena A. Study of occlusal contact variability within individuals in a position of maximum intercuspation using the T-SCAN system. J Oral Rehabil 1997;24:287-90.
22. Lyons MF, Sharkey SW, Lamey PJ. An evaluation of the T-Scan computerised occlusal analysis system. Int J Prosthodont 1992;5:166-172.
23. Jaschouz S, Mehl A. Reproducibility of habitual intercuspation in vivo. J Dent 2014;42:210-218

24. Piehslinger E, Celar AG, Celar RM, Slavicek R. Computerized axiography: principles and methods. Cranio 1991;9:344-355.

25. Parker, MW. The significance of occlusion in restorative dentistry. Dent Clin North Am 1993;37:341-351.

26. Taylor, TD, Bidra, AS, Nazarova, Wiens, JP. Clinical significance of immediate mandibular lateral translation: A systematic review. J Prosthet Dent 2016;115:412-418

APPENDIX

"AXIOQUICK AQR RECORDER DATA"

Patient	Group (1=Alert, 2=Supine, 3=VPS, 4=Wax)	Trial (0-5)	Condyle (1=Right, 2+Left)	X-axis (anterior-posterior)	Y-axis (medial-lateral)	Z-axis (superior-inferior)
1	1	0	1	-0.2	0.1	0.1
1	1	1	1	-0.4	0.1	-0.1
1	1	2	1	-0.3	0.1	0.1
1	1	3	1	-0.4	0.1	0.1
1	1	4	1	-0.4	0.1	0
1	1	5	1	-0.4	0.1	-0.1
1	1	0	2	-0.1	-0.1	0.2
1	1	1	2	-0.3	-0.1	-0.1
1	1	2	2	-0.2	-0.1	0.1
1	1	3	2	-0.3	-0.1	0.1
1	1	4	2	-0.2	-0.1	0
1	1	5	2	-0.3	-0.1	0
1	2	0	1	0.1	-0.1	-0.1
1	2	1	1	0.2	0	-0.2
1	2	2	1	0.3	0	-0.2
1	2	3	1	0.3	0.1	-0.2
1	2	4	1	0.3	0.2	-0.5
1	2	5	1	0.3	0.1	-0.3
1	2	0	2	0	0.1	-0.1
1	2	1	2	0.2	0	-0.1
1	2	2	2	0.4	0	-0.2
1	2	3	2	0.4	-0.1	0
1	2	4	2	0.5	-0.2	-0.3
1	2	5	2	0.5	-0.1	0
1	3	0	1	0.1	0	0
1	3	1	1	0	-0.2	-0.5
1	3	2	1	0	-0.1	-0.4
1	3	3	1	0.2	-0.2	-0.5
1	3	4	1	0.2	-0.1	-0.7
1	3	5	1	0.2	-0.2	-0.9
1	3	0	2	0	0	0.2
1	3	1	2	-0.1	0.2	-0.4
1	3	2	2	0	0.1	-0.6
1	3	3	2	0.1	0.2	-0.4
1	3	4	2	0.1	0.1	-0.6
1	3	5	2	0.1	0.2	-0.7

Patient	Group (1=Alert, 2=Supine, 3=VPS, 4=Wax)	Trial (0-5)	Condyle (1=Right, 2+Left)	X-axis (anterior-posterior)	Y-axis (medial-lateral)	Z-axis (superior-inferior)
1	4	0	1	-0.2	0.2	0.1
1	4	1	1	0.1	0.3	-0.1
1	4	2	1	0	0.2	-0.1
1	4	3	1	-0.1	0.4	0
1	4	4	1	-0.1	0.3	-0.4
1	4	5	1	0	0.2	-0.3
1	4	0	2	-0.1	-0.2	0.1
1	4	1	2	0.3	-0.3	0
1	4	2	2	0.2	-0.2	-0.1
1	4	3	2	0.2	-0.4	0.2
1	4	4	2	0.3	-0.3	0
1	4	5	2	0.2	-0.2	-0.1
2	1	0	1	0	0.1	0.1
2	1	1	1	-0.1	0.1	-0.1
2	1	2	1	-0.1	0	-0.1
2	1	3	1	0	0	-0.2
2	1	4	1	-0.1	0	-0.1
2	1	5	1	0	0.1	0
2	1	0	2	0.1	-0.1	0.1
2	1	1	2	-0.1	-0.1	-0.1
2	1	2	2	-0.2	0	-0.1
2	1	3	2	-0.1	0	-0.3
2	1	4	2	-0.1	0	-0.1
2	1	5	2	0	-0.1	0
2	2	0	1	0.2	0	-0.1
2	2	1	1	0.2	-0.1	-0.6
2	2	2	1	0.1	-0.1	-0.3
2	2	3	1	0.2	0	-0.3
2	2	4	1	0.5	-0.3	-1
2	2	5	1	0.3	-0.2	-0.5
2	2	0	2	0.2	0	-0.1
2	2	1	2	-0.1	0.1	-0.5
2	2	2	2	-0.1	0.1	-0.5
2	2	3	2	0.3	0	-0.3
2	2	4	2	0.2	0.3	-1.2
2	2	5	2	0	0.2	-0.8
2	3	0	1	0	0.1	-0.2
2	3	1	1	0.1	0.2	-0.1
2	3	2	1	0.1	0.1	-0.6
2	3	3	1	0.2	0.2	-0.5
2	3	4	1	0.2	0	-0.5
2	3	5	1	0.2	0	-1

Patient	Group (1=Alert, 2=Supine, 3=VPS, 4=Wax)	Trial (0-5)	Condyle (1=Right, 2+Left)	X-axis (anterior-posterior)	Y-axis (medial-lateral)	Z-axis (superior-inferior)
2	3	0	2	0	-0.1	0
2	3	1	2	0.1	-0.2	0.1
2	3	2	2	0.2	-0.1	-0.5
2	3	3	2	0.4	-0.2	-0.3
2	3	4	2	0.1	0	-0.3
2	3	5	2	0.2	0	-0.8
2	4	0	1	-0.1	0.1	0.2
2	4	1	1	0.1	0.3	-0.3
2	4	2	1	0.2	0.1	-0.7
2	4	3	1	0.1	0.3	-0.2
2	4	4	1	0.2	0.1	-0.6
2	4	5	1	0.2	0.2	-0.3
2	4	0	2	-0.1	-0.1	0.3
2	4	1	2	0.4	-0.3	-0.5
2	4	2	2	0.4	-0.1	-1
2	4	3	2	0.4	-0.3	-0.5
2	4	4	2	0.2	-0.1	-0.6
2	4	5	2	0.4	-0.2	-0.4
3	1	0	1	-0.1	0.1	0.2
3	1	1	1	0	0.1	-0.2
3	1	2	1	0	0.1	-0.2
3	1	3	1	-0.1	0.1	-0.4
3	1	4	1	-0.1	0.2	-0.4
3	1	5	1	0	0	0
3	1	0	2	0	-0.1	0.2
3	1	1	2	-0.1	-0.1	0.1
3	1	2	2	0	-0.1	0.1
3	1	3	2	0	-0.1	-0.2
3	1	4	2	0	-0.2	-0.2
3	1	5	2	-0.3	0	-0.1
3	2	0	1	0	0.3	0.1
3	2	1	1	0.1	0.3	-0.3
3	2	2	1	0.3	0.3	-0.2
3	2	3	1	0.2	0.2	-0.2
3	2	4	1	0.1	0.2	-0.3
3	2	5	1	0	0.1	-0.1
3	2	0	2	0.1	-0.3	0.2
3	2	1	2	0.2	-0.3	-0.2
3	2	2	2	0.2	-0.3	0
3	2	3	2	0.1	-0.2	0.1
3	2	4	2	0	-0.2	0.2
3	2	5	2	-0.1	-0.1	0.3

