

Anatomic Landmarks on CBCT in Orthodontics: Utility, Accuracy, and Reliability

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Abstract

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INTRODUCTION: CBCT is an increasingly utilized imaging modality in orthodontics, however the increased diagnostic data from it is not being fully utilized. The goal of this study was to develop a comprehensive list of accurate, reliable anatomic landmarks which could be used in the development of a three-dimensional measurement analysis.

METHODS: A list 58 landmarks on the dentition, maxilla, mandible, and cranial base was developed and each landmark defined based on a literature review and discussions with orthodontists, radiologists and anatomists. CBCTs were taken of 31 dried human skulls before and after fiducial markers were placed. Images were superimposed to equilibrate orientation and coordinate axes. Two examiners (1 orthodontic resident and 1 dental student) located the landmarks on CBCT images based on the landmarks' definitions. Coordinates for landmarks were recorded in each plane (x, y, z). Accuracy was calculated via ICC and Mean Difference, and reliability was determined via Dahlberg's error. These values were calculated for Examiner 1 (E1) vs True Landmark, Examiner 2 (E2) vs True Landmark, and E1 vs E2.

RESULTS: All landmarks had an excellent Intraclass correlation coefficient (ICC) of ≥ 0.97 . A value of $>0.5\text{mm}$ was considered the threshold for a significant Mean Difference (Mean Diff.) and Dahlberg's Error (D. Error). All landmarks had excellent accuracy (Mean Diff. $\leq 0.5\text{mm}$) and reliability (D. Error $\leq 0.5\text{mm}$) except for: maxillary canine cusp tips, mandibular molar mesial root

apices, maxillary alveolar crest, anterior palate, greater palatine foramina, zygomaticomaxillary sutures, superior and posterior condyle, mandibular alveolar crest, anterior gonial angle, and gonion.

All of these landmarks were within 1.4mm of the True Landmark.

CONCLUSION: There are many landmarks with excellent accuracy and reliability on the dentition, maxilla, mandible, and cranial base that can be used in the development of a three-dimensional CBCT measurement analysis for orthodontic diagnosis. A final comprehensive list was compiled.

1. INTRODUCTION

Orthodontic measurements based on anatomic landmarks on head films play a major role in diagnosis, treatment planning, and outcomes assessment.¹ When anatomic landmarks are accurately and precisely located, the resulting measurements can be used descriptively in numerous ways. Such ways include categorizing cases by type, defining the degree to which a case departs from an accepted norm, and indicating the extent of change during and after treatment.²

Traditionally, measurements have been made based on anatomic landmarks identified on 2D lateral cephalograms. These images capture both internal and external bony anatomy but compress three-dimensional information into a two-dimensional image.¹ This limits the measurements made to the anterior-posterior and vertical dimensions, omitting the transverse and any bilateral differences or asymmetries. Furthermore, there can be considerable variability in reliably locating some landmarks on cephalograms due to overlapping images of anatomic structures, separation of bilateral landmarks due to positioning error, and variable magnification error.²⁻⁴ This results in error in projection and error in identification of landmarks, both of which contribute to measurement error which can affect the diagnosis and treatment decisions.²

Nevertheless, orthodontists have relied on 2D lateral cephalograms for diagnosis and evaluation of skeletal patterns, dental patterns, and their interrelationships since the first cephalometric analysis designed to look at these parameters was introduced by Downs in 1948.⁵ Nearly two decades after the introduction of the cephalometer by Broadbent, Down's analysis simplified and made evident the clinical usefulness of cephalometrics.¹

The specialty of orthodontics adopted cephalometrics, leading to a boom in research on craniofacial form, increased application in clinical care, orthodontic education, and research.¹ Orthodontists continually found new, innovative ways to make use of the information provided

by the cephalogram through landmark identification, various measurement analyses, and superimposition. In 1953, Steiner introduced further ways in which cephalometrics could be used for treatment planning. He included in his anatomic reference points and analysis considerations of skeletal balance, incisor angulations, and profile characteristics.⁶ Johnston and Ricketts recognized the importance of skeletal growth evaluation in orthodontic treatment, and published methods to study and predict growth based on cephalometric measurements and landmark tracing superimposition.^{7,8} Finally, we have arguably the greatest visionary in cephalometrics, Baumrind, who published over 75 articles in the orthodontic literature regarding imaging.¹ Baumrind's most notable contribution was his 1971 seminal articles on landmark identification and its effect on the reliability of head film measurements.^{1,2,4}

Baumrind concluded that the two main sources of measurement error are in projection and identification of landmarks.² Researchers have since bolstered Baumrind's conclusions, attributing the considerable variability in reliably locating landmarks on cephalograms to overlapping images of anatomic structures, separation of bilateral landmarks due to positioning error, and variable magnification error.^{3,9-11} Landmark localization is further complicated by significant asymmetries in patients and utilization of landmarks along gradual curves.^{2,9} A solution for these errors was suggested back in 1971 by Baumrind, when he stated that meaningful systematic correction could be achieved by the use of stereo-head films or by the integration of information from lateral and frontal films (Broadbent's method); essentially suggesting the solution was a more three-dimensional imaging modality.^{1,2} However, at this time there was no 3D imaging modality that was considered practical for routine clinical use². Allow this past to inspire the present.

Fast forward to the present—CBCT imaging offers a three-dimensional alternative that resolves projection and positioning error, while also allowing more precise, accurate, and reliable location of anatomic landmarks compared to cephalograms.^{3,12} Therefore, CBCT offers the possibility of identifying alternative anatomic landmarks for orthodontic measurements that are reliable, not identifiable on cephalograms, and that can provide more information about dentoskeletal relationships in all three dimensions. CBCT introduces the need to find bilateral landmarks to assess asymmetries and provide information about the transverse dimension, which were not an option for the 2D lateral cephalometric analyses. In addition, certain conventional cephalometric landmarks may be more accurately and reliably identified on CBCT images.^{13–15}

In the modern age of orthodontics, innovations in 3D imaging such as intraoral scanning, digital dental setups, and CBCT imaging are becoming more commonly utilized tools—and lending increased diagnostic data.¹ However, not all the available data is currently being taken advantage of, especially when it comes to CBCT images. Without a reliable, standardized set of anatomic landmarks and measurement analysis, many orthodontists extract 2D cephalograms from 3D CBCT images in order to make skeletal and dental diagnoses.¹⁶ This limits the measurements made to the anterior-posterior and vertical dimensions, omitting important information about the transverse and any bilateral differences or asymmetries.

Numerous studies have looked at the identification of traditional cephalometric landmarks on CBCT^{9,13,17–28}. Two systematic reviews found that the most reliable cephalometric landmarks on CBCT were in the midsagittal plane and dental landmarks, however a minimum number of dental landmarks have been reported.^{14,15} They also found that cephalometric landmarks with the lowest reliability on CBCT were those on anatomic structures with

prominent curvatures without definitive boundaries, such as on the condyle, porion, and orbitale.^{14,15}

Only two studies have attempted to define new, useful landmarks on CBCT for orthodontic assessment.^{22,29} Of these two studies, one chose landmarks solely based on radiographic characteristics that make them pragmatic to mark on CBCT image slices, rather than also considering clinical and diagnostic usefulness.²² While landmarks must be practical in their ability to be well defined and easily located on CBCT, they should also be clinically relevant for the development of measurement analyses for clinical diagnosis in orthodontics.

Despite the rising use of CBCT in orthodontics, there is still no well-established 3D measurement analysis, especially based on landmarks with a high level of accuracy and reliability.¹⁵ All standard head film analyses consist of sets of linear or angular measures based on pairs, triads, or tetrads of landmarks.⁴ Therefore, the first step in developing a 3D CBCT analysis is to identify an accurate, reliable, and clinically meaningful set of dental and skeletal landmarks.

The first aim of this study is to develop a comprehensive list of anatomic landmarks that will be useful for orthodontic measurements and feasible to identify on CBCT. The set of landmarks will be selected via literature review and survey of orthodontists, anatomists, and radiologists. The set of landmarks will largely consist of novel anatomic landmarks as well as some traditional cephalometric landmarks. The second aim is to define each landmark overall and in individual planes of space. Each landmark will only be defined in the necessary planes of space that lend to the accuracy of locating the landmark on CBCT. The third aim is to quantify and describe the accuracy and reliability of the landmarks on CBCTs of human skulls. Finally, the fourth aim of this study is to present a refined comprehensive list of landmarks to be used for

the development of a future 3D measurement analysis. This list will be recommended based on the results of this study.

2. MATERIALS & METHODS

2.1 AIM 1: DETERMINE LANDMARKS

An extensive literature review was performed to identify craniofacial landmarks of orthodontic clinical/diagnostic interest and value. Publications in the areas of orthodontics, craniofacial radiology, and oral maxillofacial surgery were searched for measurements useful for orthodontic diagnosis, treatment planning, and the evaluation of outcomes. For example, areas of interest that were searched in the maxilla included measurements of width, length, relationship to the mandible, relationship to the cranial base, symmetry, and cant.

Literature on the traditional cephalometric landmarks, both from lateral and anteroposterior cephalograms, that had been located on CBCTs was also searched. Certain cephalometric landmarks previously found to be accurate and reliable on CBCT were considered for inclusion. Discussions with UW anatomist (Dr. Rafferty) along with an anatomist trained outside of UW (Dr. Dandajena) and a committee of orthodontists inspired the addition of novel landmarks. Discussions with UW radiologists (Dr. Lee and radiology resident Dr. Chang) eliminated landmarks not easily identified on CBCT. The list of landmarks was further refined based on their utility or potential to measure and describe the maxilla, mandible, and dentition in all three dimensions in future measurement analyses. In summary, landmarks were excluded if they were determined to not be clinically/diagnostically useful or were not consistently visible on CBCT images.

2.2 AIM 2: DEFINE LANDMARKS

Review of landmarks on sample CBCTs provided by UW radiology with a radiologist (Dr. Lee) allowed initial definitions to be developed. Through this collaboration with Dr. Lee it was determined in which planes of space each landmark needed to be defined in order to accurately locate the landmark on CBCT. The landmarks were then defined overall, and separately in each necessary plane (Table 2 and Table 3). Landmarks and definitions were refined or changed as needed based on the intra-rater and inter-rater reliability testing performed during the calibration described in the next section.

2.3 AIM 3: ASSESS ACCURACY AND RELIABILITY OF LANDMARKS

A sample of 32 skulls were selected, with 31 skulls being necessary based on the sample size calculation in Table 1. The selection criteria for the skulls was that the skulls and mandibles were well preserved, had most permanent first molars, canines, and central incisors, stable occlusion, and intact anatomic structures of interest (where landmarks were to be located). Skulls will be excluded if they have mobile first molars, canines, or central incisors. In addition, skulls will be excluded if they had prosthetic work in order to avoid major scanning artifacts. Finally, skulls containing fractures or with significant deviations from normal anatomy will be excluded.

Table 1

ICC (reliability)	Number of examiners		
	2 ^A	3 ^B	4 ^B
0.75	75	52	44
0.80	51	36	31
0.85	31	23	20
0.90	15	12	10

Sample size require to estimate the intraclass correlation coefficient (ICC) with a precision of ± 0.10 based on a $\frac{1}{2}$ width of a 95% confidence interval.

^AThe scenario of 2 examiners is for the comparison of each orthodontic resident examiner's landmark measurement to the true landmark and the reproducibility of repeated measurements by an examiner.

^BThe scenarios of 3 and 4 examiners are for the comparison among the 3 to 4 orthodontic resident examiners.

The skull and the mandible were articulated in best fit occlusion for reproducibility of positioning. Three fiducial markers were identically placed on each skull at mid-mental and right and left zygoma for later superimposition methods. CBCT images were acquired for each skull both before and after 0.5mm fiducial markers made of gutta percha were placed at each anatomic landmark by the principal investigator and verified by its definition. Images were then acquired on a clinical CBCT machine commonly used in private orthodontic practices—iCAT FLX V-17. The manufacturer recommended settings for this CBCT machine set on “Standard” (360°, 300 frames, 120 kVp, 5 mA, 3.7 sec) were used. All CBCT scans were taken at a resolution of 0.3mm slice thickness/voxel size and a field of view which included the cranial base, the entire maxilla and mandible. The 3D volumes were then de-identified and imported in DICOM format to the Dolphin®3D imaging system for further processing to be standardized and re-oriented to an anatomic frame of reference described below.

After upload of the DICOM files to the Dolphin®3D imaging system, each unmarked CBCT was oriented using the following guidelines:

- 1) Frankfort horizontal from the right-side view (Image 1).
- 2) Using the “Auto Alignment Tool” a 3-point plane was marked at the mid-mental and on the right and left zygomatic arches based on fiducial markers that were placed on the skull (Image 2).

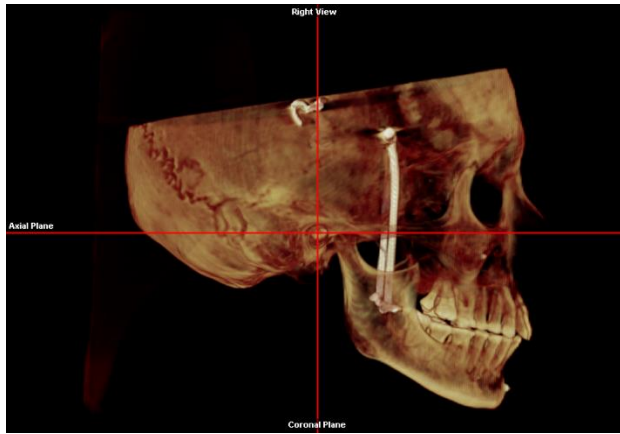


Image 1

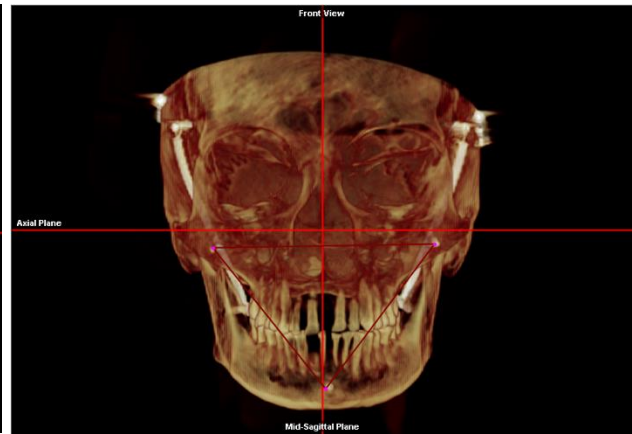


Image 2

Each marked CBCT was then super-imposed onto its unmarked CBCT of the same skull in order to equilibrate the orientation and coordinate axes between the two images. The Dolphin® voxel-based superimposition method was utilized, as it has been validated to be reliable and precise.³⁰ The two volumes were first manually aligned using 3 fiducial markers identically placed on each skull at mid-mental and right and left zygoma (Image 3).

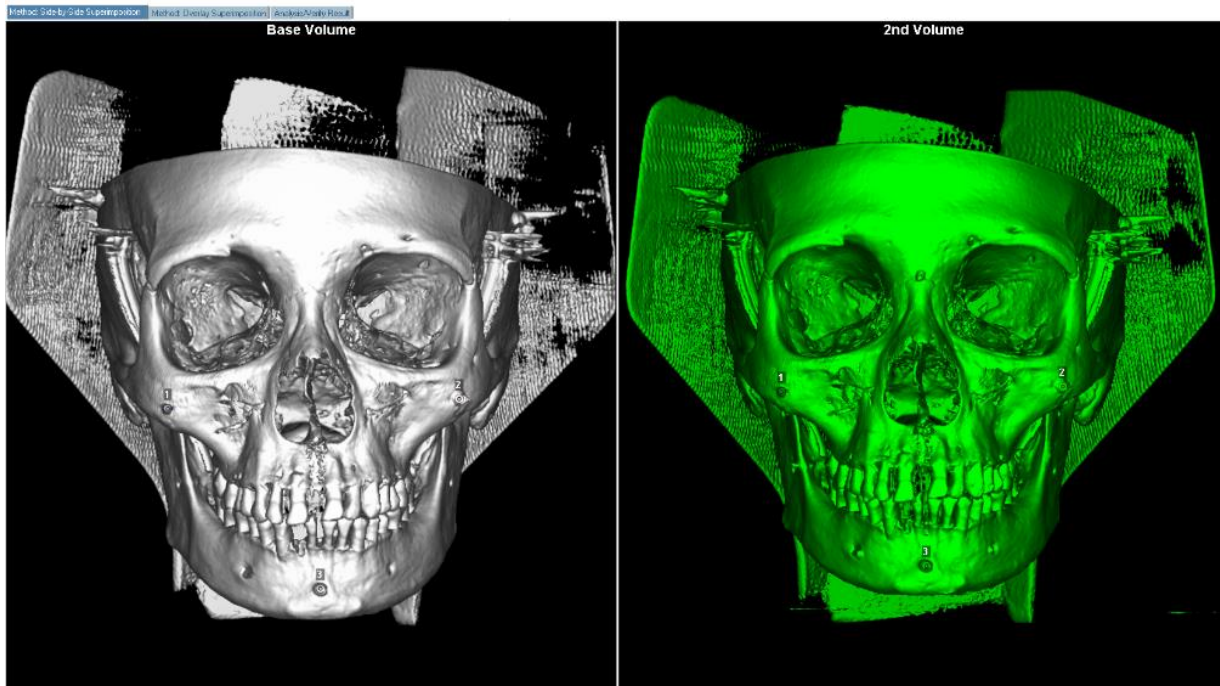


Image 3: 3 Point Side-by-side Superimposition

Next, the volumes were auto-superimposed based on a subregion of the volumes that was manually defined (Image 4). The subregion included the 3 orientation fiducial markers along with all landmarks being measured in this study. The superimposition accuracy was confirmed with the color mapping feature in Dolphin (Image 5). After superimposition, the marked image took on the exact same orientation and coordinates as the unmarked image. Finally, the marked and unmarked images from each skull were saved as separate files so that examiners only had access to view the unmarked image.