Patient	Group (1=Alert, 2=Supine, 3=VPS, 4=Wax)	Trial (0-5)	Condyle (1=Right, 2+Left)	X-axis (anterior-posterior)	Y-axis (medial-lateral)	Z-axis (superior-inferior)
3	3	0	1	0.1	0	-0.1
3	3	1	1	0.2	-0.1	0.1
3	3	2	1	0.3	-0.1	-0.4
3	3	3	1	0.5	0	-0.7
3	3	4	1	0.8	0	-0.4
3	3	5	1	0.9	0.2	-0.8
3	3	0	2	0.1	0	0
3	3	1	2	0.1	0.1	0.3
3	3	2	2	0.3	0.1	-0.3
3	3	3	2	0.5	0	-0.5
3	3	4	2	0.8	0	-0.1
3	3	5	2	0.6	-0.2	0.2
3	4	0	1	0	-0.2	0.1
3	4	1	1	0	0.1	0.2
3	4	2	1	0.1	-0.2	0.2
3	4	3	1	0	-0.1	0.1
3	4	4	1	0.1	-0.3	0
3	4	5	1	0.2	-0.1	-0.3
3	4	0	2	-0.2	0.2	0.1
3	4	1	2	0	-0.1	-0.1
3	4	2	2	-0.1	0.2	-0.1
3	4	3	2	-0.1	0.1	-0.1
3	4	4	2	-0.4	0.4	-0.2
3	4	5	2	0	0.1	-0.2
4	1	0	1	0	0.1	0.1
4	1	1	1	-0.1	0	0
4	1	2	1	-0.1	0.2	-0.1
4	1	3	1	-0.1	0.1	0
4	1	4	1	-0.1	0.1	0.1
4	1	5	1	0.1	0.1	0
4	1	0	2	0	-0.1	0
4	1	1	2	-0.2	0	-0.1
4	1	2	2	0.1	-0.2	-0.1
4	1	3	2	0	-0.1	0
4	1	4	2	0	-0.1	0.1
4	1	5	2	0.1	-0.1	0
4	2	0	1	0	0	0.1
4	2	1	1	-0.1	0.1	-0.1
4	2	2	1	-0.1	0.1	0
4	2	3	1	0	0	0
4	2	4	1	-0.1	0.1	-0.1
4	2	5	1	0	0	0

Patient	Group (1=Alert, 2=Supine, 3=VPS, 4=Wax)	Trial (0-5)	Condyle (1=Right, 2+Left)	X-axis (anterior-posterior)	Y-axis (medial-lateral)	Z-axis (superior-inferior)
4	2	0	2	-0.1	0	0.1
4	2	1	2	0	-0.1	-0.2
4	2	2	2	0	-0.1	-0.1
4	2	3	2	0	0	0
4	2	4	2	0	-0.1	-0.1
4	2	5	2	0	0	-0.1
4	3	0	1	0.1	0	0
4	3	1	1	0.1	-0.1	-0.4
4	3	2	1	0.1	0	-0.1
4	3	3	1	0.1	-0.1	-0.5
4	3	4	1	0.1	-0.1	-0.4
4	3	5	1	0.1	-0.1	-0.1
4	3	0	2	0.2	0	-0.4
4	3	1	2	-0.1	0.1	-0.4
4	3	2	2	0	0	-0.1
4	3	3	2	0.1	0.1	-0.4
4	3	4	2	0	0.1	-0.2
4	3	5	2	0.1	0.1	-0.2
4	4	0	1	0.2	-0.1	-0.1
4	4	1	1	0	-0.1	-0.3
4	4	2	1	0	-0.2	-0.4
4	4	3	1	0	-0.2	-0.4
4	4	4	1	0	-0.1	-0.6
4	4	5	1	0	-0.2	-0.7
4	4	0	2	0.1	0.1	-0.2
4	4	1	2	0.1	0.1	-0.1
4	4	2	2	0	0.2	-0.3
4	4	3	2	0	0.2	-0.1
4	4	4	2	0.1	0.1	-0.3
4	4	5	2	0.4	0.2	0
5	1	0	1	-0.1	0.1	0.2
5	1	1	1	-0.6	0	-0.1
5	1	2	1	-0.6	0	-0.2
5	1	3	1	-0.5	0	-0.3
5	1	4	1	-0.5	-0.1	-0.2
5	1	5	1	-0.5	0	-0.3
5	1	0	2	0	-0.1	0.2
5	1	1	2	-0.5	0	0
5	1	2	2	-0.5	0	-0.1
5	1	3	2	-0.5	0	-0.2
5	1	4	2	-0.6	0.1	-0.2
5	1	5	2	-0.5	0	-0.2

Patient	Group (1=Alert, 2=Supine, 3=VPS, 4=Wax)	Trial (0-5)	Condyle (1=Right, 2+Left)	X-axis (anterior-posterior)	Y-axis (medial-lateral)	Z-axis (superior-inferior)
5	2	0	1	0	0.1	-0.1
5	2	1	1	-0.1	0.1	-0.2
5	2	2	1	0.1	0	-0.1
5	2	3	1	0	0	0
5	2	4	1	0.1	0	-0.1
5	2	5	1	0.1	0	-0.1
5	2	0	2	0.1	-0.1	0
5	2	1	2	0	-0.1	0
5	2	2	2	0	0	0
5	2	3	2	-0.1	0	0.2
5	2	4	2	0	0	0.1
5	2	5	2	0	0	0.1
5	3	0	1	0	0.1	0
5	3	1	1	0.2	0.1	-0.3
5	3	2	1	0.1	0.1	0
5	3	3	1	0.1	0.2	-0.2
5	3	4	1	0.3	0	-0.3
5	3	5	1	0.3	0	-0.5
5	3	0	2	0.1	-0.1	0.2
5	3	1	2	0.3	-0.1	-0.2
5	3	2	2	0.2	-0.1	-0.2
5	3	3	2	0.3	-0.2	-0.4
5	3	4	2	0.3	0	-0.5
5	3	5	2	0.3	0	-0.4
5	4	0	1	0.1	-0.1	-0.1
5	4	1	1	0.3	0	-0.4
5	4	2	1	0.3	0	-0.3
5	4	3	1	0.4	0	-0.5
5	4	4	1	0.5	-0.1	-0.6
5	4	5	1	0.5	0	-0.3
5	4	0	2	0	0.1	-0.1
5	4	1	2	0.3	0	-0.1
5	4	2	2	0.3	0	-0.1
5	4	3	2	0.4	0	-0.2
5	4	4	2	0.4	0.1	-0.5
5	4	5	2	0.5	0	-0.1
6	1	0	1	0	-0.1	-0.1
6	1	1	1	0	0	-0.2
6	1	2	1	0	0.1	-0.5
6	1	3	1	0.1	0.1	-0.5
6	1	4	1	0.1	0.1	-0.2
6	1	5	1	0.2	0.2	-0.6