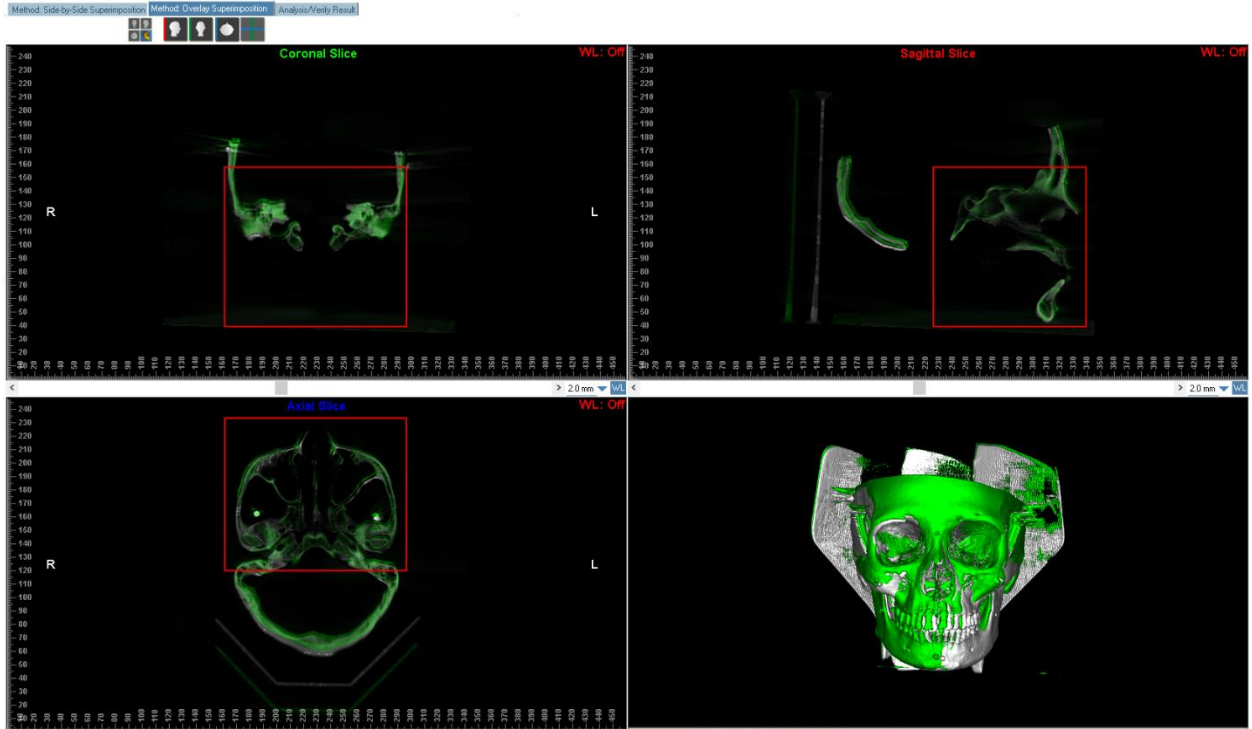


Image 4: Overlay Superimposition on Subregion

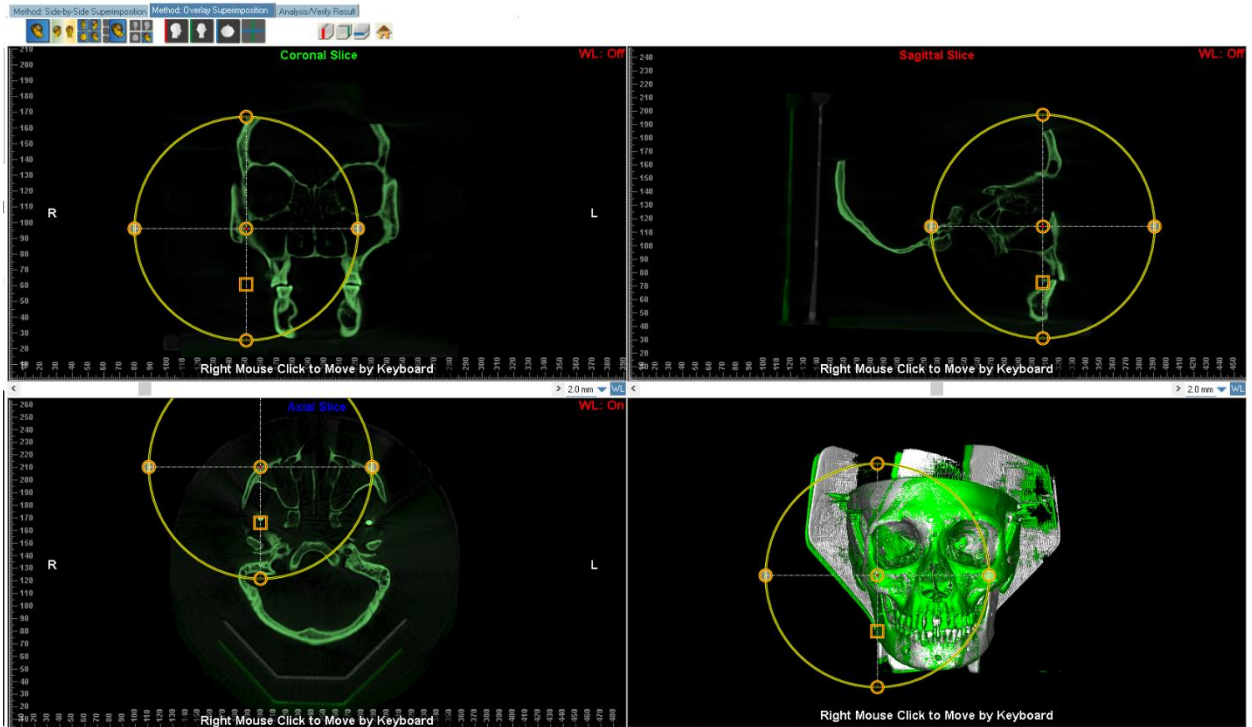


Image 5: Manual Verification of Overlay Superimposition

Two examiners were selected—an experienced 3rd year orthodontic resident (Examiner 1) and a less experienced 3rd year dental student (Examiner 2). This study included a difference of experience in looking at CBCTs to demonstrate practicality amongst a diverse provider population. Prior to beginning this study, examiners were provided with specific 3D definitions for each landmark (Table 2 and 3) and were calibrated using 4 cases. Each examiner viewed the CBCT images in their set orientation. Landmarks were initially approximated on the volumetric rendering of the CBCT images according to their general definition, then refined in the sagittal, transverse, and coronal cross-sections according to the definitions in the required planes.

To measure the error of the identification method (reproducibility) and assess calibration, 4 skulls' CBCTs were selected and measured twice, on 2 separate dates by each examiner. Inter-rater and intra-rater reliability testing was then performed. Summaries were reported both in 3-dimensional space and separately in each plane (i.e., the x-plane, y-plane and z-plane). Landmarks and definitions were refined or changed as needed based on the results and examiners were re-calibrated accordingly.

Following completion of calibration and inter-rater & intra-rater reliability testing, the 2 examiners located the same set of landmarks on each of 32 skulls over 3 months. The x, y, and z coordinates of each landmark were recorded in Excel with x corresponding to the sagittal plane, y to the transverse plane, and z to the coronal plane. Accuracy and reliability were then tested overall and in each of 3 planes as discussed in the data analysis below.

Landmarks were excluded if they were on teeth that had severe wear, fractures, or were missing. Landmarks on apices were excluded if the root was severely dilacerated or resorbed. Furthermore, landmarks blocked by metallic hardware or with significant anatomic abnormality were excluded. Landmarks on fractured bony features will be excluded. Finally, landmarks on

areas where perfect superimposition could not be obtained (ie condyle not in identical CR in both scans) were excluded. Skull 7 had error in positioning when the CBCT was taken and could not be adequately superimposed, so it was excluded. Thus, a final count of 31 skulls were included in this study.

Data Analysis

The accuracy and reliability of each landmark was based on the Euclidean distance between the true location (fiducial markers on CBCTs of marked skulls) and the examiner's measured landmark position in 3-dimensional space and separately in each plane (i.e., the x-plane, y-plane and z-plane). The accuracy and reliability was determined separately for each landmark and examiner.

In the initial phase the study, calibration, the intra-rater and inter-rater reliability between the 2 examiners was determined for all 58 landmarks on 4 skulls. For all apices, only the inter-rater reliability was assessed because these landmarks could not be accessed to place fiducial markers without destroying the skulls. The results were reported as the mean difference, intraclass correlation coefficient (ICC) with a 95% confidence interval (CI), and Dahlberg's error with its minimum and maximum absolute value (Appendix 1). Bland-Altman plots was also used to observe any possible discrepancies between the true location and examiner measured location during the calibration phase.³¹ Definitions were revised according to the outcome of the calibration testing and will be described in the results and discussion.

After completion of calibration, accuracy and reliability (precision) were tested for all landmarks according to their final definitions (Tables 2 and 3). Accuracy is defined as how close each examiner's landmark position is to the true landmark location. To describe the accuracy, the mean difference with a 95% confidence interval (CI) was calculated. Reliability is defined as the

precision with which the landmarks are located by the examiners. The reliability (precision) was summarized by the ICC with a 95% CI and Dahlberg's error with its minimum and maximum absolute value. All 3 aforementioned statistical tests are further described below.

The **mean difference** assesses whether, on average, the examiner is over or under measuring the landmark. From there one can look at the mean difference in each plane (x,y,z) to decide where the over or under measuring occurred.

The **ICC** is a relative measure of agreement (reliability)—measuring how much of the variation in a measurement is due to differences between the skulls compared to differences between the examiner and true landmark. An ICC > 0.75 generally indicates excellent reliability, 0.40 to 0.75 is fair to good reliability, and below 0.40 is poor reliability.³² The ICC was also used to quantify the inter-examiner reliability between the 2 examiners for each landmark, and to measure the error of the identification methods (reproducibility) as described under the calibration methods.

Dahlberg's Error was used to quantify the absolute measurement error. The average measurement error is expressed in the units of the variable being measured (mm in this study).^{31,33} The formula for Dahlberg's error is given below. In addition, the minimum and maximum values for the absolute difference gives the smallest and largest measurement error.

Dahlberg's error = $\sqrt{\sum_{i=1}^n d_i^2 / 2n}$ where d is the difference between two measurements and n is the number of skulls.

A VALUE OF >0.5MM IS THE THRESHOLD FOR WHICH DAHLBERG'S ERROR WAS CONSIDERED TO BE CLINICALLY RELEVANT IN THIS STUDY SINCE THE FIDUCIAL MARKERS WERE 0.5MM IN SIZE. ANY MEASUREMENT LESS THAN 0.5MM MAY STILL BE WITHIN THE 0.5MM FIDUCIAL

MARKER PLACED ON THE TRUE LANDMARK.2.4 AIM 4: PRESENT A REFINED COMPREHENSIVE LIST OF LANDMARKS

Based on the results described below, the list of landmarks included in the study will be analyzed and reduced into a more succinct, practical list of landmarks for the development of a future 3D measurement analysis. Landmarks that lack accuracy and/or reliability will be excluded. In regions where more than 1 landmark was chosen to be tested, a single landmark will be suggested based on its superior accuracy and/or reliability compared to others. These regions include: anterior maxilla near the midline, bilateral anterior superior maxilla, bilateral posterior maxilla, the condyles, internal ramus, and mandibular angle.

3. RESULTS

3.1 AIM 1: DETERMINE LANDMARKS & AIM 2: DEFINE LANDMARKS

A comprehensive list of 58 landmarks was developed and each landmark was defined overall, and separately in each necessary plane (Table 2 and Table 3). Landmarks and definitions were refined or changed as needed based on the intra-rater and inter-rater reliability testing performed during the calibration.

Table 2 – Three-dimensional Dental Landmarks

Three-dimensional DENTAL Landmark	Definition	Sagittal (x-plane)	Transverse (Axial) (y-plane)	Coronal (z-plane)
UR6 Mesiolingual cusp tip	The most occlusal point on the mesiolingual cusp of the upper right first molar	Inferior-most point on the mesiolingual cusp		Inferior-most point on the mesiolingual cusp
UL6 Mesiolingual cusp tip	The most occlusal point on the mesiolingual cusp of the upper left first molar	Inferior-most point on the mesiolingual cusp		Inferior-most point on the mesiolingual cusp

UR6 Mesiobuccal root apex	The most apical point on the mesiobuccal root of upper right first molar	Superior-most point	Middle-most point	Superior-most point
UL6 Mesiobuccal root apex	The most apical point on the mesiobuccal root of upper left first molar	Superior-most point	Middle-most point	Superior-most point
LR6 central occlusal point	The most centered occlusal point on the lower right first molar	Mesiodistal center-most point	Middle-most point of occlusal surface	Buccolingual-most point
LL6 central occlusal point	The most centered occlusal point on the lower left first molar	Mesiodistal center-most point	Middle-most point of occlusal surface	Buccolingual-most point
LR6 mesial root apex	The most apical point on the mesial root of lower right first molar	Inferior-most point	Middle-most point	Inferior-most point
LL6 mesial root apex	The most apical point on the mesial root of lower left first molar	Inferior-most point	Middle-most point	Inferior-most point
UR3 cusp tip	The most incisal point on the maxillary right canine	Incisal-most point	Middle-most point of the cusp tip (or area of wear when cusp tip is worn)	
UL3 cusp tip	The most incisal point on the maxillary left canine	Incisal-most point	Middle-most point of the cusp tip (or area of wear when cusp tip is worn)	
UR3 root apex	The most apical point on the root of the upper right canine	Superior-most point	Middle-most point	
UL3 root apex	The most apical point on the root of the upper left canine	Superior-most point	Middle-most point	
LR3 cusp tip	The most incisal point on the mandibular right canine	Incisal-most point	Middle-most point of the cusp tip (or area of wear when cusp tip is worn)	
LL3 cusp tip	The most incisal point on the	Incisal-most point	Middle-most point of the cusp tip (or area of	

	mandibular left canine		wear when cusp tip is worn)	
LR3 root apex	The most apical point on the root of the lower right canine	Inferior-most point	Middle-most point	
LL3 root apex	The most apical point on the root of the lower left canine	Inferior-most point	Middle-most point	
UR1 mesial incisal edge	The point where the mesial and incisal edges meet	Incisal-most point	Mesial-most point on the UR1	
UR1 root apex	The most apical point on the root of the upper right central incisor	Superior-most point	Middle-most point	Superior-most point
LR1 mesial incisal edge	The point where the mesial and incisal edges meet	Incisal-most point	Mesial-most point on LR1	
LR1 root apex	The most apical point on the root of the lower right central incisor	Inferior-most point	Middle-most point	Inferior-most point

Table 3 – Three-dimensional Skeletal Landmarks

Maxilla				
Three-dimensional SKELETAL Landmark	Definition	Sagittal	Transverse (Axial)	Coronal
Anterior palatal foramen	Posterior margin of incisive foramen	Inferior-posterior-most point	Posterior-most point	
Anterior palate	The most anterior point of the palate at the midline (anterior nasal spine)	Anterior-most point	Anterior-middle-most point	
Posterior palate	The most posterior point of the palate at the midpalatal suture	Posterior-most point	Posterior-most point	
Maxillary alveolar crest	The crestal bone most inferior-anterior	Inferior-anterior most point on alveolar crest		Inferior-most point

	at the maxillary midline			
Left greater palatine foramen	Anterior-lateral most point of left greater palatine foramen	Anterior-inferior-most point at level of foramen		Lateral-most point at the level of the adjacent hard palate
Right greater palatine foramen	Anterior-lateral most point of right greater palatine foramen	Anterior-inferior-most point at level of foramen		Lateral-most point at the level of the adjacent hard palate
Right tuberosity	The most posterior point on the right maxillary tuberosity where it meets the pterygoid plate at the hamular notch	The most superior point in the hamular notch on the maxillary tuberosity	The most posterior point on the maxillary tuberosity at the hamular notch	
Left tuberosity	The most posterior point on the left maxillary tuberosity where it meets the pterygoid at the hamular notch	The most superior point in the hamular notch on the maxillary tuberosity	The most posterior point on the maxillary tuberosity at the hamular notch	
Right infraorbital foramen	The superior-lateral most point on the right infraorbital foramen	The superior-most point	The lateral-most point	
Left infraorbital foramen	The superior-lateral most point on the left infraorbital foramen	The superior-most point	The lateral-most point	
Right Zygomaticomaxillary suture	Most inferior point on the suture between the right zygomatic and maxillary bones			Inferior-most point on suture line
Left Zygomaticomaxillary suture	Most inferior point on the suture between the left zygomatic and maxillary bones			Inferior-most point on suture line
Mandible				
Three-dimensional SKELETAL Landmark	Definition	Sagittal	Transverse (Axial)	Coronal
Right medial condyle	Most medial of the right condyle along the long axis		Medial-most point along the	Medial-most point

			long axis of the condyle head	
Right lateral condyle	Most lateral of the right condyle along the long axis		Lateral-most point along the long axis of the condyle head	Lateral-most point
Right posterior condyle	Most posterior point of right condyle	Posterior-most point	Posterior-most point	
Right superior condyle	Most superior point of the right condyle	Superior-most point		Superior-most point
Left medial condyle	Most medial of the left condyle along the long axis		Medial-most point along the long axis of the condyle head	Medial-most point
Left lateral condyle	Most lateral of the left condyle along the long axis		Lateral-most point along the long axis of the condyle head	Lateral-most point
Left posterior condyle	Most posterior point of left condyle	Posterior-most point	Posterior-most point	
Left superior condyle	Most superior point of the right condyle	Superior-most point		Superior-most point
Right mental foramen	Most medial superficial point of the right mental foramen		Medial-superficial-most point	
Left mental foramen	Most medial superficial point of the left mental foramen		Medial-superficial-most point	
Mid-mental	Calculated midpoint of the line between the most medial point of the right and left mental foramina			
Mandibular alveolar crest	The crestal bone most super at the mandibular midline	Superior-anterior most point on alveolar crest		Superior-most point
Right lingula	Most superior point of the lingula of the right mandibular foramen			Superior-most point
Left lingula	Most superior point of the lingula of the left mandibular foramen			Superior-most point

Right Inferior Alveolar Foramen	The most inferior-medial point of the right alveolar foramen			Inferior-medial-most point
Left Inferior Alveolar Foramen	The most inferior-medial point of the left alveolar foramen			Inferior-medial-most point
Right coronoid notch	The most inferior point along the curvature of the right coronoid notch	Inferior-most point on the coronoid notch	Posterior-most point	
Left coronoid notch	The most inferior point along the curvature of the left coronoid notch	Inferior-most point on the coronoid notch	Posterior-most point	
Right gonion	The most middle point along the curvature of the mandibular angle	The middle-most point along the curvature of the mandibular angle	Posterior-most point	
Left gonion	The most middle point along the curvature of the mandibular angle	The middle-most point along the curvature of the mandibular angle	Posterior-most point	
Right anterior gonial angle	The most anterior point of the gonial angle where the curvature begins			Inferior-most point
Left anterior gonial angle				Inferior-most point
Cranial Base				
Three-dimensional SKELETAL Landmark	Definition	Sagittal	Transverse (Axial)	Coronal
Right anterior clinoid	Posterior-most point of the right anterior clinoid process	Posterior-most point	Posterior-most point	
Left anterior clinoid	Posterior-most point of the left anterior clinoid process	Posterior-most point	Posterior-most point	
Mid-clinoid	Calculated midpoint of the line between the most superior points of two anterior clinoid processes			

Nasion	The most anterior point of the frontonasal suture at the midline	Anterior-most point		Middle-most point on the frontonasal suture
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Intra-rater and inter-rater reliability was run on an initial sample of 4 skulls to calibrate the 2 examiners and make an initial assessment of the landmarks' definitions. The reliability was excellent ($ICC > 0.75$) for all landmarks except for those subsequently described. For examiner 1, the intra-rater reliability of the left and right greater palatine foramen was poor (0.39, 0.38), left superior condyle was poor (0.22), and nasion was fair (0.61). For examiner 2, the intra-rater reliability of the right medial condyle was good (0.72), right and left superior condyles were good (0.6, 0.58), right inferior alveolar foramen was good (0.71), and left gonion was poor (0.19). Between both examiners the inter-rater reliability of the right medial condyle was poor (0.34), left medial condyle was good (0.71), left posterior condyle was good (0.73), left superior condyle was good (0.73), and nasion was good (0.61). See Appendix 1 for all calibration results.

3.2 AIM 3: ASSESS ACCURACY AND RELIABILITY OF LANDMARKS

Image 6 **Dental: E1 vs True Landmark**

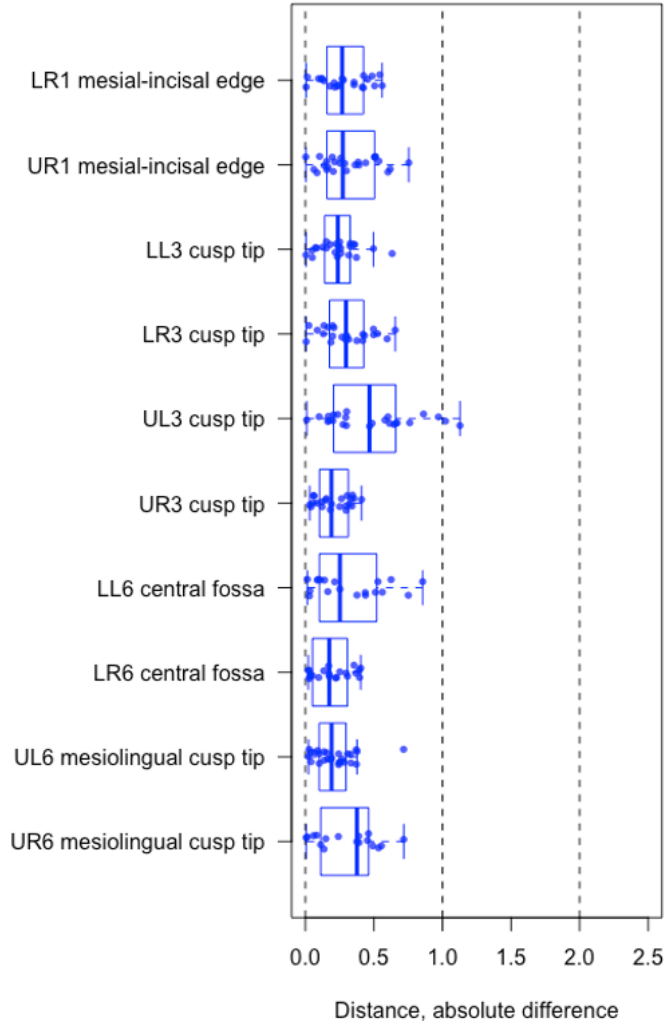


Image 7 **Maxilla: E1 vs True Landmark**

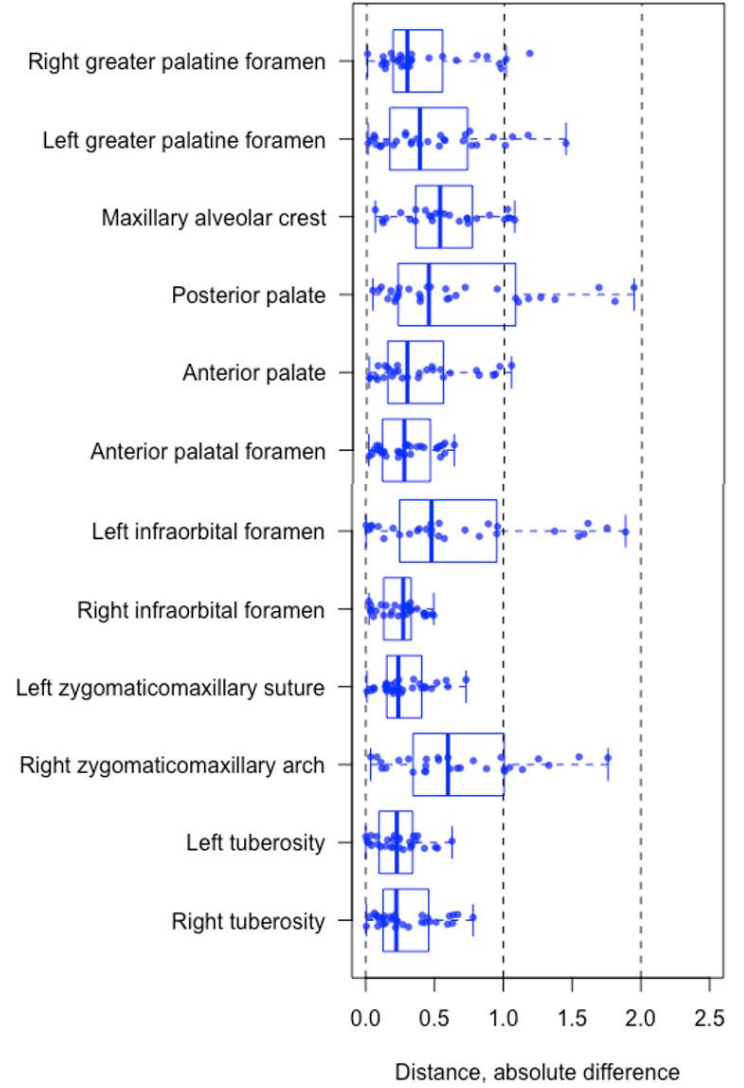


Image 8 **Mandible: E1 vs True Landmark**

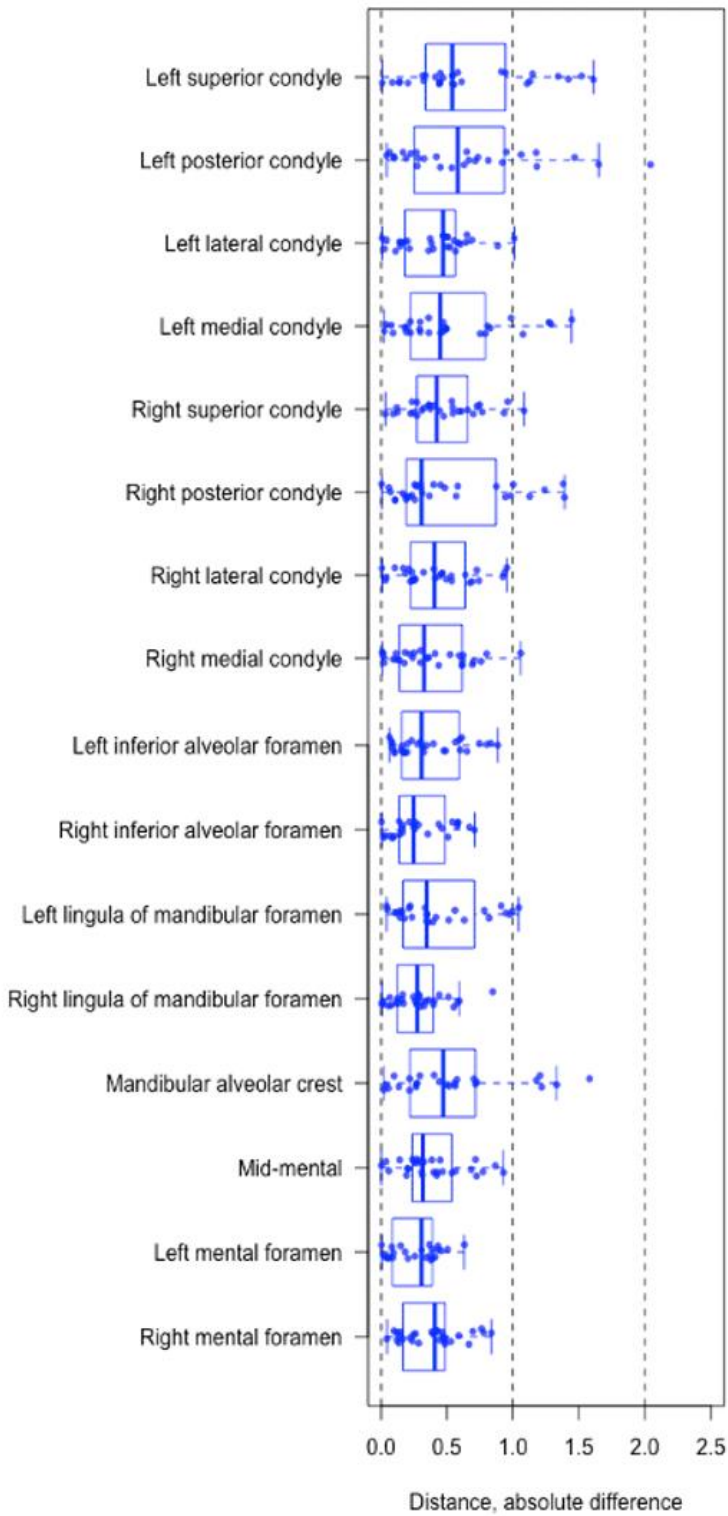


Image 9 **Mandible: E1 vs True Landmark**

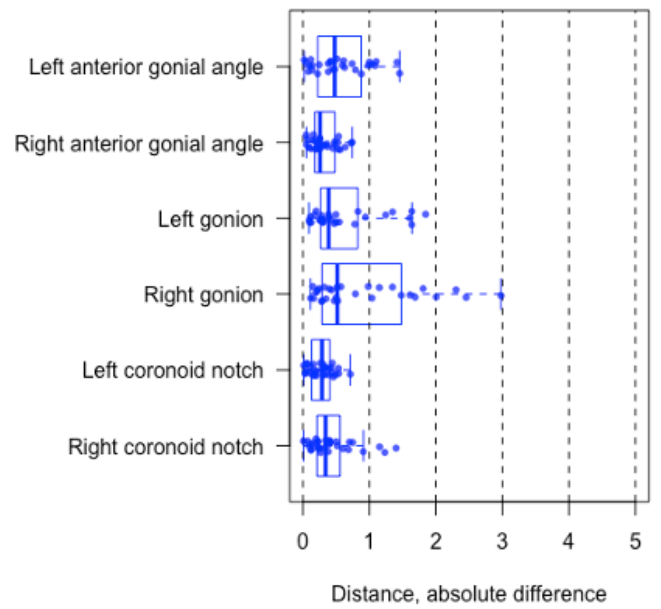


Image 10 **Cranial Base: E1 vs True Landmark**

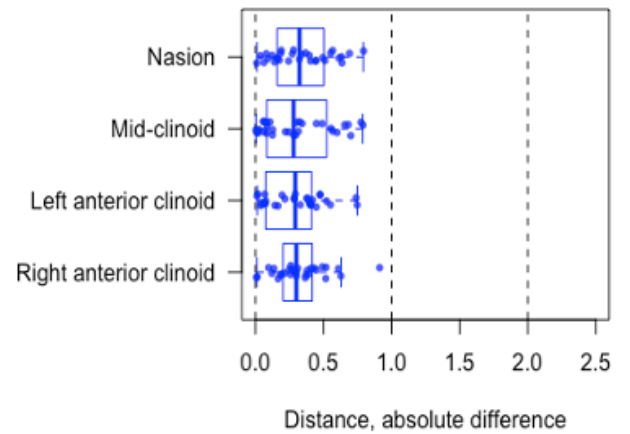


Table 4: Accuracy and Reliability for Examiner 1 (E1)