Patient	Group (1=Alert, 2=Supine, 3=VPS, 4=Wax)	Trial (0-5)	Condyle (1=Right, 2+Left)	X-axis (anterior-posterior)	Y-axis (medial-lateral)	Z-axis (superior-inferior)
6	1	0	2	0	0.1	-0.1
6	1	1	2	-0.1	0	-0.2
6	1	2	2	0.1	-0.1	-0.5
6	1	3	2	0.2	-0.1	-0.6
6	1	4	2	0.2	-0.1	-0.2
6	1	5	2	0.3	-0.2	-0.5
6	2	0	1	0	-0.1	0.2
6	2	1	1	0.1	0	0.1
6	2	2	1	0.2	-0.1	-0.3
6	2	3	1	0.1	0	-0.2
6	2	4	1	0.1	0	0
6	2	5	1	0.1	0	0.2
6	2	0	2	-0.1	0.1	0.1
6	2	1	2	0.1	0	0
6	2	2	2	0.1	0.1	-0.3
6	2	3	2	0.1	0	-0.3
6	2	4	2	0	0	-0.1
6	2	5	2	0.1	0	0
6	3	0	1	0	0	0
6	3	1	1	0	-0.1	-0.2
6	3	2	1	0	0	-0.4
6	3	3	1	0.3	0	-0.8
6	3	4	1	0.3	0	-0.5
6	3	5	1	0.3	0.1	-1.1
6	3	0	2	-0.1	0	0
6	3	1	2	-0.1	0.1	-0.2
6	3	2	2	-0.1	0	-0.4
6	3	3	2	0	0	-0.5
6	3	4	2	0.1	0	-0.2
6	3	5	2	0.2	-0.1	-0.7
6	4	0	1	0	0	0
6	4	1	1	0.6	0	-0.9
6	4	2	1	0.7	0	-0.9
6	4	3	1	0.7	-0.1	-1.2
6	4	4	1	0.7	0.1	-1
6	4	5	1	0.9	0	-1.4
6	4	0	2	0	0	0
6	4	1	2	0.7	0	-1.1
6	4	2	2	0.8	0	-1.1
6	4	3	2	0.8	0.1	-1.4
6	4	4	2	0.8	-0.1	-0.9
6	4	5	2	1.1	0	-1.4

Patient	Group (1=Alert, 2=Supine, 3=VPS, 4=Wax)	Trial (0-5)	Condyle (1=Right, 2+Left)	X-axis (anterior-posterior)	Y-axis (medial-lateral)	Z-axis (superior-inferior)
7	1	0	1	0	0	0.2
7	1	1	1	0.7	0.2	-1.3
7	1	2	1	0.7	0.2	-1
7	1	3	1	0.8	0.1	-1.3
7	1	4	1	0.7	0.1	-0.8
7	1	5	1	0.6	0.2	-0.9
7	1	0	2	0	0	0.2
7	1	1	2	0.7	-0.2	-1
7	1	2	2	0.7	-0.2	-0.7
7	1	3	2	0.7	-0.1	-1
7	1	4	2	0.7	-0.1	-0.6
7	1	5	2	0.6	-0.2	-0.8
7	2	0	1	0	0	-0.2
7	2	1	1	0.5	0.1	-0.6
7	2	2	1	0.4	0.1	-0.4
7	2	3	1	0.5	0.1	-0.5
7	2	4	1	0.5	0.1	-0.6
7	2	5	1	0.5	0	-0.7
7	2	0	2	0	0	-0.2
7	2	1	2	0.5	-0.1	-0.6
7	2	2	2	0.5	-0.1	-0.4
7	2	3	2	0.5	-0.1	-0.5
7	2	4	2	0.5	-0.1	-0.7
7	2	5	2	0.5	0	-0.7
7	3	0	1	0.1	-0.1	-0.2
7	3	1	1	0.9	0	-1
7	3	2	1	1.1	0	-1.2
7	3	3	1	1.2	0.2	-2
7	3	4	1	1.4	0	-1.9
7	3	5	1	1.5	0	-1.8
7	3	0	2	0.1	0.1	-0.1
7	3	1	2	0.7	0	-0.6
7	3	2	2	0.9	0	-0.8
7	3	3	2	1.1	-0.2	-1.4
7	3	4	2	1.2	0	-1.5
7	3	5	2	1.3	0	-1.4
7	4	0	1	0	0.1	0
7	4	1	1	0.6	0.2	-0.9
7	4	2	1	0.7	0.1	-1
7	4	3	1	0.7	0.2	-1.2
7	4	4	1	0.8	0.3	-1.4
7	4	5	1	0.8	0.3	-1.4