E1 Dental: Overall Distance

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
LR1 mesial-incisal edge	21	0.0 (0.2) [-0.1, 0.1]	1.00 (1.00, 1.00)	0.2 (0.0, 0.4)
UR1 mesial-incisal edge	24	-0.2 (0.2) [-0.3, -0.1]	1.00 (1.00, 1.00)	0.2 (0.0, 0.6)
LL3 cusp tip	17	0.2 (0.3) [0.1, 0.4]	1.00 (1.00, 1.00)	0.3 (0.0, 0.7)
LR3 cusp tip	19	0.0 (0.4) [-0.2, 0.2]	1.00 (1.00, 1.00)	0.3 (0.0, 0.9)
UL3 cusp tip	25	-0.4 (0.4) [-0.6, -0.2]	1.00 (1.00, 1.00)	0.4 (0.0, 1.1)
UR3 cusp tip	26	-0.2 (0.3) [-0.3, 0.0]	1.00 (1.00, 1.00)	0.3 (0.0, 0.8)
LL6 central fossa	27	0.1 (0.3) [0.0, 0.2]	1.00 (1.00, 1.00)	0.2 (0.0, 0.7)
LR6 central fossa	23	0.0 (0.2) [-0.1, 0.1]	1.00 (1.00, 1.00)	0.2 (0.0, 0.4)
UL6 mesiolingual cusp tip	24	0.0 (0.4) [-0.2, 0.1]	1.00 (1.00, 1.00)	0.2 (0.0, 0.7)
UR6 mesiolingual cusp tip	23	0.0 (0.3) [-0.2, 0.1]	1.00 (1.00, 1.00)	0.2 (0.0, 0.6)

E1 Maxilla: Overall Distance

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Right greater palatine foramen	29	0.2 (0.5) [0.0, 0.4]	1.00 (1.00, 1.00)	0.4 (0.0, 1.2)
Left greater palatine foramen	30	0.4 (0.7) [0.1, 0.7]	0.99 (0.99, 1.00)	0.6 (0.0, 1.9)
Maxillary alveolar crest	27	-0.6 (0.3) [-0.7, -0.5]	1.00 (0.99, 1.00)	0.5 (0.1, 1.1)
Posterior palate	31	0.3 (0.5) [0.2, 0.5]	1.00 (0.99, 1.00)	0.4 (0.0, 1.4)
Anterior palate	29	-0.2 (0.5) [-0.4, 0.0]	1.00 (1.00, 1.00)	0.4 (0.0, 1.1)
Anterior palatal foramen	31	-0.1 (0.3) [-0.2, 0.0]	1.00 (1.00, 1.00)	0.2 (0.0, 0.6)
Left infraorbital foramen	30	0.0 (0.3) [-0.1, 0.1]	1.00 (1.00, 1.00)	0.2 (0.0, 0.6)
Right infraorbital foramen	30	0.0 (0.3) [-0.1, 0.2]	1.00 (1.00, 1.00)	0.2 (0.0, 0.7)
Left zygomaticomaxillary suture	29	-0.5 (0.7) [-0.7, -0.2]	0.99 (0.99, 1.00)	0.6 (0.0, 1.8)
Right zygomaticomaxillary suture	29	-0.3 (0.8) [-0.6, 0.0]	0.99 (0.99, 1.00)	0.6 (0.0, 1.9)
Left tuberosity	28	-0.1 (0.3) [-0.2, 0.0]	1.00 (1.00, 1.00)	0.2 (0.0, 0.6)
Right tuberosity	29	0.0 (0.3) [-0.1, 0.1]	1.00 (1.00, 1.00)	0.2 (0.0, 0.5)

E1 Mandible: Overall Distance

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Left superior condyle	30	-0.1 (0.5) [-0.3, 0.1]	0.98 (0.97, 0.99)	0.4 (0.0, 1.1)
Left posterior condyle	30	0.0 (0.7) [-0.3, 0.2]	0.99 (0.97, 0.99)	0.5 (0.0, 1.4)
Left lateral condyle	30	-0.2 (0.4) [-0.4, -0.1]	0.99 (0.99, 1.00)	0.3 (0.0, 1.1)
Left medial condyle	30	0.4 (0.4) [0.2, 0.5]	0.99 (0.98, 0.99)	0.4 (0.0, 1.0)
Right superior condyle	29	-0.2 (0.8) [-0.5, 0.1]	0.98 (0.96, 0.99)	0.6 (0.0, 1.6)
Right posterior condyle	28	-0.4 (0.7) [-0.7, -0.1]	0.98 (0.96, 0.99)	0.6 (0.0, 2.0)
Right lateral condyle	29	-0.5 (0.4) [-0.7, -0.3]	0.99 (0.97, 0.99)	0.5 (0.0, 1.4)
Right medial condyle	29	0.2 (0.4) [0.0, 0.4]	0.99 (0.98, 1.00)	0.3 (0.0, 1.0)
Left inferior alveolar foramen	30	0.1 (0.4) [-0.1, 0.3]	1.00 (1.00, 1.00)	0.3 (0.0, 0.8)
Right inferior alveolar foramen	28	0.1 (0.5) [-0.1, 0.3]	1.00 (0.99, 1.00)	0.4 (0.0, 1.0)
Left lingula	25	0.0 (0.3) [-0.1, 0.2]	1.00 (1.00, 1.00)	0.2 (0.0, 0.6)
Right lingula	27	0.0 (0.4) [-0.1, 0.2]	1.00 (1.00, 1.00)	0.3 (0.0, 0.7)
Mandibular alveolar crest	26	-0.5 (0.5) [-0.7, -0.3]	1.00 (0.99, 1.00)	0.5 (0.0, 1.6)

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Mid-mental	30	0.0 (0.3) [-0.1, 0.1]	1.00 (1.00, 1.00)	0.2 (0.0, 0.8)
Left mental foramen	30	0.0 (0.5) [-0.1, 0.2]	1.00 (1.00, 1.00)	0.3 (0.0, 0.9)
Right mental foramen	30	0.0 (0.4) [-0.2, 0.1]	1.00 (1.00, 1.00)	0.3 (0.1, 0.9)
Left anterior gonial angle	31	0.2 (0.5) [0.1, 0.4]	1.00 (1.00, 1.00)	0.4 (0.0, 1.4)
Right anterior gonial angle	30	-0.2 (0.8) [-0.5, 0.1]	1.00 (0.99, 1.00)	0.6 (0.1, 1.8)
Left gonion	30	0.7 (1.0) [0.3, 1.1]	0.99 (0.98, 0.99)	0.8 (0.1, 3.0)
Right gonion	29	0.1 (0.7) [-0.2, 0.4]	1.00 (0.99, 1.00)	0.5 (0.0, 1.5)
Left coronoid notch	31	0.1 (0.3) [-0.1, 0.2]	1.00 (1.00, 1.00)	0.2 (0.0, 0.7)
Right coronoid notch	31	0.2 (0.3) [0.1, 0.3]	1.00 (1.00, 1.00)	0.3 (0.0, 0.8)

E1 Cranial Base: Overall Distance

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Nasion	31	-0.2 (0.3) [-0.3, -0.1]	1.00 (1.00, 1.00)	0.3 (0.0, 0.8)
Mid-clinoid	31	0.2 (0.3) [0.1, 0.3]	1.00 (1.00, 1.00)	0.3 (0.0, 0.7)
Left anterior clinoid	31	0.2 (0.3) [0.0, 0.3]	1.00 (1.00, 1.00)	0.3 (0.0, 0.9)
Right anterior clinoid	31	0.2 (0.3) [0.1, 0.3]	1.00 (1.00, 1.00)	0.3 (0.0, 0.8)

n is the number of skulls for which each landmark was located

Mean Diff. is the average distance between the average E1 and the True Landmark locations (units are mm)

SD is Standard Deviation (units are mm)

ICC is intraclass correlation coefficient

D. Error is Dahlberg's Error (units are mm)

For examiner 1 all landmarks were placed within 0.5mm of the true landmark location (per Dahlberg's error) except for: left greater palatine foramen (0.6mm), left and right zygomaticomaxillary suture (0.6mm, 0.6mm), right superior and posterior condyle (0.6mm), right anterior gonial angle (0.6mm), and left gonion (0.8mm) (Table 4). The ICC for all landmarks was ≥ 0.98 indicating small measurement error relative to variation amongst skulls (Table 4). This means we can trust the outcome of Dahlberg's error and the landmarks listed above lack ideal precision ($<0.5\text{mm}$).

For examiner 1 all landmarks were accurate according to a Mean Difference $>\pm 0.5\text{mm}$ except for: maxillary alveolar crest (-0.6mm) and left gonion (0.7mm) (Table 4). The accuracy error for maxillary alveolar crest was largely due to inaccuracy in the coronal (Z) (Table 4.1). The accuracy error for left gonion was due to the inaccuracy in all 3 planes with the greatest

source being the transverse (-0.6mm) (Table 4.2). Tables with measurements in each plane for each landmark (E1 vs True Landmark) can be found in Appendix 2.1.

Table 4.1

E1: Maxillary alveolar crest

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	27	-0.6 (0.3) [-0.7, -0.5]	1.00 (0.99, 1.00)	0.5 (0.1, 1.1)
X	27	0.0 (0.4) [-0.2, 0.2]	0.99 (0.98, 1.00)	0.3 (0.0, 0.9)
Y	27	0.1 (0.7) [-0.2, 0.4]	1.00 (0.99, 1.00)	0.5 (0.0, 1.9)
Z	27	-0.6 (0.4) [-0.8, -0.4]	1.00 (0.99, 1.00)	0.5 (0.0, 1.6)

Table 4.2

E1: Left Gonion

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	30	0.7 (1.0) [0.3, 1.1]	0.99 (0.98, 0.99)	0.8 (0.1, 3.0)
X	30	0.3 (0.6) [0.0, 0.5]	0.99 (0.97, 0.99)	0.5 (0.0, 1.3)
Y	30	-0.6 (1.1) [-1.0, -0.1]	0.99 (0.98, 1.00)	0.9 (0.0, 3.0)
Z	30	0.5 (0.7) [0.3, 0.8]	0.99 (0.99, 1.00)	0.6 (0.0, 2.1)

Image 11 **Dental: E2 vs True Landmark**

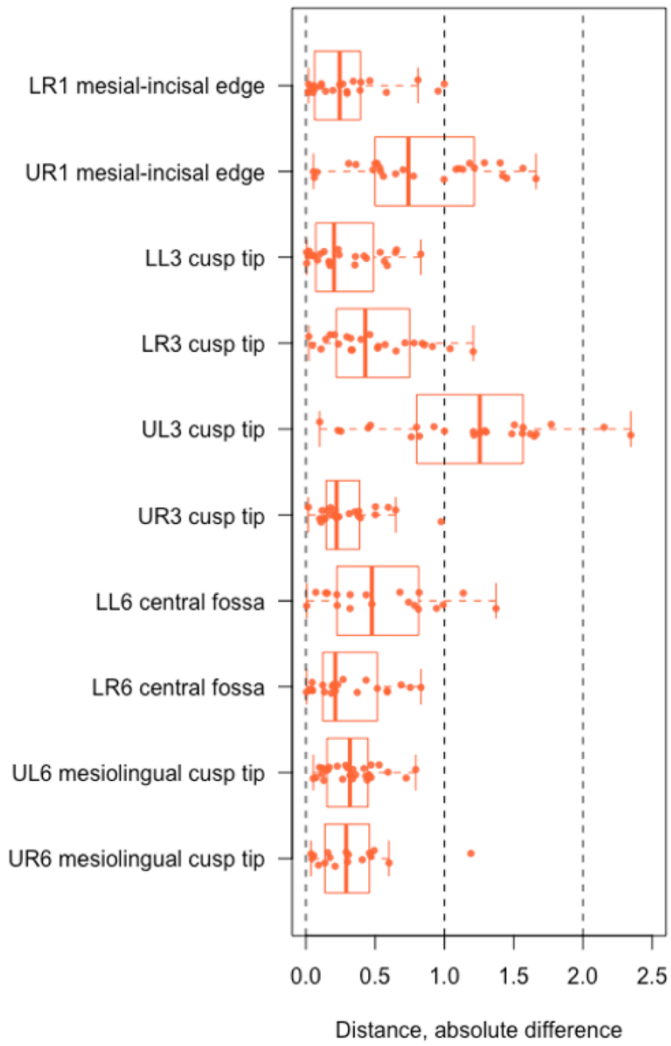


Image 12 **Maxilla: E2 vs True Landmark**

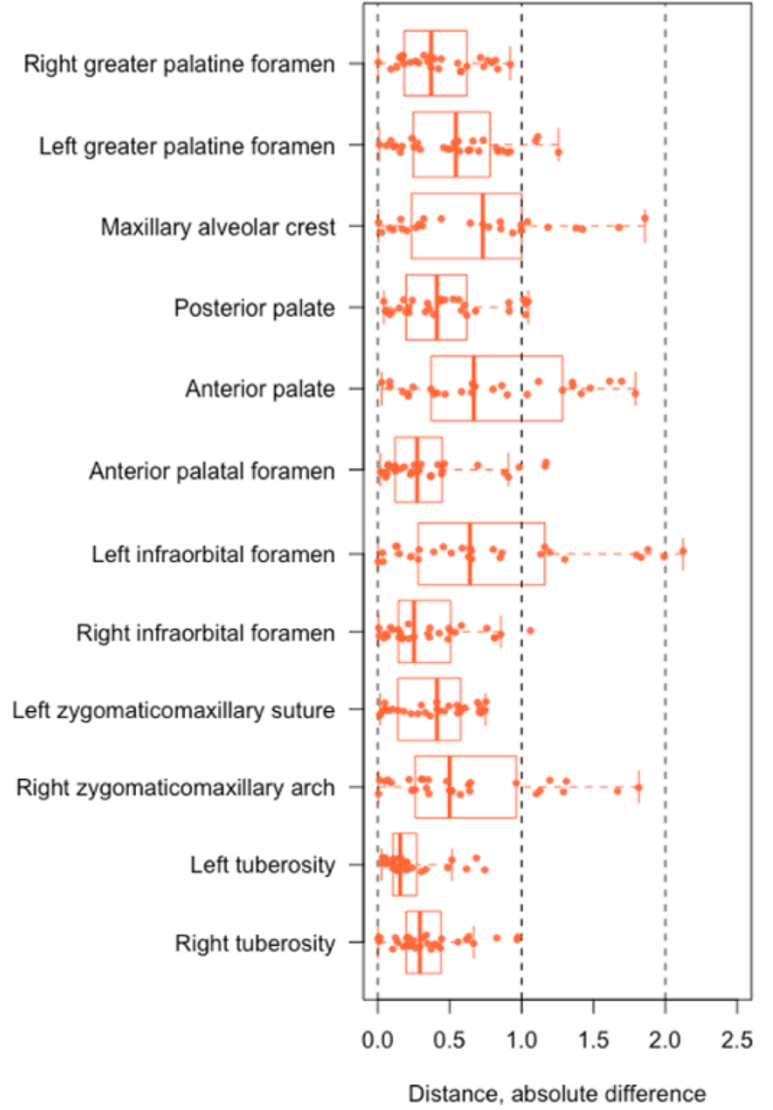


Image 13 **Mandible: E2 vs True Landmark**

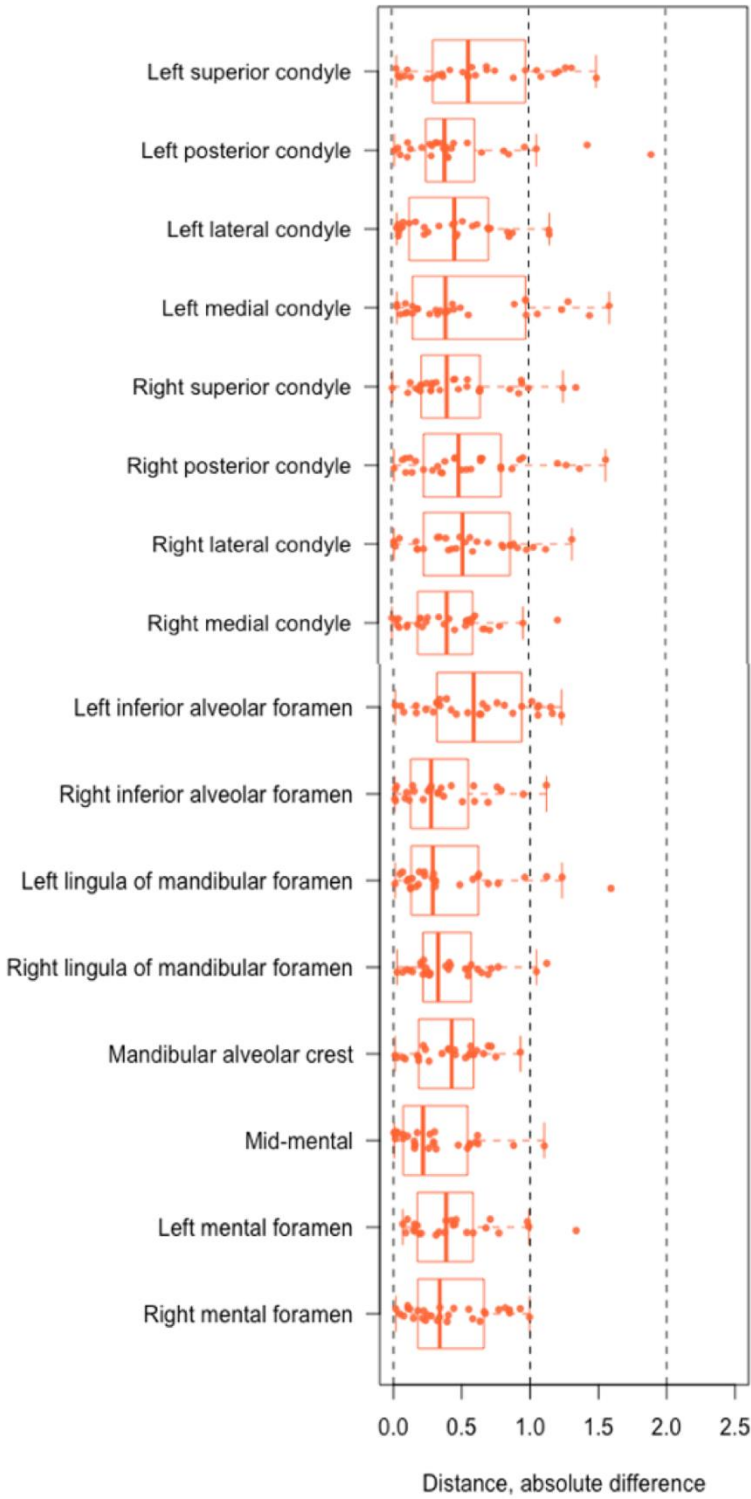


Image 14 **Mandible: E2 vs True Landmark**

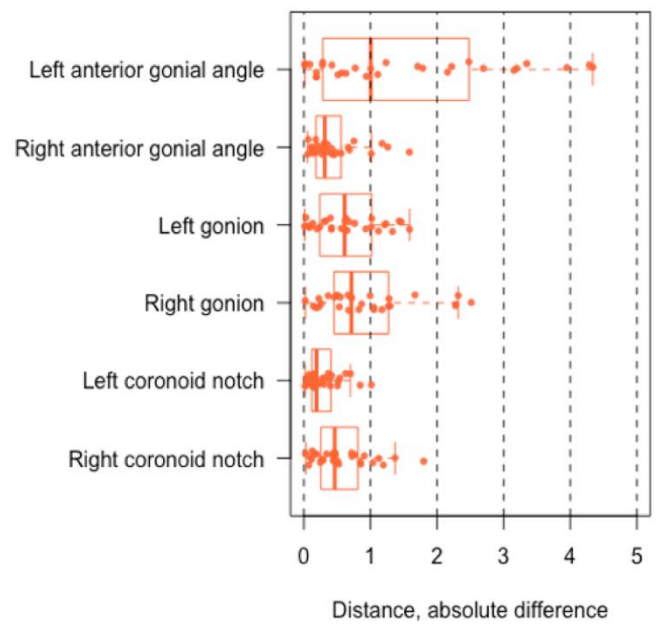


Image 15 **Cranial Base: E2 vs True Landmark**

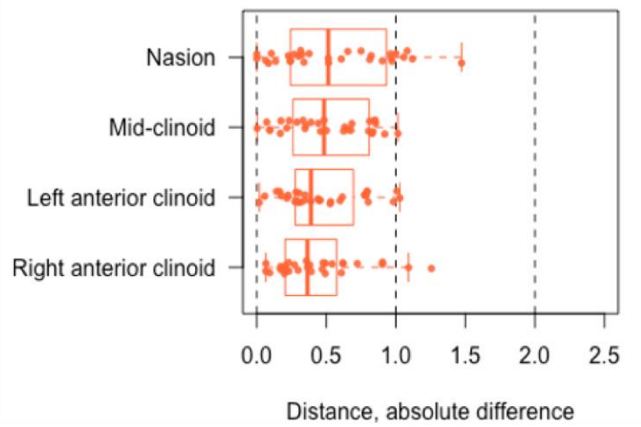


Table 5: Accuracy and Reliability for Examiner 2 (E2)

E2 Dental: Overall Distance

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
LR1 mesial-incisal edge	21	0.1 (0.4) [0.0, 0.3]	1.00 (1.00, 1.00)	0.3 (0.0, 0.8)
UR1 mesial-incisal edge	24	-0.2 (0.3) [-0.3, -0.1]	1.00 (1.00, 1.00)	0.3 (0.0, 0.8)
LL3 cusp tip	17	0.1 (0.4) [-0.1, 0.3]	1.00 (1.00, 1.00)	0.3 (0.0, 1.2)
LR3 cusp tip	19	-0.2 (0.6) [-0.6, 0.1]	1.00 (0.99, 1.00)	0.5 (0.0, 1.4)
UL3 cusp tip	25	-1.2 (0.6) [-1.4, -0.9]	0.99 (0.97, 0.99)	0.9 (0.1, 2.3)
UR3 cusp tip	26	-0.8 (0.5) [-1.0, -0.6]	0.99 (0.99, 1.00)	0.7 (0.1, 1.7)
LL6 central fossa	27	0.1 (0.4) [0.0, 0.3]	1.00 (1.00, 1.00)	0.3 (0.1, 0.8)
LR6 central fossa	23	0.2 (0.3) [0.1, 0.3]	1.00 (1.00, 1.00)	0.3 (0.0, 1.0)
UL6 mesiolingual cusp tip	24	-0.3 (0.5) [-0.5, -0.1]	1.00 (0.99, 1.00)	0.4 (0.0, 1.2)
UR6 mesiolingual cusp tip	23	-0.2 (0.4) [-0.4, 0.0]	1.00 (1.00, 1.00)	0.3 (0.0, 1.0)

E2 Maxilla: Overall Distance

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Right greater palatine foramen	29	0.0 (0.5) [-0.2, 0.2]	1.00 (1.00, 1.00)	0.4 (0.0, 0.9)
Left greater palatine foramen	30	0.2 (0.5) [0.0, 0.4]	1.00 (0.99, 1.00)	0.4 (0.0, 1.0)
Maxillary alveolar crest	27	-0.7 (0.6) [-0.9, -0.4]	1.00 (0.99, 1.00)	0.6 (0.0, 1.9)
Posterior palate	31	0.4 (0.5) [0.2, 0.6]	1.00 (0.99, 1.00)	0.4 (0.0, 1.3)
Anterior palate	29	-0.7 (0.6) [-1.0, -0.5]	0.99 (0.99, 1.00)	0.7 (0.0, 1.8)
Anterior palatal foramen	31	-0.2 (0.5) [-0.4, 0.0]	1.00 (1.00, 1.00)	0.3 (0.0, 1.2)
Left infraorbital foramen	30	-0.2 (0.4) [-0.3, 0.0]	1.00 (1.00, 1.00)	0.3 (0.0, 1.1)
Right infraorbital foramen	30	-0.3 (0.4) [-0.4, -0.2]	1.00 (1.00, 1.00)	0.3 (0.0, 0.8)
Left zygomaticomaxillary suture	29	0.0 (0.8) [-0.3, 0.3]	0.99 (0.99, 1.00)	0.6 (0.0, 1.8)
Right zygomaticomaxillary suture	29	-0.1 (1.0) [-0.5, 0.2]	0.99 (0.98, 1.00)	0.7 (0.0, 2.1)
Left tuberosity	28	0.1 (0.3) [-0.1, 0.2]	1.00 (1.00, 1.00)	0.2 (0.0, 0.7)
Right tuberosity	29	0.1 (0.4) [-0.1, 0.3]	1.00 (1.00, 1.00)	0.3 (0.0, 1.1)

E2 Mandible: Overall Distance

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Left superior condyle	30	-0.1 (0.6) [-0.3, 0.1]	0.98 (0.96, 0.99)	0.4 (0.0, 1.3)
Left posterior condyle	30	-0.1 (0.7) [-0.3, 0.2]	0.98 (0.97, 0.99)	0.5 (0.0, 1.6)
Left lateral condyle	30	-0.3 (0.4) [-0.5, -0.2]	0.99 (0.98, 1.00)	0.4 (0.0, 1.2)
Left medial condyle	30	0.5 (0.4) [0.4, 0.7]	0.98 (0.96, 0.99)	0.5 (0.0, 1.3)
Right superior condyle	29	-0.3 (0.7) [-0.5, 0.0]	0.98 (0.96, 0.99)	0.5 (0.0, 1.5)
Right posterior condyle	28	-0.3 (0.6) [-0.5, -0.1]	0.99 (0.98, 0.99)	0.5 (0.0, 1.9)
Right lateral condyle	29	-0.5 (0.5) [-0.7, -0.4]	0.98 (0.97, 0.99)	0.5 (0.0, 1.6)
Right medial condyle	29	0.4 (0.4) [0.2, 0.5]	0.99 (0.98, 0.99)	0.4 (0.0, 1.2)
Left inferior alveolar foramen	30	0.3 (0.4) [0.1, 0.4]	1.00 (0.99, 1.00)	0.4 (0.0, 1.0)

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Right inferior alveolar foramen	28	0.2 (0.6) [0.0, 0.4]	1.00 (0.99, 1.00)	0.4 (0.0, 1.6)
Left lingula	25	0.2 (0.5) [0.0, 0.4]	1.00 (0.99, 1.00)	0.4 (0.1, 1.3)
Right lingula	27	0.2 (0.4) [0.0, 0.3]	1.00 (0.99, 1.00)	0.3 (0.0, 1.1)
Mandibular alveolar crest	26	-0.1 (0.5) [-0.3, 0.1]	1.00 (1.00, 1.00)	0.3 (0.0, 0.9)
Mid-mental	30	0.2 (0.5) [0.0, 0.4]	1.00 (1.00, 1.00)	0.3 (0.0, 1.1)
Left mental foramen	30	0.2 (0.4) [0.0, 0.3]	1.00 (1.00, 1.00)	0.3 (0.0, 1.1)
Right mental foramen	30	0.2 (0.7) [-0.1, 0.4]	1.00 (0.99, 1.00)	0.5 (0.0, 1.2)
Left anterior gonial angle	31	0.4 (0.6) [0.1, 0.6]	1.00 (0.99, 1.00)	0.5 (0.0, 1.8)
Right anterior gonial angle	30	-0.5 (0.7) [-0.7, -0.2]	1.00 (0.99, 1.00)	0.6 (0.0, 1.6)
Left gonion	30	0.4 (1.1) [0.0, 0.8]	0.99 (0.98, 1.00)	0.8 (0.0, 2.5)
Right gonion	29	-1.3 (1.6) [-1.9, -0.7]	0.97 (0.95, 0.99)	1.4 (0.0, 4.3)
Left coronoid notch	31	0.2 (0.3) [0.1, 0.3]	1.00 (0.99, 1.00)	0.3 (0.0, 1.0)
Right coronoid notch	31	0.5 (0.4) [0.4, 0.7]	1.00 (0.99, 1.00)	0.5 (0.0, 1.5)

E2 Cranial Base: Overall Distance

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Nasion	31	-0.5 (0.3) [-0.6, -0.4]	1.00 (1.00, 1.00)	0.4 (0.0, 1.0)
Mid-clinoid	31	0.4 (0.3) [0.3, 0.6]	1.00 (0.99, 1.00)	0.4 (0.0, 1.0)
Left anterior clinoid	31	0.4 (0.3) [0.3, 0.5]	1.00 (0.99, 1.00)	0.4 (0.1, 1.3)
Right anterior clinoid	31	0.5 (0.4) [0.4, 0.7]	1.00 (0.99, 1.00)	0.5 (0.0, 1.5)

n is the number of skulls for which each landmark was located

Mean Diff. is the average distance between average E2 and the True Landmark locations (units are mm)

SD is Standard Deviation (units are mm)

D. Error is Dahlberg's Error (units are mm)

For examiner 2 all landmarks were placed within 0.5mm of the true landmark location (per Dahlberg's error) except for: UL3 cusp tip (0.9mm), UR3 cusp tip (0.7mm), maxillary alveolar crest (0.6mm), anterior palate (0.7mm), left and right zygomaticomaxillary suture (0.6mm, 0.7mm), right anterior gonial angle (0.6mm), left and right gonion (0.8mm, 1.4mm) (Table 5). The ICC for all landmarks was ≥ 0.97 indicating small measurement error relative to variation amongst skulls (Table 5). This means we can trust the outcome of Dahlberg's error and the landmarks listed above lack ideal precision (<0.5 mm).

For examiner 2 all landmarks were accurate according to a Mean Difference $\geq \pm 0.5$ mm except for: UL3 cusp tip (-1.2mm), UR3 cusp tip (-0.8mm), maxillary alveolar crest (-0.7mm), anterior palate (-0.7mm), and right gonion (-1.3mm) (Table 5). The accuracy error for UL3 cusp tip was due to inaccuracy in all 3 planes, with the greatest source being the coronal (-0.9mm)

(Table 5.1). The accuracy error for UR3 cusp tip was due to the inaccuracy in all 3 planes with the greatest source also being the coronal (-0.6mm) (Table 5.2). The accuracy error for Maxillary alveolar crest was largely due to the inaccuracy in the transverse plane (0.9mm) (Table 5.3). The accuracy error for anterior palate was largely due to the inaccuracy in the coronal plane (-0.8mm) (Table 5.4). Finally, the accuracy error for right gonion was due to the inaccuracy in all 3 planes with the greatest source also being the transverse (1.4mm) (Table 5.5). Tables with measurements in each plane for each landmark (E2 vs True Landmark) can be found in Appendix 2.2.

Table 5.1

UL3 Cusp Tip

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	25	-1.2 (0.6) [-1.4, -0.9]	0.99 (0.97, 0.99)	0.9 (0.1, 2.3)
X	25	-0.3 (0.8) [-0.6, 0.1]	0.97 (0.93, 0.99)	0.6 (0.0, 2.1)
Y	25	0.7 (0.4) [0.5, 0.9]	0.99 (0.99, 1.00)	0.6 (0.1, 1.4)
Z	25	-0.9 (0.6) [-1.2, -0.7]	0.99 (0.98, 1.00)	0.8 (0.0, 2.2)

Table 5.2

UL3 Cusp Tip

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	26	-0.8 (0.5) [-1.0, -0.6]	0.99 (0.99, 1.00)	0.7 (0.1, 1.7)
X	26	0.2 (0.7) [0.0, 0.5]	0.96 (0.92, 0.98)	0.5 (0.1, 1.8)
Y	26	0.5 (0.5) [0.3, 0.8]	0.99 (0.99, 1.00)	0.5 (0.1, 1.2)
Z	26	-0.6 (0.4) [-0.8, -0.4]	1.00 (0.99, 1.00)	0.5 (0.0, 1.6)

Table 5.3

Maxillary Alveolar Crest

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	27	-0.7 (0.6) [-0.9, -0.4]	1.00 (0.99, 1.00)	0.6 (0.0, 1.9)
X	27	-0.1 (0.6) [-0.3, 0.2]	0.98 (0.96, 0.99)	0.4 (0.0, 1.3)
Y	27	0.9 (1.0) [0.5, 1.3]	0.99 (0.97, 0.99)	0.9 (0.0, 2.8)
Z	27	-0.3 (0.4) [-0.5, -0.2]	1.00 (1.00, 1.00)	0.4 (0.0, 1.1)

Table 5.4

Anterior Palate

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	29	-0.7 (0.6) [-1.0, -0.5]	0.99 (0.99, 1.00)	0.7 (0.0, 1.8)
X	29	0.1 (0.4) [-0.1, 0.2]	0.98 (0.97, 0.99)	0.3 (0.0, 0.9)
Y	29	0.0 (0.5) [-0.2, 0.2]	1.00 (1.00, 1.00)	0.3 (0.1, 1.2)
Z	29	-0.8 (0.6) [-1.0, -0.5]	0.99 (0.99, 1.00)	0.7 (0.1, 1.7)

Table 5.5

Right Gonion

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	29	-1.3 (1.6) [-1.9, -0.7]	0.97 (0.95, 0.99)	1.4 (0.0, 4.3)
X	29	0.1 (0.7) [-0.2, 0.4]	0.99 (0.97, 0.99)	0.5 (0.0, 1.7)
Y	29	1.4 (1.8) [0.7, 2.1]	0.98 (0.95, 0.99)	1.6 (0.1, 5.4)
Z	29	-0.5 (1.2) [-0.9, 0.0]	0.99 (0.98, 1.00)	0.9 (0.1, 2.6)