Patient	Group (1=Alert, 2=Supine, 3=VPS, 4=Wax)	Trial (0-5)	Condyle (1=Right, 2+Left)	X-axis (anterior-posterior)	Y-axis (medial-lateral)	Z-axis (superior-inferior)
7	4	0	2	0	-0.1	0
7	4	1	2	0.7	-0.2	-0.9
7	4	2	2	0.6	-0.1	-0.8
7	4	3	2	0.7	-0.2	-1
7	4	4	2	0.8	-0.3	-1.2
7	4	5	2	0.8	-0.3	-1.2
8	1	0	1	-0.1	0.2	0
8	1	1	1	-0.2	0.2	0.3
8	1	2	1	-0.2	0.1	0
8	1	3	1	-0.1	0	0.2
8	1	4	1	-0.1	0.1	0.2
8	1	5	1	-0.1	0.1	0.2
8	1	0	2	0	-0.2	0.2
8	1	1	2	0	-0.2	0.4
8	1	2	2	0	-0.1	0.2
8	1	3	2	0	0	0.3
8	1	4	2	0	-0.1	0.3
8	1	5	2	0.1	-0.1	0.4
8	2	0	1	0.2	-0.1	-0.1
8	2	1	1	0	0.1	-0.4
8	2	2	1	-0.1	0.2	-0.3
8	2	3	1	0	0.2	-0.2
8	2	4	1	0	-0.1	-0.1
8	2	5	1	0.1	0.1	-0.3
8	2	0	2	0	0.1	0
8	2	1	2	0.1	-0.1	-0.3
8	2	2	2	0	-0.2	-0.4
8	2	3	2	0.1	-0.2	-0.1
8	2	4	2	-0.1	0.1	-0.1
8	2	5	2	0.1	-0.1	-0.3
8	3	0	1	0.1	-0.1	-0.1
8	3	1	1	0.2	0.1	-0.4
8	3	2	1	0.2	0.2	-0.2
8	3	3	1	0.2	0.3	-0.1
8	3	4	1	0.2	0.1	-0.3
8	3	5	1	0.2	0.4	-0.4
8	3	0	2	0	0.1	-0.2
8	3	1	2	0.2	-0.1	-0.4
8	3	2	2	0.2	-0.2	-0.3
8	3	3	2	0.2	-0.3	-0.1
8	3	4	2	0.3	-0.1	-0.3
8	3	5	2	0.4	-0.4	-0.4

Patient	Group (1=Alert, 2=Supine, 3=VPS, 4=Wax)	Trial (0-5)	Condyle (1=Right, 2+Left)	X-axis (anterior-posterior)	Y-axis (medial-lateral)	Z-axis (superior-inferior)
8	4	0	1	-0.1	0.1	0.4
8	4	1	1	0	0.2	0.4
8	4	2	1	0	0.1	0.2
8	4	3	1	0.1	-0.4	-0.1
8	4	4	1	-0.1	-0.1	0.2
8	4	5	1	0.1	0.1	0.2
8	4	0	2	0	-0.1	0.2
8	4	1	2	0.1	-0.2	0.3
8	4	2	2	0	-0.1	0.1
8	4	3	2	-0.1	0.4	-0.5
8	4	4	2	-0.2	0.1	0.1
8	4	5	2	0.1	-0.1	0.2
9	1	0	1	0.1	0.1	-0.1
9	1	1	1	0.3	-0.3	-0.1
9	1	2	1	0.2	0.1	-0.2
9	1	3	1	0.3	-0.1	-0.2
9	1	4	1	0.2	0.1	0
9	1	5	1	0.2	0	-0.1
9	1	0	2	0.1	-0.1	-0.2
9	1	1	2	0.2	0.3	-0.4
9	1	2	2	0.3	-0.1	-0.3
9	1	3	2	0.2	0.1	-0.3
9	1	4	2	0.2	-0.1	-0.1
9	1	5	2	0.3	0	-0.2
9	2	0	1	0	0.2	0
9	2	1	1	0.1	0.2	0.1
9	2	2	1	0.2	0	0.1
9	2	3	1	0	0.3	0.1
9	2	4	1	0.1	0.2	0.3
9	2	5	1	0.1	0.3	-0.1
9	2	0	2	0.1	-0.2	0.1
9	2	1	2	0.4	-0.2	-0.3
9	2	2	2	0.2	0	-0.2
9	2	3	2	0.2	-0.3	-0.1
9	2	4	2	0.2	-0.2	0.1
9	2	5	2	0.4	-0.3	-0.4
9	3	0	1	0.1	0	-0.1
9	3	1	1	0.6	0.1	-0.7
9	3	2	1	0.7	0.1	-0.8
9	3	3	1	0.7	0.1	-0.7
9	3	4	1	0.8	0.2	-0.8
9	3	5	1	0.9	0	-0.9

Patient	Group (1=Alert, 2=Supine, 3=VPS, 4=Wax)	Trial (0-5)	Condyle (1=Right, 2+Left)	X-axis (anterior-posterior)	Y-axis (medial-lateral)	Z-axis (superior-inferior)
9	3	0	2	0.1	0	0
9	3	1	2	0.7	-0.1	-0.8
9	3	2	2	0.8	-0.1	-1
9	3	3	2	0.8	-0.1	-0.9
9	3	4	2	1	-0.2	-1.2
9	3	5	2	0.9	0	-1.1
9	4	0	1	-0.1	0	0.2
9	4	1	1	0.7	0	-0.7
9	4	2	1	0.6	-0.1	-0.5
9	4	3	1	0.6	0	-0.4
9	4	4	1	0.9	-0.3	-0.8
9	4	5	1	0.7	-0.2	-0.7
9	4	0	2	-0.1	0	0.2
9	4	1	2	0.7	0	-0.6
9	4	2	2	0.6	0.1	-0.5
9	4	3	2	0.7	0	-0.5
9	4	4	2	0.8	0.3	-1
9	4	5	2	0.7	0.2	-0.9
10	1	0	1	-0.1	0	0.1
10	1	1	1	0.5	0.2	0.5
10	1	2	1	0.1	0	-0.3
10	1	3	1	0.1	0	-0.2
10	1	4	1	0.2	-0.1	-0.2
10	1	5	1	0.2	0	-0.2
10	1	0	2	0	0	0
10	1	1	2	0.5	-0.2	0.5
10	1	2	2	0.2	0	-0.2
10	1	3	2	0.1	0	-0.1
10	1	4	2	0.1	0.1	-0.1
10	1	5	2	0.2	0	-0.2
10	2	0	1	0	-0.1	0
10	2	1	1	0	-0.2	0.1
10	2	2	1	0	-0.1	0.2
10	2	3	1	0	-0.1	0.3
10	2	4	1	0	-0.1	0.2
10	2	5	1	0	0	0.2
10	2	0	2	0	0.1	0.1
10	2	1	2	-0.1	0.2	0.2
10	2	2	2	0	0.1	0.3
10	2	3	2	0	0.1	0.3
10	2	4	2	0	0.1	0.4
10	2	5	2	0	0	0.4