Image 16 **Dental: E1 vs E2**

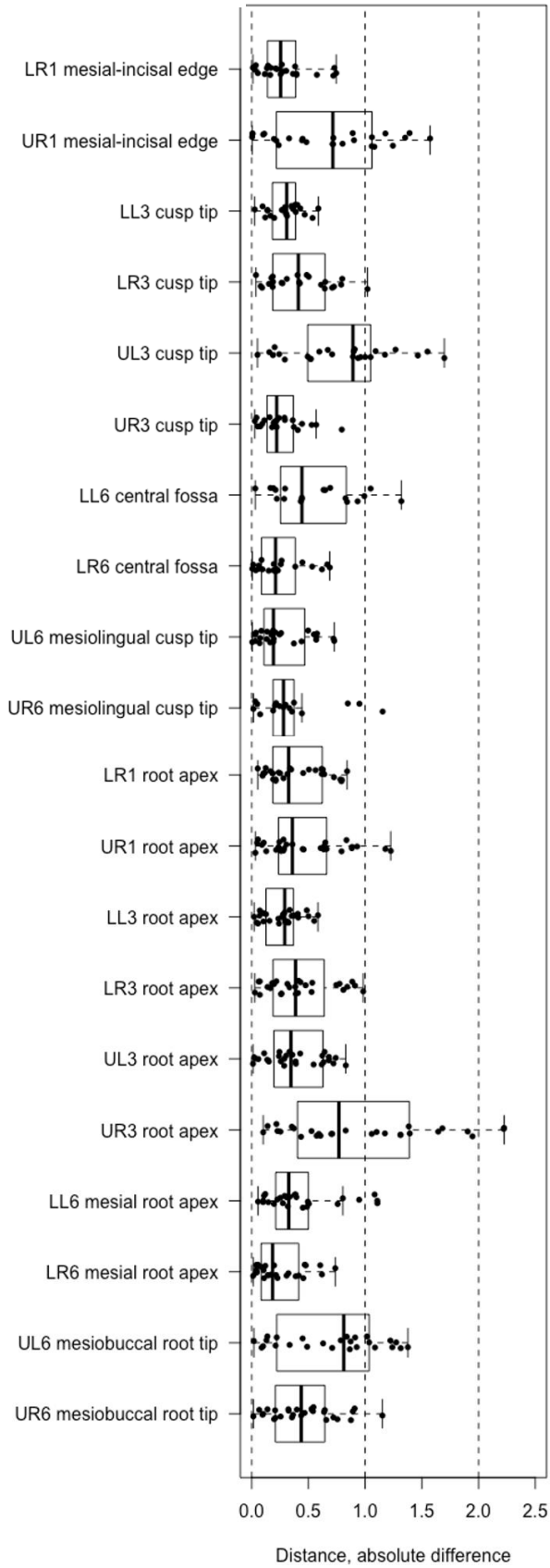


Image 17 **Maxilla: E1 vs E2**

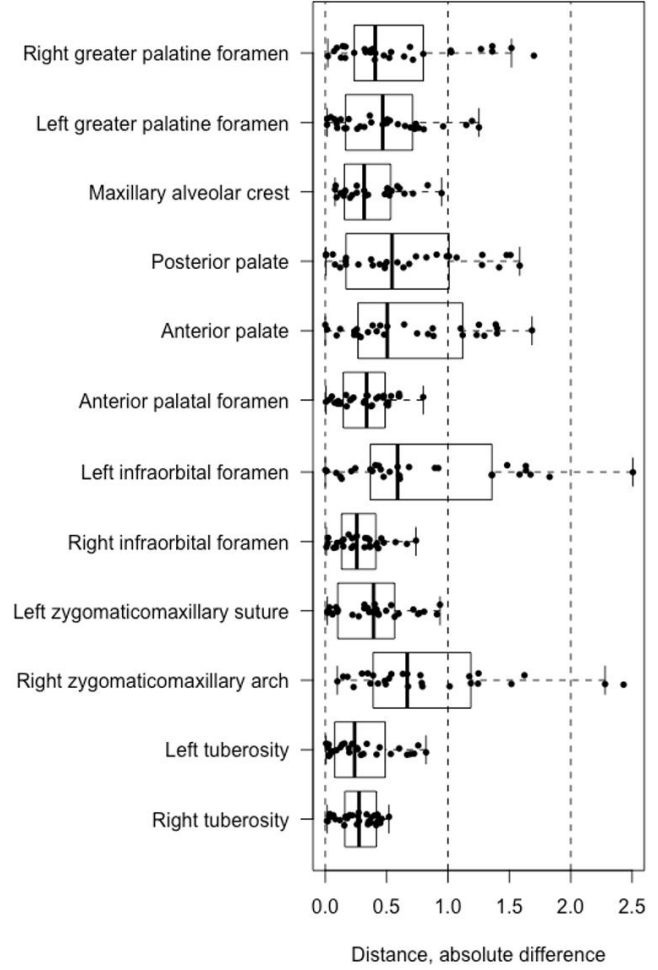


Image 18 **Mandible: E1 vs E2**

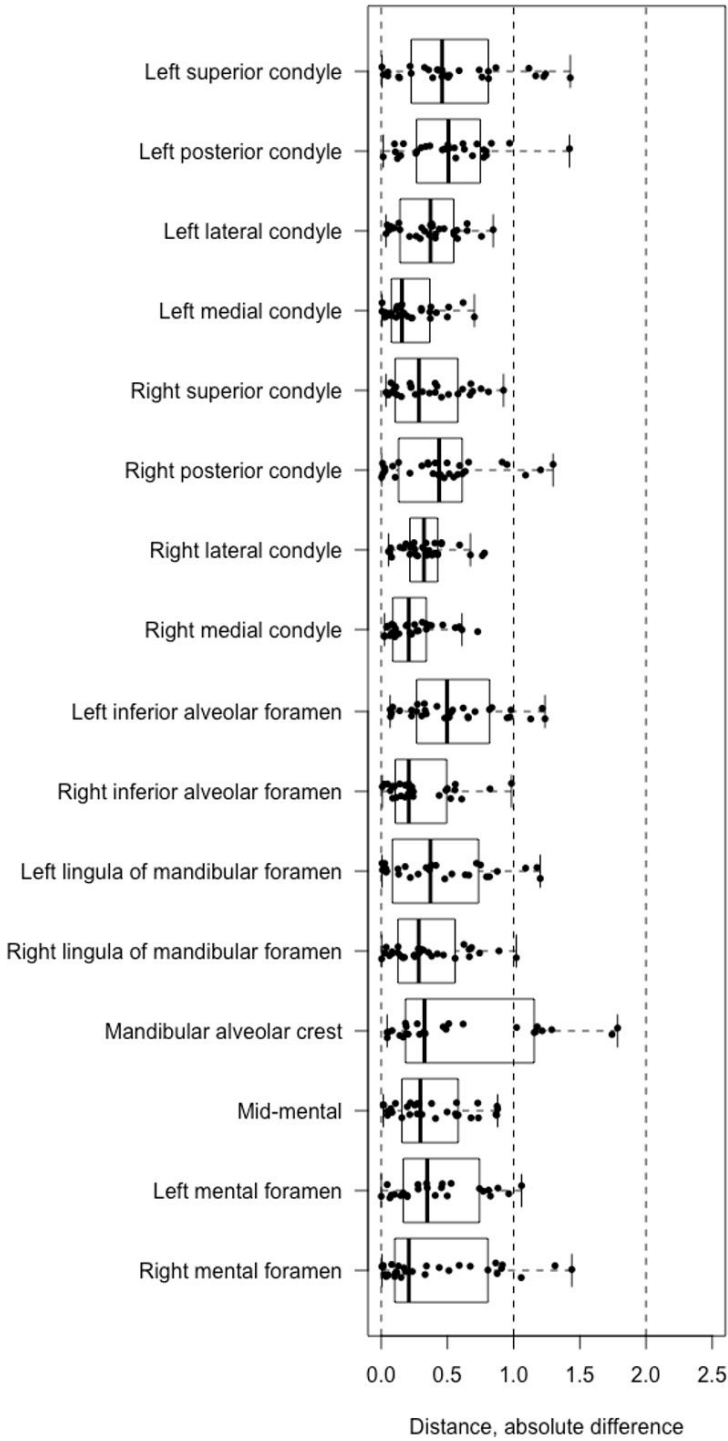


Image 19 **Mandible: E1 vs E2**

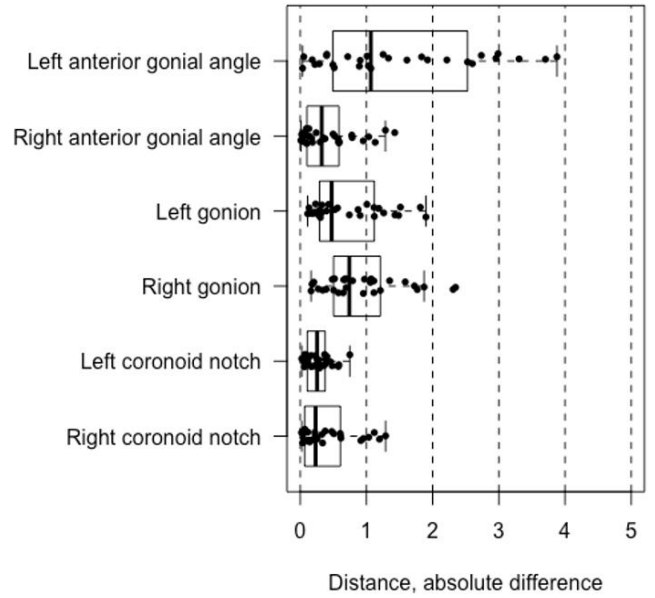


Image 20 **Cranial Base: E1 vs E2**

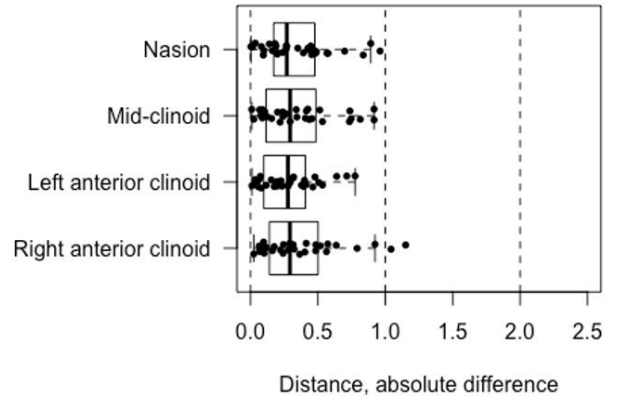


Table 6: Reproducibility for Examiner 1 (E1) and Examiner 2 (E2)

E1 vs E2 Dental: Overall Distance

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
LR1 mesial-incisal edge	21	-0.2 (0.3) [-0.3, 0.0]	1.00 (1.00, 1.00)	0.2 (0.0, 0.7)
UR1 mesial-incisal edge	24	0.0 (0.3) [-0.1, 0.2]	1.00 (1.00, 1.00)	0.2 (0.0, 0.6)
LL3 cusp tip	17	0.1 (0.5) [-0.1, 0.3]	1.00 (1.00, 1.00)	0.3 (0.0, 1.2)
LR3 cusp tip	19	0.2 (0.6) [-0.1, 0.5]	1.00 (0.99, 1.00)	0.5 (0.0, 1.3)
UL3 cusp tip	25	0.8 (0.5) [0.6, 1.0]	0.99 (0.99, 1.00)	0.6 (0.1, 1.7)
UR3 cusp tip	26	0.6 (0.5) [0.4, 0.9]	1.00 (0.99, 1.00)	0.6 (0.0, 1.6)
LL6 central fossa	27	-0.1 (0.4) [-0.2, 0.1]	1.00 (1.00, 1.00)	0.2 (0.0, 0.7)
LR6 central fossa	23	-0.2 (0.3) [-0.3, 0.0]	1.00 (1.00, 1.00)	0.2 (0.0, 0.8)
UL6 mesiolingual cusp tip	24	0.2 (0.4) [0.0, 0.4]	1.00 (1.00, 1.00)	0.4 (0.0, 1.0)
UR6 mesiolingual cusp tip	23	0.2 (0.3) [0.0, 0.3]	1.00 (1.00, 1.00)	0.3 (0.0, 0.7)
LR1 root apex	26	0.0 (0.3) [-0.1, 0.1]	1.00 (1.00, 1.00)	0.2 (0.0, 0.7)
UR1 root apex	29	0.0 (0.3) [-0.1, 0.1]	1.00 (1.00, 1.00)	0.2 (0.0, 0.6)
LL3 root apex	29	0.3 (0.4) [0.2, 0.5]	1.00 (1.00, 1.00)	0.4 (0.0, 1.2)
LR3 root apex	28	0.3 (0.5) [0.1, 0.5]	1.00 (1.00, 1.00)	0.4 (0.1, 1.1)
UL3 root apex	28	0.1 (0.4) [-0.1, 0.3]	1.00 (1.00, 1.00)	0.3 (0.0, 0.8)
UR3 root apex	29	0.1 (0.6) [-0.1, 0.3]	1.00 (1.00, 1.00)	0.4 (0.0, 1.2)
LL6 mesial root apex	26	0.7 (0.5) [0.5, 0.9]	0.99 (0.99, 1.00)	0.6 (0.0, 1.4)
LR6 mesial root apex	28	0.9 (0.7) [0.6, 1.2]	0.99 (0.98, 1.00)	0.8 (0.1, 2.2)
UL6 mesiobuccal root tip	28	-0.1 (0.5) [-0.3, 0.1]	1.00 (1.00, 1.00)	0.4 (0.0, 1.0)
UR6 mesiobuccal root tip	28	0.0 (0.5) [-0.2, 0.2]	1.00 (1.00, 1.00)	0.3 (0.1, 0.8)

E1 vs E2 Maxilla: Overall Distance

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Right greater palatine foramen	29	0.2 (0.8) [-0.1, 0.4]	1.00 (0.99, 1.00)	0.5 (0.0, 1.7)
Left greater palatine foramen	30	0.3 (0.8) [0.0, 0.6]	0.99 (0.99, 1.00)	0.6 (0.0, 1.6)
Maxillary alveolar crest	27	0.1 (0.4) [-0.1, 0.3]	1.00 (1.00, 1.00)	0.3 (0.1, 0.9)
Posterior palate	31	0.0 (0.6) [-0.2, 0.2]	1.00 (0.99, 1.00)	0.4 (0.0, 1.3)
Anterior palate	29	0.5 (0.7) [0.3, 0.8]	1.00 (0.99, 1.00)	0.6 (0.0, 1.7)
Anterior palatal foramen	31	0.1 (0.4) [0.0, 0.3]	1.00 (1.00, 1.00)	0.3 (0.0, 0.8)
Left infraorbital foramen	30	0.2 (0.5) [0.0, 0.4]	1.00 (1.00, 1.00)	0.4 (0.0, 1.2)
Right infraorbital foramen	30	0.3 (0.4) [0.2, 0.5]	1.00 (1.00, 1.00)	0.3 (0.0, 0.9)
Left zygomaticomaxillary suture	29	-0.5 (1.0) [-0.8, -0.1]	0.99 (0.98, 0.99)	0.8 (0.1, 3.0)
Right zygomaticomaxillary suture	29	-0.1 (1.0) [-0.5, 0.3]	0.99 (0.98, 1.00)	0.7 (0.0, 2.5)
Left tuberosity	28	-0.1 (0.4) [-0.3, 0.0]	1.00 (1.00, 1.00)	0.3 (0.0, 0.8)
Right tuberosity	29	-0.1 (0.3) [-0.2, 0.0]	1.00 (1.00, 1.00)	0.2 (0.0, 0.7)