Patient	Group (1=Alert, 2=Supine, 3=VPS, 4=Wax)	Trial (0-5)	Condyle (1=Right, 2+Left)	X-axis (anterior-posterior)	Y-axis (medial-lateral)	Z-axis (superior-inferior)
10	3	0	1	0	0.1	-0.2
10	3	1	1	0	0	0
10	3	2	1	-0.1	0	0.2
10	3	3	1	-0.4	0	0
10	3	4	1	-0.1	0.1	0
10	3	5	1	-0.1	0.1	-0.3
10	3	0	2	0	-0.1	-0.1
10	3	1	2	-0.2	0	0.4
10	3	2	2	-0.3	0	0.3
10	3	3	2	-0.3	0	0.3
10	3	4	2	0	-0.1	0.1
10	3	5	2	-0.1	-0.1	-0.1
10	4	0	1	0	0.1	0.1
10	4	1	1	0.2	0.2	0.1
10	4	2	1	0.1	0	0.4
10	4	3	1	0.1	0.1	0.3
10	4	4	1	0.2	-0.1	0.5
10	4	5	1	0.1	0.1	0.5
10	4	0	2	0	-0.1	0.1
10	4	1	2	0.2	-0.2	0.3
10	4	2	2	0.1	0	0.2
10	4	3	2	0.2	-0.1	0.1
10	4	4	2	0.2	0.1	0.2
10	4	5	2	0.3	-0.1	0.2
11	1	0	1	0.1	-0.1	-0.3
11	1	1	1	0.4	0	-0.6
11	1	2	1	0.4	0.2	-1
11	1	3	1	0.3	0.2	-0.8
11	1	4	1	0.4	0.1	-0.8
11	1	5	1	0.4	0.1	-0.6
11	1	0	2	0.1	0.1	-0.1
11	1	1	2	0.4	0	-0.3
11	1	2	2	0.6	-0.2	-0.5
11	1	3	2	0.5	-0.2	-0.3
11	1	4	2	0.5	-0.1	-0.4
11	1	5	2	0.5	-0.1	-0.2
11	2	0	1	0	0	-0.1
11	2	1	1	0.1	0.1	-0.1
11	2	2	1	0.1	-0.1	0
11	2	3	1	0.1	0.2	-0.2
11	2	4	1	0.2	-0.3	-0.1
11	2	5	1	0.1	0	0

Patient	Group (1=Alert, 2=Supine, 3=VPS, 4=Wax)	Trial (0-5)	Condyle (1=Right, 2+Left)	X-axis (anterior-posterior)	Y-axis (medial-lateral)	Z-axis (superior-inferior)
11	2	0	2	0.1	0	-0.1
11	2	1	2	0.1	-0.1	-0.2
11	2	2	2	0	0.1	-0.1
11	2	3	2	0.2	-0.2	-0.2
11	2	4	2	0	0.3	-0.2
11	2	5	2	0.1	0	-0.1
11	3	0	1	-0.1	0.2	-0.1
11	3	1	1	0.4	0.1	-0.6
11	3	2	1	0.4	0.1	-0.9
11	3	3	1	0.4	0.1	-0.6
11	3	4	1	0.3	0	-0.8
11	3	5	1	0.2	0	-0.6
11	3	0	2	0	-0.2	-0.1
11	3	1	2	0.4	-0.1	-0.7
11	3	2	2	0.5	-0.1	-0.8
11	3	3	2	0.4	-0.1	-0.5
11	3	4	2	0.4	0	-1
11	3	5	2	0.2	0	-0.6
11	4	0	1	0.1	-0.1	0
11	4	1	1	0.6	0.2	-0.6
11	4	2	1	0.5	0.2	-0.8
11	4	3	1	0.5	0.1	-0.7
11	4	4	1	0.5	0.1	-0.6
11	4	5	1	0.7	0.3	-1
11	4	0	2	0	0.1	0.2
11	4	1	2	0.5	-0.2	-0.3
11	4	2	2	0.4	-0.2	-0.4
11	4	3	2	0.3	-0.1	-0.1
11	4	4	2	0.4	-0.1	-0.3
11	4	5	2	0.7	-0.3	-0.6
12	1	0	1	0	0	0.1
12	1	1	1	-0.2	0	-0.1
12	1	2	1	-0.1	0.1	-0.2
12	1	3	1	-0.1	0.1	-0.1
12	1	4	1	-0.1	0	-0.2
12	1	5	1	-0.2	0	-0.1
12	1	0	2	0	0	0.1
12	1	1	2	-0.2	0	0
12	1	2	2	0	-0.1	-0.1
12	1	3	2	0	-0.1	0
12	1	4	2	-0.1	0	0
12	1	5	2	-0.2	0	0

Patient	Group (1=Alert, 2=Supine, 3=VPS, 4=Wax)	Trial (0-5)	Condyle (1=Right, 2+Left)	X-axis (anterior-posterior)	Y-axis (medial-lateral)	Z-axis (superior-inferior)
12	2	0	1	0	0	-0.1
12	2	1	1	0.1	0	-0.1
12	2	2	1	0	0	-0.1
12	2	3	1	0.1	0	0.1
12	2	4	1	0.3	-0.2	-0.4
12	2	5	1	0.1	0	-0.1
12	2	0	2	0	0	0
12	2	1	2	0.1	0	-0.1
12	2	2	2	0	0	-0.1
12	2	3	2	0	0	0.1
12	2	4	2	0.1	0.2	-0.3
12	2	5	2	0	0	0
12	3	0	1	0.1	0	-0.2
12	3	1	1	0.4	0.1	-0.2
12	3	2	1	0.5	-0.2	-0.2
12	3	3	1	0.4	-0.2	-0.3
12	3	4	1	0.4	0	-0.3
12	3	5	1	0.2	0	-0.4
12	3	0	2	0.1	0	-0.1
12	3	1	2	0.3	-0.1	-0.1
12	3	2	2	0.2	0.2	-0.4
12	3	3	2	0.1	0.2	-0.4
12	3	4	2	0.1	0	-0.3
12	3	5	2	0	0	0
12	4	0	1	0.1	-0.1	0.1
12	4	1	1	0.2	0	-0.2
12	4	2	1	0.3	-0.1	0
12	4	3	1	0.2	0	-0.1
12	4	4	1	0.1	-0.1	-0.2
12	4	5	1	0.3	0	0
12	4	0	2	0	0.1	-0.1
12	4	1	2	0.2	0	-0.4
12	4	2	2	0.1	0.1	-0.1
12	4	3	2	0.3	0	-0.2
12	4	4	2	0	0.1	0.1
12	4	5	2	0.3	0	-0.3
13	1	0	1	0	0	0.2
13	1	1	1	0.6	-0.2	-0.4
13	1	2	1	0.4	0	0
13	1	3	1	0.5	0.2	-0.3
13	1	4	1	0.6	-0.1	-0.2
13	1	5	1	0.5	0.3	-0.2