E1 vs E2 Mandible: Overall Distance

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Left superior condyle	30	0.0 (0.4) [-0.2, 0.2]	0.99 (0.98, 0.99)	0.3 (0.0, 0.9)
Left posterior condyle	30	0.1 (0.6) [-0.2, 0.3]	0.99 (0.98, 0.99)	0.4 (0.0, 1.3)
Left lateral condyle	30	0.1 (0.3) [0.0, 0.2]	1.00 (0.99, 1.00)	0.2 (0.0, 0.7)
Left medial condyle	30	-0.2 (0.4) [-0.3, 0.0]	0.99 (0.99, 1.00)	0.3 (0.1, 0.8)
Right superior condyle	29	0.0 (0.7) [-0.2, 0.3]	0.99 (0.97, 0.99)	0.5 (0.0, 1.4)
Right posterior condyle	28	0.0 (0.6) [-0.3, 0.2]	0.99 (0.98, 1.00)	0.4 (0.0, 1.4)
Right lateral condyle	29	0.0 (0.3) [-0.1, 0.2]	1.00 (0.99, 1.00)	0.2 (0.0, 0.7)
Right medial condyle	29	-0.2 (0.4) [-0.3, 0.0]	0.99 (0.99, 1.00)	0.3 (0.0, 0.8)
Left inferior alveolar foramen	30	-0.2 (0.6) [-0.4, 0.0]	1.00 (0.99, 1.00)	0.4 (0.0, 1.4)
Right inferior alveolar foramen	28	-0.1 (0.6) [-0.3, 0.1]	1.00 (0.99, 1.00)	0.4 (0.0, 1.2)
Left lingula	25	-0.2 (0.5) [-0.4, 0.0]	1.00 (0.99, 1.00)	0.4 (0.0, 1.1)
Right lingula	27	-0.1 (0.4) [-0.3, 0.0]	1.00 (1.00, 1.00)	0.3 (0.0, 1.0)
Mandibular alveolar crest	26	-0.4 (0.7) [-0.7, -0.1]	0.99 (0.99, 1.00)	0.6 (0.0, 1.8)
Mid-mental	30	-0.2 (0.4) [-0.3, 0.0]	1.00 (1.00, 1.00)	0.3 (0.0, 1.0)
Left mental foramen	30	-0.1 (0.5) [-0.3, 0.0]	1.00 (1.00, 1.00)	0.3 (0.0, 0.9)
Right mental foramen	30	-0.2 (0.6) [-0.4, 0.0]	1.00 (0.99, 1.00)	0.5 (0.1, 1.2)
Left anterior gonial angle	31	-0.1 (0.6) [-0.3, 0.1]	1.00 (1.00, 1.00)	0.4 (0.0, 1.3)
Right anterior gonial angle	30	0.3 (0.9) [-0.1, 0.6]	1.00 (0.99, 1.00)	0.6 (0.1, 1.9)
Left gonion	30	0.3 (1.1) [-0.1, 0.7]	0.99 (0.98, 1.00)	0.8 (0.2, 2.3)
Right gonion	29	1.4 (1.3) [0.9, 1.9]	0.98 (0.95, 0.99)	1.3 (0.0, 3.9)
Left coronoid notch	31	-0.2 (0.3) [-0.3, -0.1]	1.00 (1.00, 1.00)	0.2 (0.0, 0.7)
Right coronoid notch	31	-0.3 (0.3) [-0.4, -0.2]	1.00 (1.00, 1.00)	0.3 (0.0, 1.0)

E1 vs E2 Cranial Base: Overall Distance

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Nasion	31	0.3 (0.4) [0.1, 0.4]	1.00 (1.00, 1.00)	0.3 (0.0, 0.9)
Mid-clinoid	31	-0.2 (0.3) [-0.3, -0.1]	1.00 (1.00, 1.00)	0.2 (0.0, 0.8)
Left anterior clinoid	31	-0.2 (0.4) [-0.4, -0.1]	1.00 (1.00, 1.00)	0.3 (0.0, 1.2)
Right anterior clinoid	31	-0.3 (0.3) [-0.4, -0.2]	1.00 (1.00, 1.00)	0.3 (0.0, 1.0)

n is the number of skulls for which each landmark was located

Mean Diff. is the average distance between the average E1 and E2 locations (units are mm)

SD is Standard Deviation (units are mm)

D. Error is Dahlberg's Error (units are mm)

Between examiners 1 and 2, all landmarks were placed within 0.5mm of each other (per Dahlberg's error) except for: UL3 cusp tip (0.6mm), UR3 cusp tip (0.6mm), LL6 mesial root apex (0.6mm), LR6 mesial root apex (0.8mm), left greater palatine foramen (0.6mm), anterior palate (0.6mm), left and right zygomaticomaxillary sutures (0.8mm, 0.7mm), mandibular

alveolar crest (0.6mm), right anterior gonial angle (0.6mm), left and right gonion (0.8mm, 1.3mm) (Table 6). The ICC for all landmarks was ≥ 0.98 indicating small measurement error relative to variation amongst skulls (Table 6). This means we can trust the outcome of Dahlberg's error and the landmarks listed above lack ideal precision ($<0.5\text{mm}$).

Between examiners 1 and 2 all landmarks were accurate according to a Mean Difference $\geq \pm 0.5\text{mm}$ except for: UL3 cusp tip (0.8mm), UR3 cusp tip (0.6mm), LL6 mesial root apex (0.7mm), LR6 mesial root apex (0.9mm), and right gonion (1.4mm) (Table 6). The accuracy error for UL3 cusp tip was due to inaccuracy in all 3 planes, with the greatest source being the transverse (-0.7mm) (Table 6.1). Similarly, the accuracy error for UR3 cusp tip was due to inaccuracy in all 3 planes with the greatest source also being the transverse (-0.5mm) (Table 6.2). Next, the accuracy error for LL6 mesial root apex was largely due to the inaccuracy in the transverse plane (-0.9mm) (Table 6.3). The accuracy error for LR6 was due to inaccuracy in all 3 planes, with the greatest source also being in the transverse (-0.9mm) (Table 6.4). Finally, the accuracy error for right gonion was due to the inaccuracy in all 3 planes with the greatest source also being the transverse (-1.3mm) (Table 6.5). Tables with measurements in each plane for each landmark (E1 vs E2) can be found in Appendix 2.3.

Table 6.1
UL3 Cusp Tip

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	25	0.8 (0.5) [0.6, 1.0]	0.99 (0.99, 1.00)	0.6 (0.1, 1.7)
X	25	0.3 (0.5) [0.1, 0.5]	0.98 (0.97, 0.99)	0.4 (0.0, 1.4)
Y	25	-0.7 (0.4) [-0.9, -0.6]	0.99 (0.99, 1.00)	0.6 (0.0, 1.4)
Z	25	0.4 (0.5) [0.3, 0.6]	1.00 (1.00, 1.00)	0.4 (0.1, 1.6)

Table 6.2
UR3 Cusp Tip

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	26	0.6 (0.5) [0.4, 0.9]	1.00 (0.99, 1.00)	0.6 (0.0, 1.6)
X	26	-0.1 (0.5) [-0.3, 0.1]	0.98 (0.96, 0.99)	0.4 (0.0, 1.4)
Y	26	-0.5 (0.5) [-0.7, -0.3]	0.99 (0.98, 1.00)	0.5 (0.1, 1.5)
Z	26	0.4 (0.4) [0.3, 0.6]	1.00 (1.00, 1.00)	0.4 (0.0, 1.3)

Table 6.3
LL6 mesial root apex

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	26	0.7 (0.5) [0.5, 0.9]	0.99 (0.99, 1.00)	0.6 (0.0, 1.4)
X	26	0.2 (0.7) [0.0, 0.6]	0.95 (0.90, 0.98)	0.6 (0.0, 2.0)
Y	26	-0.9 (0.7) [-1.2, -0.6]	0.99 (0.98, 1.00)	0.8 (0.0, 3.0)
Z	26	0.0 (0.5) [-0.2, 0.2]	1.00 (1.00, 1.00)	0.3 (0.0, 1.1)

Table 6.4
LR6 mesial root apex

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	28	0.9 (0.7) [0.6, 1.2]	0.99 (0.98, 1.00)	0.8 (0.1, 2.2)
X	28	-0.7 (0.7) [-1.0, -0.4]	0.95 (0.90, 0.98)	0.7 (0.1, 2.1)
Y	28	-0.9 (0.7) [-1.2, -0.6]	0.99 (0.98, 0.99)	0.8 (0.1, 2.6)
Z	28	0.2 (0.7) [-0.1, 0.4]	1.00 (0.99, 1.00)	0.5 (0.0, 1.6)

Table 6.5
Right gonion

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	29	1.4 (1.3) [0.9, 1.9]	0.98 (0.95, 0.99)	1.3 (0.0, 3.9)
X	29	-0.4 (0.7) [-0.7, -0.2]	0.98 (0.97, 0.99)	0.6 (0.1, 1.9)
Y	29	-1.3 (1.5) [-1.9, -0.7]	0.98 (0.96, 0.99)	1.4 (0.1, 4.8)
Z	29	0.6 (0.8) [0.3, 0.9]	0.99 (0.99, 1.00)	0.7 (0.0, 2.2)

4. DISCUSSION

4.1 AIM 1: DETERMINE LANDMARKS

This study sought to develop a comprehensive list of landmarks for CBCT for orthodontic diagnosis inspired by those previously utilized and studied in the literature, along with innovative, new landmarks. An extensive literature review was performed to identify craniofacial landmarks of orthodontic clinical/diagnostic utility and ease of localization on CBCT. Publications in the areas of orthodontics, craniofacial radiology, and oral maxillofacial surgery were searched for landmarks useful for orthodontic diagnosis, treatment planning, and the evaluation of outcomes.

Numerous studies looked at the identification of traditional cephalometric landmarks on CBCT^{9,13,17-27}. The most reliable were dental landmarks and those in the midsagittal plane.^{14,15}

Therefore, this study selected 20 dental landmarks on crowns and apices of first molars, canines, and central incisors. The mesiolingual cusp tips of the upper first molars along with the central fossa of the mandibular molars were chosen since they articulate in an ideal Class I occlusion, and are landmarks from which a clinician may measure to evaluate for a transverse discrepancy between the dental arches. Canines were chosen for their importance in the stability of the arch form.³⁴ Finally, incisors were included as it is important to be able to evaluate their position and inclination.

Midsagittal landmarks were included for the maxilla, mandible, and cranial base in accordance with this finding. They are as follows: Maxilla— anterior palatal foramen, anterior palate, posterior palate, and maxillary alveolar crest; Mandible—mid-mental, mandibular alveolar crest; Cranial base—mid-clinoid and nasion. However, it was also deemed necessary to include bilateral landmarks in the maxilla and mandible to assess the transverse and bilateral asymmetries. Bilateral landmarks selected are as follows (all left & right): Maxilla—greater palatine foramen, tuberosity, infraorbital foramen, zygomaticomaxillary suture; Mandible—medial, lateral, posterior, and superior condyle, mental foramen, lingula, inferior alveolar foramen, coronoid notch, gonion, and anterior gonial angle.

Systematic reviews also found that cephalometric landmarks with the lowest reliability on CBCT were those on anatomic structures with prominent curvatures without definitive boundaries, such as on the condyle, porion, and orbitale.^{14,15} For landmarks located on a curve, such as on the condyle, gonion, and greater palatine foramen, alternate landmarks were tested to see if there was a more accurate, reliable option for that curved region. Four landmarks were located on each condyle—medial, lateral, posterior, and superior condyle. Anterior condyle was excluded due to it not being able to be acutely defined to one point. In addition to gonion,

anterior gonial angle was included for testing. Greater palatine foramen is a rather ovoid, curved structure and thus the tuberosity was included as an alternative structure since it is also bilateral in the posterior maxilla.

Finally, when selecting cranial base landmarks, it was considered that the anterior cranial base has long been considered a stable reference structure.³⁵ Also, in 2D cephalometric the anterior cranial base is used as a reference to the upper and lower jaws. For this reason, the left and right anterior clinoid processes and nasion, all on the anterior cranial base, were selected. Mid-clinoid was included as a calculated single midpoint structure on the anterior cranial base. It is important to note that with growth the anterior clinoid processes do increase in length, and nasion moves forward leading to an increased length in the cranial base.^{35,36} This should be considered in the future application of these landmarks for skeletal measurements.

4.2 AIM 2: DEFINE LANDMARKS

All landmarks were initially reviewed with a radiologist (Dr. Peggy Lee) and evaluated for feasibility in localization on sample CBCTs. Next, they were given an overall definition. Some prior studies only provided an overall definition for landmarks^{3,9}, while some others provided definitions in each plane.^{22,37} It was determined that not all landmarks needed to be defined in each plane. Rather, definitions were only necessary in planes that would lend to increased accuracy of localization. For example, canines included definitions in the sagittal and transverse, but not the coronal as they are located along a curve and cannot be adequately viewed in the coronal plane.

Intra-rater and inter-rater reliability was run on an initial sample of 4 skulls to calibrate the 2 examiners and make an initial assessment of the landmarks' definitions. For landmarks with less than excellent reliability during the calibration testing (reported in results section 3.1

with data in Appendix 1), the following revisions to definitions were made prior to beginning data collection on all skulls.

For the condylar landmarks, definitions were reviewed and determined to be adequate, so examiners were again calibrated to the definitions. For nasion, most error resulted from the coronal plane so the definition in the coronal was refined, and the examiners were re-calibrated to this definition. For right lingula and right inferior alveolar foramen, it was determined that 1 skull had hardware obscuring these landmarks causing the decreased reliability, so no change in definition was made. For the right and left greater palatine foramen it was determined that these landmarks were inherently difficult to locate so definitions were refined and re-calibrated to, and an alternative set of bilateral posterior maxillary landmarks was added to the list—right and left maxillary tuberosity. Similarly, for left gonion it was determined that this landmark was inherently difficult to locate since it was along a curve, so an alternative set of bilateral landmarks on the angle of the mandible was added—right and left anterior gonial angle. Both examiners were calibrated to the definitions of added landmarks.

4.3 AIM 3: ASSESS ACCURACY AND RELIABILITY OF LANDMARKS

Accuracy and reliability were tested for landmarks and a value of $>0.5\text{mm}$ was considered the threshold for a significant Mean Difference (Mean Diff.) and Dahlberg's Error (D. Error). This threshold was determined since the fiducial markers placed on the true landmark were 0.5mm in size and any measurement $<0.5\text{mm}$ may still be within the marker. This is a relatively strict threshold, as it has previously been suggested that $<1.50\text{mm}$ is a clinically acceptable threshold for digitization error of landmarks on CBCT images.³⁸

All landmarks had good reliability (D. Error $\leq 0.5\text{mm}$) and accuracy (Mean Diff. $>\pm 0.5\text{mm}$) except as described below. Values for Mean Diff, and D. Error reported in

parentheses are the most significant values from E1 vs True, E2 vs True, and E1 vs E2. For all values refer to results in Section 3.

Maxillary canine cusp tips (UL3 and UR3 cusp tip) had decreased reliability (D. Error = 0.9mm and 0.7mm) and accuracy (Mean Diff. = -1.2mm and 0.8mm). The decreased reliability and accuracy for the canines was likely due to wear. Although severely worn canines were excluded, most canines in the sample had some wear, similar to a general population.³⁹ The maxillary canine tips lacked accuracy primarily in the coronal and transverse planes. These landmarks were not defined in the coronal plane due to their location along the curvature of the dental arch and it being difficult to view canines in the coronal as a result. Error in the transverse is likely due to the larger surface area of worn cusp tips. It is important clinically to understand canine relationships (classification, intercanine width, etc), therefore it is advised that this landmark is included in the final comprehensive list of landmarks.

Next, mandibular first molar mesial root apices (LL6 and LR6 apex) had decreased reliability (D. Error = 0.6mm and 0.8mm) and accuracy (Mean Diff. = 0.7mm and 0.9mm). The decreased reliability and accuracy was likely due to the common curvature of these roots making the apices more difficult to locate.⁴⁰ The mandibular first molar mesial root apices lacked accuracy primarily in the transverse plane, as they were identified too superiorly and should be identified more inferiorly. Having a landmark on the apices of lower molars (along with on their crowns) allows clinical evaluation of their tip and torque. This is important to evaluate curve of Wilson and molar uprighting. It is recommended that this landmark is included in the final comprehensive list of landmarks.

The greater palatine foramen had decreased reliability (D. Error = 0.6mm) but had good accuracy. This foramen possesses varying degrees of broad curvature, likely contributing to its

decreased reliability.⁴¹ A bilateral maxillary landmark can inform us clinically about the skeletal transverse (especially with expansion), and potentially be used in conjunction with an anterior maxillary landmark to assess growth. An alternate bilateral maxillary landmark, rather than the greater palatine foramen, would be the maxillary tuberosity which had good reliability and accuracy in this study.

The maxillary alveolar crest had decreased reliability (D. Error = 0.6mm) and accuracy (Mean Diff. = -0.7mm). Similarly, the mandibular alveolar crest lacked ideal reliability (D. Error = 0.6mm) but had good accuracy. The decreased accuracy of the maxillary alveolar crest was primarily in the coronal and transverse planes, as it was measured too inferior and posterior overall. It is important to note that the maxillary and mandibular alveolar crests between the central incisors can vary in thickness and morphology (pointed vs blunted) based on the vertical position and inclination of the incisors, therefore leading to the found decreased reliability and accuracy of this landmark.⁴⁰ It is recommended that these landmarks be excluded from the final list.