Patient	Group (1=Alert, 2=Supine, 3=VPS, 4=Wax)	Trial (0-5)	Condyle (1=Right, 2+Left)	X-axis (anterior-posterior)	Y-axis (medial-lateral)	Z-axis (superior-inferior)
13	1	0	2	0	0	0.1
13	1	1	2	0.2	0.2	-0.4
13	1	2	2	0.3	0	0
13	1	3	2	0.5	-0.2	-0.5
13	1	4	2	0.4	0.1	-0.4
13	1	5	2	0.5	-0.3	-0.2
13	2	0	1	-0.2	0	0.3
13	2	1	1	-0.3	-0.3	0.4
13	2	2	1	-0.4	-0.5	0.6
13	2	3	1	-0.4	-0.3	0.6
13	2	4	1	-0.2	-0.4	0.3
13	2	5	1	-0.2	-0.4	0.1
13	2	0	2	-0.2	0	0.2
13	2	1	2	0.5	0.4	0.5
13	2	2	2	0.7	0.5	0.3
13	2	3	2	0.8	0.3	0.3
13	2	4	2	0.8	0.4	0.2
13	2	5	2	0.9	0.4	0.1
13	3	0	1	0	-0.1	0
13	3	1	1	0.3	0	-0.5
13	3	2	1	0.3	0.1	-0.2
13	3	3	1	0.5	0.1	-0.8
13	3	4	1	0.5	0.1	-0.7
13	3	5	1	0.5	0.2	-0.8
13	3	0	2	0	0.1	0.3
13	3	1	2	0.3	0	-0.7
13	3	2	2	0.5	-0.1	-0.4
13	3	3	2	0.6	-0.1	-0.7
13	3	4	2	0.6	-0.1	-0.6
13	3	5	2	0.6	-0.2	-0.7
13	4	0	1	0	0.1	-0.2
13	4	1	1	0.3	0	2
13	4	2	1	0.4	0	-0.6
13	4	3	1	0.4	-0.1	-0.2
13	4	4	1	0.4	0.1	-0.6
13	4	5	1	0.5	-0.1	-0.2
13	4	0	2	0	-0.1	-0.2
13	4	1	2	0.1	0	-0.1
13	4	2	2	0.3	0	-0.9
13	4	3	2	0.2	0.1	-0.2
13	4	4	2	0.4	-0.1	-0.6
13	4	5	2	0.3	0.1	-0.7

Patient	Group (1=Alert, 2=Supine, 3=VPS, 4=Wax)	Trial (0-5)	Condyle (1=Right, 2+Left)	X-axis (anterior-posterior)	Y-axis (medial-lateral)	Z-axis (superior-inferior)
14	1	0	1	-0.1	0	0.4
14	1	1	1	0.2	0.1	-0.1
14	1	2	1	0.4	0	-0.2
14	1	3	1	0.5	0	-0.8
14	1	4	1	0.6	0	-0.8
14	1	5	1	0.5	0.1	-0.4
14	1	0	2	0	0	0.3
14	1	1	2	0.4	-0.1	-0.1
14	1	2	2	0.4	0	-0.3
14	1	3	2	0.7	0	-0.8
14	1	4	2	0.7	0	-0.8
14	1	5	2	0.6	-0.1	-0.5
14	2	0	1	-0.1	0.1	0.1
14	2	1	1	0.2	-0.1	-0.2
14	2	2	1	0.4	-0.3	-1.1
14	2	3	1	0.3	-0.1	-0.5
14	2	4	1	0.3	0.1	-0.5
14	2	5	1	0.3	-0.2	-0.6
14	2	0	2	0	-0.1	0.1
14	2	1	2	0.2	0.1	-0.4
14	2	2	2	0.2	0.3	-1.3
14	2	3	2	0.4	0.1	-0.9
14	2	4	2	0.4	-0.1	-0.8
14	2	5	2	0.4	0.2	-0.9
14	3	0	1	0.1	0.1	-0.1
14	3	1	1	0.6	0.1	-0.5
14	3	2	1	0.6	0	-0.9
14	3	3	1	0.6	0.1	-0.7
14	3	4	1	0.8	0.1	-0.8
14	3	5	1	1	-0.1	-1.4
14	3	0	2	0.2	-0.1	-0.2
14	3	1	2	0.9	-0.1	-0.8
14	3	2	2	0.7	0	-0.9
14	3	3	2	0.8	-0.1	-0.5
14	3	4	2	1	-0.1	-0.5
14	3	5	2	1.1	0.1	-0.9
14	4	0	1	0.1	-0.2	0.1
14	4	1	1	0.6	-0.2	-0.4
14	4	2	1	0.5	0.2	-0.6
14	4	3	1	0.8	0	-0.6
14	4	4	1	0.8	0.3	-0.5
14	4	5	1	0.7	0.1	-0.6

Patient	Group (1=Alert, 2=Supine, 3=VPS, 4=Wax)	Trial (0-5)	Condyle (1=Right, 2+Left)	X-axis (anterior-posterior)	Y-axis (medial-lateral)	Z-axis (superior-inferior)
14	4	0	2	0	0.2	0
14	4	1	2	0.4	0.2	-0.3
14	4	2	2	0.6	-0.2	-0.6
14	4	3	2	0.7	0	-0.6
14	4	4	2	0.9	-0.3	-0.2
14	4	5	2	0.7	-0.1	-0.3
15	1	0	1	0	0	-0.3
15	1	1	1	0.2	0.1	-0.3
15	1	2	1	0.2	0.1	-0.6
15	1	3	1	0.2	0.1	-0.5
15	1	4	1	0.2	0.1	-0.4
15	1	5	1	0.2	0.1	-0.7
15	1	0	2	0.1	0	-0.3
15	1	1	2	0.1	-0.1	-0.2
15	1	2	2	0.3	-0.1	-0.5
15	1	3	2	0.2	-0.1	-0.3
15	1	4	2	0.2	-0.1	-0.2
15	1	5	2	0.2	-0.1	-0.4
15	2	0	1	-0.1	0.1	0.3
15	2	1	1	-0.1	0.2	0.3
15	2	2	1	0	0.2	0.3
15	2	3	1	-0.1	0.3	0.3
15	2	4	1	-0.1	0.3	0.3
15	2	5	1	-0.1	0.3	0.4
15	2	0	2	0	-0.1	0.2
15	2	1	2	0	-0.2	0.4
15	2	2	2	0.1	-0.2	0.4
15	2	3	2	0.1	-0.3	0.4
15	2	4	2	0.1	-0.3	0.3
15	2	5	2	0.1	-0.3	0.5
15	3	0	1	-0.2	-0.1	0.2
15	3	1	1	-0.3	-0.1	0
15	3	2	1	-0.3	0	-0.1
15	3	3	1	0.4	0	-0.5
15	3	4	1	-0.4	0.1	-0.5
15	3	5	1	-0.4	0.1	-0.5
15	3	0	2	-0.3	0.1	0.1
15	3	1	2	-0.5	0.1	0
15	3	2	2	-0.5	0	0.1
15	3	3	2	0.3	0	-0.4
15	3	4	2	-0.5	-0.1	-0.4
15	3	5	2	-0.4	-0.1	-0.5

Patient	Group (1=Alert, 2=Supine, 3=VPS, 4=Wax)	Trial (0-5)	Condyle (1=Right, 2+Left)	X-axis (anterior-posterior)	Y-axis (medial-lateral)	Z-axis (superior-inferior)
15	4	0	1	-0.1	0.2	0
15	4	1	1	0.6	-0.1	-0.1
15	4	2	1	1	0	-0.5
15	4	3	1	1.2	-0.2	-0.3
15	4	4	1	1.2	0	-0.4
15	4	5	1	1.3	0	-0.4
15	4	0	2	-0.1	-0.2	0.1
15	4	1	2	0.4	0.1	-0.1
15	4	2	2	0.9	0	-0.5
15	4	3	2	0.9	0.2	-0.2
15	4	4	2	0.9	0	-0.3
15	4	5	2	1.1	0	-0.3
16	1	0	1	-0.3	0	0
16	1	1	1	-0.1	0	-0.3
16	1	2	1	-0.1	0.1	-0.5
16	1	3	1	-0.2	0.2	-0.4
16	1	4	1	-0.1	-0.1	-0.7
16	1	5	1	-0.1	0.1	-0.6
16	1	0	2	-0.2	0	0.1
16	1	1	2	-0.2	0	0
16	1	2	2	-0.2	-0.1	0
16	1	3	2	-0.2	-0.2	0.2
16	1	4	2	-0.2	0.1	-0.1
16	1	5	2	-0.2	-0.1	-0.1
16	2	0	1	0	0	0.2
16	2	1	1	0.1	0	1.2
16	2	2	1	0.2	-0.1	1.2
16	2	3	1	0.3	0	1.1
16	2	4	1	0.3	0	1.3
16	2	5	1	0.2	0	1.3
16	2	0	2	0.1	0	0
16	2	1	2	0.7	0.1	0.8
16	2	2	2	0.8	0.1	0.8
16	2	3	2	0.9	0	0.6
16	2	4	2	0.9	0	0.8
16	2	5	2	0.9	0	0.9
16	3	0	1	0	-0.1	0.1
16	3	1	1	-0.1	-0.1	-0.4
16	3	2	1	0.1	-0.1	-0.6
16	3	3	1	0.4	-0.1	-0.8
16	3	4	1	0.3	-0.1	-0.6
16	3	5	1	-0.1	0	-0.9

Patient	Group (1=Alert, 2=Supine, 3=VPS, 4=Wax)	Trial (0-5)	Condyle (1=Right, 2+Left)	X-axis (anterior-posterior)	Y-axis (medial-lateral)	Z-axis (superior-inferior)
16	3	0	2	0	0.1	0
16	3	1	2	-0.1	0.1	-0.5
16	3	2	2	0	0.1	-0.5
16	3	3	2	0.3	0.1	-0.6
16	3	4	2	0.1	0.1	-0.4
16	3	5	2	-0.1	0	-0.6
16	4	0	1	0	-0.1	-0.1
16	4	1	1	0.6	0	-0.7
16	4	2	1	0.7	0.2	-0.9
16	4	3	1	0.7	0	-0.6
16	4	4	1	0.7	0	-0.6
16	4	5	1	0.5	0.1	-0.5
16	4	0	2	-0.1	0.1	-0.1
16	4	1	2	0.4	0	-0.6
16	4	2	2	0.5	-0.2	-0.5
16	4	3	2	0.5	0	-0.5
16	4	4	2	0.4	0	-0.3
16	4	5	2	0.9	-0.1	-0.6
17	1	0	1	-0.1	0.2	0
17	1	1	1	0.3	0.2	-0.6
17	1	2	1	0.3	0.3	-0.9
17	1	3	1	0.4	0.1	-1
17	1	4	1	0.5	0.2	-1.6
17	1	5	1	0.4	0.3	-1.1
17	1	0	2	0	-0.2	0
17	1	1	2	0.2	-0.2	0
17	1	2	2	0.2	-0.3	-0.2
17	1	3	2	0.1	-0.1	-0.2
17	1	4	2	0.2	-0.2	-0.5
17	1	5	2	0.2	-0.3	-0.2
17	2	0	1	0	-0.1	0.2
17	2	1	1	0.2	0.2	-0.9
17	2	2	1	0.2	0.2	-0.7
17	2	3	1	0.3	0.1	-0.8
17	2	4	1	0.3	0.1	-1
17	2	5	1	0.4	0.3	-1.2
17	2	0	2	-0.1	0.1	0.2
17	2	1	2	0	-0.2	0.3
17	2	2	2	-0.1	-0.2	0.4
17	2	3	2	-0.1	-0.1	0.5
17	2	4	2	-0.1	-0.1	0.3
17	2	5	2	0	-0.3	0.1

Patient	Group (1=Alert, 2=Supine, 3=VPS, 4=Wax)	Trial (0-5)	Condyle (1=Right, 2+Left)	X-axis (anterior-posterior)	Y-axis (medial-lateral)	Z-axis (superior-inferior)
17	3	0	1	0	-0.1	0.2
17	3	1	1	0.1	-0.1	0.2
17	3	2	1	0.3	0.2	-0.5
17	3	3	1	0.3	0.2	-0.7
17	3	4	1	0.3	0.2	-0.5
17	3	5	1	0.6	0.3	-1.7
17	3	0	2	0	0.1	0.1
17	3	1	2	0	0.1	0.4
17	3	2	2	0.2	-0.1	0
17	3	3	2	0.3	-0.2	-0.1
17	3	4	2	0.2	-0.2	0.3
17	3	5	2	0.4	-0.3	-0.7
17	4	0	1	0.1	0	-0.2
17	4	1	1	0.3	0.3	-0.8
17	4	2	1	0.5	0.3	-1
17	4	3	1	0.5	0.4	-1.2
17	4	4	1	0.6	0	-1.1
17	4	5	1	0.5	0.3	-1.3
17	4	0	2	0.1	0	-0.1
17	4	1	2	0.3	-0.2	-0.1
17	4	2	2	0.5	-0.3	-0.1
17	4	3	2	0.6	-0.4	-0.2
17	4	4	2	0.4	0	-0.3
17	4	5	2	0.6	-0.3	-0.5
18	1	0	1	-0.2	0.1	0.1
18	1	1	1	0.1	-0.1	0
18	1	2	1	-0.1	0.2	0
18	1	3	1	0.3	-0.1	-0.3
18	1	4	1	0.2	0	-0.6
18	1	5	1	0.1	0.2	-0.4
18	1	0	2	0	-0.1	0.2
18	1	1	2	0.1	0.1	-0.2
18	1	2	2	0.1	-0.2	0.1
18	1	3	2	0.3	0.1	-0.4
18	1	4	2	0.3	0	-0.6
18	1	5	2	0.3	-0.2	-0.4
18	2	0	1	0.1	0	-0.1
18	2	1	1	-0.2	-0.2	-0.1
18	2	2	1	-0.4	0	-0.1
18	2	3	1	-0.5	0	-0.3
18	2	4	1	-0.2	-0.2	-0.3
18	2	5	1	-0.2	-0.1	0.1

Patient	Group (1=Alert, 2=Supine, 3=VPS, 4=Wax)	Trial (0-5)	Condyle (1=Right, 2+Left)	X-axis (anterior-posterior)	Y-axis (medial-lateral)	Z-axis (superior-inferior)
18	2	0	2	0.1	0	-0.1
18	2	1	2	-0.2	0.2	0.4
18	2	2	2	-0.2	0	0.4
18	2	3	2	-0.4	0	0.3
18	2	4	2	-0.2	0.2	0.1
18	2	5	2	-0.1	0.1	0.4
18	3	0	1	0	0.1	-0.2
18	3	1	1	0.1	0	-0.1
18	3	2	1	0.2	0.1	-0.4
18	3	3	1	0.4	0	-0.4
18	3	4	1	0.3	0	-0.4
18	3	5	1	0.5	-0.1	-0.5
18	3	0	2	0.1	-0.1	-0.3
18	3	1	2	0	0	-0.1
18	3	2	2	0.1	-0.1	-0.3
18	3	3	2	0.4	0	-0.4
18	3	4	2	0.4	0	-0.3
18	3	5	2	0.5	0.1	-0.5
18	4	0	1	0	0.1	-0.1
18	4	1	1	0.5	0	-0.6
18	4	2	1	0.5	0	-0.7
18	4	3	1	0.3	0.1	-0.6
18	4	4	1	0.2	0.1	-0.3
18	4	5	1	0	0.1	0
18	4	0	2	0.1	-0.1	0
18	4	1	2	0.5	0	-0.6
18	4	2	2	0.6	0	-0.8
18	4	3	2	0.4	-0.1	-0.5
18	4	4	2	0.3	-0.1	-0.1
18	4	5	2	0	-0.1	0
19	1	0	1	-0.1	0	0.1
19	1	1	1	0.4	0.1	-0.7
19	1	2	1	0.7	0.1	-0.9
19	1	3	1	0.4	0.1	-0.6
19	1	4	1	0.4	0.1	-0.5
19	1	5	1	0.4	0	-0.5
19	1	0	2	-0.1	0	0.1
19	1	1	2	0.3	-0.1	-0.4
19	1	2	2	0.6	-0.1	-0.6
19	1	3	2	0.4	-0.1	-0.4
19	1	4	2	0.4	-0.1	-0.2
19	1	5	2	0.4	0	-0.1

Patient	Group (1=Alert, 2=Supine, 3=VPS, 4=Wax)	Trial (0-5)	Condyle (1=Right, 2+Left)	X-axis (anterior-posterior)	Y-axis (medial-lateral)	Z-axis (superior-inferior)
19	2	0	1	-0.1	0.1	0
19	2	1	1	0.2	0.1	-0.4
19	2	2	1	0.1	0.2	-0.1
19	2	3	1	0.1	0.4	-0.6
19	2	4	1	0.2	0.2	-0.3
19	2	5	1	0	0.3	0.1
19	2	0	2	0	-0.1	0.1
19	2	1	2	0.2	-0.1	-0.1
19	2	2	2	0.2	-0.2	0.1
19	2	3	2	0.4	-0.4	-0.4
19	2	4	2	0.4	-0.2	-0.2
19	2	5	2	0.2	-0.3	0.1
19	3	0	1	0	-0.1	0.2
19	3	1	1	0.5	-0.1	-0.5
19	3	2	1	0.6	-0.2	-0.7
19	3	3	1	0.6	-0.1	-0.6
19	3	4	1	0.6	0	-0.9
19	3	5	1	0.6	0	-0.5
19	3	0	2	-0.1	0.1	0.1
19	3	1	2	0.3	0.1	-0.3
19	3	2	2	0.4	0.2	-0.4
19	3	3	2	0.5	0.1	-0.3
19	3	4	2	0.5	0	-0.4
19	3	5	2	0.5	0	-0.2
19	4	0	1	0.1	-0.1	-0.2
19	4	1	1	0.7	0.1	-1.1
19	4	2	1	0.7	0	-0.6
19	4	3	1	0.9	0	-1.2
19	4	4	1	0.8	0.1	-1
19	4	5	1	0.8	0.1	-1.2
19	4	0	2	0.1	0.1	-0.1
19	4	1	2	0.6	-0.1	-0.6
19	4	2	2	0.5	0	-0.2
19	4	3	2	0.6	0	-0.7
19	4	4	2	0.7	-0.1	-0.6
19	4	5	2	0.7	-0.1	-0.8
20	1	0	1	0.1	0	0
20	1	1	1	0.7	0.1	-0.3
20	1	2	1	0.6	0.3	-0.4
20	1	3	1	0.9	0	-0.5
20	1	4	1	0.9	0.1	-1
20	1	5	1	0.7	0	-0.2

Patient	Group (1=Alert, 2=Supine, 3=VPS, 4=Wax)	Trial (0-5)	Condyle (1=Right, 2+Left)	X-axis (anterior-posterior)	Y-axis (medial-lateral)	Z-axis (superior-inferior)
20	1	0	2	0	0	-0.2
20	1	1	2	0.8	-0.1	-0.2
20	1	2	2	0.8	-0.3	-0.2
20	1	3	2	0.9	0	-0.6
20	1	4	2	1	-0.1	-1
20	1	5	2	0.7	0	-0.4
20	2	0	1	0	-0.1	0.2
20	2	1	1	0.4	0	-0.2
20	2	2	1	0.4	-0.1	-0.1
20	2	3	1	0.5	-0.1	-0.2
20	2	4	1	0.4	0	-0.2
20	2	5	1	0.5	0	-0.3
20	2	0	2	0	0.1	0.2
20	2	1	2	0.3	0	-0.1
20	2	2	2	0.3	0.1	-0.2
20	2	3	2	0.4	0.1	-0.2
20	2	4	2	0.4	0	-0.3
20	2	5	2	0.5	0	-0.4
20	3	0	1	0	0	-0.1
20	3	1	1	0.9	0	-1.3
20	3	2	1	1	0.1	-1.5
20	3	3	1	1	0	-1
20	3	4	1	1.2	0	-1.3
20	3	5	1	1.2	-0.2	-1
20	3	0	2	0	0	-0.2
20	3	1	2	0.9	0	-1.1
20	3	2	2	1.2	-0.1	-1.3
20	3	3	2	1.2	0	-0.6
20	3	4	2	1.3	0	-1.1
20	3	5	2	1.2	0.2	-0.8
20	4	0	1	0.1	-0.2	-0.1
20	4	1	1	0.8	-0.1	-1.5
20	4	2	1	0.8	-0.2	-1.6
20	4	3	1	0.8	0	-1.6
20	4	4	1	0.7	0	-1.2
20	4	5	1	0.7	-0.1	-1
20	4	0	2	0	0.2	-0.1
20	4	1	2	0.7	0.1	-1.3
20	4	2	2	0.7	0.2	-1.1
20	4	3	2	0.8	0	-1.3
20	4	4	2	0.7	0	-1.2
20	4	5	2	0.8	0.1	-0.9