The anterior palate landmark had decreased reliability (D. Error = 0.7mm) and accuracy (Mean Diff. = -0.7mm). Decreased accuracy occurred primarily in the coronal plane where it was not defined and could not be adequately viewed. The anterior palate (anterior nasal spine) is formed by the fusion of two bones at the intermaxillary suture. Sometimes this suture lacks fusion at the tip, causing the appearance of 2 tips instead of 1 and decreasing the reliability and accuracy with which this landmark can be located.⁴² However, the anterior palate landmark has the potential to inform clinicians of maxillary anteroposterior length and position, and therefore is recommended to be included in the final comprehensive list of landmarks.

The zygomaticomaxillary sutures (left and right) had decreased reliability (D. Error = 0.6mm, 0.7mm) but good accuracy. These sutures can have variable opacity and density based on the stage of maturation, potentially contributing to the lack of reliability in identifying the inferior aspect as a landmark.⁴³ A bilateral landmark on the anterior superior aspect of the maxilla would be helpful clinically to measure maxillary asymmetries. Rather than utilize the zygomaticomaxillary sutures, it is recommended to use the left and right infraorbital foramen which had good reliability and accuracy. The infraorbital foramina are symmetric bilaterally and therefore useful to measure asymmetry and maxillary vertical height.⁴⁴

The superior and posterior landmarks on the condyle (right side only) were found to have decreased reliability (D. Error = 0.6mm, 0.6mm) but good accuracy. Given together that decreased reliability was not found for the left condyle, the accuracy is good, and the reliability is only 0.1mm off from the ideal 0.5mm, it is recommended that these landmarks are maintained in the final comprehensive list. Although 4 landmarks on each condyle (medial, lateral, posterior, superior) may not be necessary in every patient, for patients with evidence of adverse condylar change, asymmetries, or TMD it would be clinically helpful to diagnose and monitor the condyles.⁴⁵

Finally, gonion (left and right) was found to have decreased reliability (D. Error = 0.8mm, 1.4mm) and accuracy (Mean Diff. = 0.7mm, -1.4mm). This is similar to what prior studies found due to gonion being a point along a gradual curve.^{14,15} Anterior gonial angle was included in this study as alternate landmark on the mandibular angle. Overall this landmark had better reliability and reproducibility, therefore it is recommended to include anterior gonial angle and exclude gonion in the final landmark list. It is important to include a bilateral landmark on the mandibular angle in order to measure mandibular height, length, and asymmetry.

4.4 AIM 4: PRESENT A REFINED COMPREHENSIVE LIST OF LANDMARKS

Overall, most landmarks in this study had good accuracy and reliability and may be utilized in a three-dimensional CBCT orthodontic measurement analysis. Those recommended to be used in the future development of an orthodontic CBCT analysis are as follows: Dental—left/right first molar mesiolingual cusp tips and mesiobuccal root apices, left/right lower first molar central occlusal point and mesial root apices, left/right upper and lower canine cusp tips and apices, right or left upper/lower incisor mesial-incisal edges and apices; Maxilla—anterior palatal foramen, anterior palate, posterior palate, left/right tuberosity, and left/right infraorbital foramen; Mandible—left/right medial, lateral, posterior, and superior condyle, left/right mental foramen and calculated mid-mental, left/right inferior alveolar foramen or left/right lingula, left/right coronoid notch, left/right anterior gonial angle; Cranial Base—left/right anterior clinoid and calculated mid-clinoid, and nasion.

5. CONCLUSION

There are many landmarks with excellent accuracy and reliability on the dentition, maxilla, mandible, and cranial base that can be used in the development of a three-dimensional CBCT measurement analysis for orthodontic diagnosis. Future studies may utilize the landmarks recommended above to develop a measurement analysis and establish normative values for the population.

6. LIMITATIONS

For this study, root apices could not be labeled with fiducial markers and therefore accuracy and reliability could not be measured compared to the true landmark, only between examiners. Next, many skulls had worn dentition to some extent so only teeth with more considerable wear

were excluded. Finally, soft tissue attenuation of facial structures that normally occurs in CBCTs of living human subjects cannot be accounted for with a dry human skull.

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APPENDIX 1: CALIBRATION TESTING

1.1 Intra-Examiner Reliability for Examiner 1

E1 Intra-rater Dental: Overall Distance

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
UR6 mesiolingual cusp tip	0.0 (0.2) [-0.4, 0.3]	1.00 (1.00, 1.00)	0.1 (0.2, 0.2)
UL6 mesiolingual cusp tip	0.2 (0.3) [-0.4, 0.7]	1.00 (0.99, 1.00)	0.2 (0.3, 0.4)
UR6 mesiobuccal root tip	0.2 (0.4) [-0.5, 0.9]	1.00 (0.99, 1.00)	0.3 (0.1, 0.8)
UL6 mesiobuccal root tip	-0.8 (0.4) [-1.5, -0.1]	1.00 (0.97, 1.00)	0.6 (0.1, 1.2)
LR6 central fossa	0.1 (0.2) [-0.2, 0.5]	1.00 (1.00, 1.00)	0.2 (0.1, 0.4)
LL6 central fossa	0.2 (0.2) [-0.2, 0.5]	1.00 (1.00, 1.00)	0.2 (0.1, 0.4)
LR6 mesial root apex	-0.4 (0.5) [-1.3, 0.4]	1.00 (0.97, 1.00)	0.5 (0.1, 1.1)
LL6 mesial root apex	0.1 (0.8) [-1.1, 1.3]	1.00 (0.97, 1.00)	0.5 (0.2, 1.1)
UR3 cusp tip	0.2 (0.6) [-0.6, 1.1]	1.00 (0.99, 1.00)	0.4 (0.1, 0.9)
UL3 cusp tip	0.2 (0.6) [-0.7, 1.1]	1.00 (0.99, 1.00)	0.4 (0.1, 0.8)
UR3 root apex	0.4 (0.3) [-0.1, 0.8]	1.00 (1.00, 1.00)	0.3 (0.0, 0.7)
UL3 root apex	0.0 (1.3) [-2.0, 2.0]	1.00 (0.97, 1.00)	0.8 (0.5, 1.6)
LR3 cusp tip	0.1 (0.5) [-0.7, 0.9]	1.00 (0.99, 1.00)	0.3 (0.1, 0.8)
LL3 cusp tip	0.3 (0.8) [-1.0, 1.7]	1.00 (0.97, 1.00)	0.6 (0.0, 1.6)
LR3 root apex	-0.1 (0.3) [-0.5, 0.4]	1.00 (1.00, 1.00)	0.2 (0.2, 0.4)
LL3 root apex	-0.5 (1.3) [-2.6, 1.6]	0.99 (0.93, 1.00)	0.9 (0.2, 2.3)
UR1 mesial-incisal edge	-0.2 (0.2) [-0.7, 0.3]	1.00 (1.00, 1.00)	0.2 (0.0, 0.4)
UR1 root apex	0.2 (1.0) [-2.3, 2.6]	1.00 (0.98, 1.00)	0.6 (0.4, 1.3)
LR1 mesial-incisal edge	-0.4 (0.2) [-0.8, 0.0]	1.00 (0.99, 1.00)	0.3 (0.1, 0.7)
LR1 root apex	-0.1 (0.8) [-1.4, 1.1]	1.00 (0.98, 1.00)	0.5 (0.3, 1.1)

Maxilla: Overall Distance

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Anterior palatal foramen	2.0 (3.1) [-2.9, 6.9]	0.96 (0.69, 1.00)	2.4 (0.1, 6.6)
Anterior palate	2.0 (4.3) [-4.8, 8.8]	0.96 (0.63, 1.00)	3.0 (0.4, 8.3)
Posterior palate	1.2 (1.8) [-1.7, 4.1]	0.97 (0.72, 1.00)	1.4 (0.5, 3.7)
Maxillary alveolar crest	1.3 (3.2) [-3.8, 6.3]	0.98 (0.78, 1.00)	2.1 (0.3, 6.0)
Left greater palatine foramen	-14.4 (22.2) [-49.7, 20.9]	0.39 (-0.63, 0.94)	17.0 (0.5, 47.2)
Right greater palatine foramen	-14.1 (22.3) [-49.6, 21.4]	0.38 (-0.63, 0.94)	16.9 (0.0, 47.2)
Right zygomaticomaxillary arch	0.4 (4.6) [-6.9, 7.8]	0.94 (0.52, 1.00)	2.9 (0.5, 7.2)
Left zygomaticomaxillary suture	3.3 (4.9) [-4.5, 11.1]	0.89 (0.26, 0.99)	3.8 (0.4, 10.5)

Mandible: Overall Distance

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Right medial condyle	0.0 (0.5) [-0.8, 0.7]	0.77 (-0.13, 0.98)	0.3 (0.1, 0.7)
Right lateral condyle	0.1 (0.6) [-0.8, 1.0]	0.99 (0.92, 1.00)	0.4 (0.3, 0.7)
Right posterior condyle	-0.4 (0.9) [-1.7, 1.0]	0.89 (0.27, 0.99)	0.6 (0.4, 1.1)
Right superior condyle	-0.7 (0.8) [-1.9, 0.5]	0.89 (0.25, 0.99)	0.7 (0.3, 1.6)
Left medial condyle	0.3 (0.6) [-0.6, 1.2]	0.88 (0.24, 0.99)	0.4 (0.0, 1.1)
Left lateral condyle	-0.4 (0.5) [-1.2, 0.5]	0.97 (0.72, 1.00)	0.4 (0.1, 1.1)
Left posterior condyle	0.3 (1.2) [-1.6, 2.2]	0.83 (0.03, 0.99)	0.8 (0.4, 1.4)
Left superior condyle	0.7 (0.6) [-0.2, 1.7]	0.22 (-0.73, 0.92)	0.6 (0.2, 1.6)
Right mental foramen	-0.1 (0.7) [-1.2, 1.0]	1.00 (0.98, 1.00)	0.4 (0.0, 0.8)
Left mental foramen	-0.1 (1.1) [-1.8, 1.6]	0.99 (0.95, 1.00)	0.6 (0.2, 1.5)
Mid-mental	-0.1 (0.7) [-1.3, 1.1]	1.00 (0.97, 1.00)	0.5 (0.4, 1.0)

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Mandibular alveolar crest	-0.2 (0.3) [-0.6, 0.3]	1.00 (1.00, 1.00)	0.2 (0.1, 0.5)
Right lingula	-3.2 (3.7) [-9.1, 2.7]	0.10 (-0.78, 0.90)	3.2 (0.6, 8.6)
Left lingula	0.1 (0.7) [-0.9, 1.2]	0.97 (0.70, 1.00)	0.4 (0.1, 1.1)
Right inferior alveolar foramen	1.1 (0.8) [-0.3, 2.4]	0.95 (0.58, 1.00)	0.9 (0.0, 2.0)
Left inferior alveolar foramen	-0.1 (0.9) [-1.5, 1.4]	0.91 (0.36, 0.99)	0.6 (0.7, 1.0)
Right coronoid notch	-2.2 (5.2) [-10.6, 6.1]	0.80 (-0.05, 0.99)	3.6 (0.1, 10.1)
Left coronoid notch	0.3 (0.4) [-0.3, 1.0]	0.99 (0.91, 1.00)	0.3 (0.2, 0.7)
Right gonion	2.0 (1.3) [0.0, 4.1]	0.84 (0.06, 0.99)	1.6 (0.7, 3.5)
Left gonion	0.9 (0.6) [-0.1, 1.9]	0.93 (0.47, 1.00)	0.8 (0.3, 1.5)

Cranial Base: Overall Distance

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Right anterior clinoid	-2.2 (5.2) [-10.6, 6.1]	0.80 (-0.05, 0.99)	3.6 (0.1, 10.1)
Left anterior clinoid	-2.3 (4.7) [-9.9, 5.2]	0.82 (0.02, 0.99)	3.3 (0.0, 9.4)
Mid-clinoid	-2.6 (5.5) [-11.3, 6.1]	0.83 (0.05, 0.99)	3.8 (0.1, 10.8)
Nasion	-6.8 (14.3) [-29.6, 15.9]	0.61 (-0.41, 0.97)	10.0 (0.2, 28.3)

Dental: Distance in Each Plane

UR6 Mesiolingual cusp tip

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	0.0 (0.2) [-0.4, 0.3]	1.00 (1.00, 1.00)	0.1 (0.2, 0.2)
X	-0.3 (0.9) [-1.8, 1.1]	0.95 (0.60, 1.00)	0.6 (0.2, 1.6)
Y	0.1 (0.4) [-0.5, 0.7]	1.00 (0.98, 1.00)	0.2 (0.0, 0.6)
Z	-0.1 (0.3) [-0.5, 0.4]	1.00 (1.00, 1.00)	0.2 (0.0, 0.4)

UL6 Mesiolingual cusp tip

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	0.2 (0.3) [-0.4, 0.7]	1.00 (0.99, 1.00)	0.2 (0.3, 0.4)
X	0.2 (0.5) [-0.6, 1.1]	0.90 (0.30, 0.99)	0.4 (0.0, 1.0)
Y	0.0 (0.3) [-0.5, 0.4]	1.00 (0.99, 1.00)	0.2 (0.0, 0.4)
Z	0.2 (0.5) [-0.6, 0.9]	1.00 (0.99, 1.00)	0.3 (0.0, 0.6)

UR6 Mesiobuccal root apex

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	0.2 (0.4) [-0.5, 0.9]	1.00 (0.99, 1.00)	0.3 (0.1, 0.8)
X	-0.5 (0.4) [-1.1, 0.2]	0.98 (0.85, 1.00)	0.4 (0.1, 0.8)
Y	0.2 (0.4) [-0.3, 0.8]	1.00 (0.98, 1.00)	0.3 (0.0, 0.6)
Z	0.2 (0.4) [-0.4, 0.7]	1.00 (1.00, 1.00)	0.2 (0.1, 0.6)

UL6 Mesiobuccal root apex

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	-0.8 (0.4) [-1.5, -0.1]	1.00 (0.97, 1.00)	0.6 (0.1, 1.2)
X	0.4 (0.5) [-0.3, 1.1]	0.89 (0.28, 0.99)	0.4 (0.1, 0.8)
Y	0.6 (0.3) [0.1, 1.2]	0.99 (0.94, 1.00)	0.5 (0.3, 1.1)
Z	-0.7 (0.5) [-1.4, 0.1]	1.00 (0.99, 1.00)	0.6 (0.0, 1.1)

LR6 central fossa

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	0.1 (0.2) [-0.2, 0.5]	1.00 (1.00, 1.00)	0.2 (0.1, 0.4)
X	0.2 (0.3) [-0.3, 0.8]	0.99 (0.93, 1.00)	0.3 (0.2, 0.6)

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Y	-0.3 (0.3) [-0.8, 0.2]	1.00 (0.98, 1.00)	0.3 (0.1, 0.6)
Z	0.0 (0.3) [-0.5, 0.5]	1.00 (1.00, 1.00)	0.2 (0.1, 0.4)

LL6 central fossa

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	0.2 (0.2) [-0.2, 0.5]	1.00 (1.00, 1.00)	0.2 (0.1, 0.4)
X	0.1 (0.3) [-0.4, 0.5]	0.99 (0.92, 1.00)	0.2 (0.1, 0.4)
Y	-0.1 (0.2) [-0.4, 0.3]	1.00 (0.99, 1.00)	0.1 (0.0, 0.4)
Z	0.2 (0.3) [-0.3, 0.7]	1.00 (1.00, 1.00)	0.2 (0.1, 0.6)

LR6 mesial root apex

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	-0.4 (0.5) [-1.3, 0.4]	1.00 (0.97, 1.00)	0.5 (0.1, 1.1)
X	-0.1 (0.6) [-1.0, 0.8]	0.99 (0.88, 1.00)	0.4 (0.3, 0.7)
Y	0.1 (0.4) [-0.6, 0.8]	1.00 (0.98, 1.00)	0.3 (0.2, 0.5)
Z	-0.5 (0.8) [-1.7, 0.7]	1.00 (0.98, 1.00)	0.6 (0.3, 1.4)

LL6 mesial root apex

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	0.1 (0.8) [-1.1, 1.3]	1.00 (0.97, 1.00)	0.5 (0.2, 1.1)
X	0.3 (1.0) [-1.3, 1.9]	0.94 (0.55, 1.00)	0.6 (0.4, 1.7)
Y	0.3 (0.6) [-0.6, 1.2]	1.00 (0.95, 1.00)	0.4 (0.0, 1.1)
Z	0.3 (0.5) [-0.4, 1.1]	1.00 (0.99, 1.00)	0.4 (0.2, 1.0)

UR3 cusp tip

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	0.2 (0.6) [-0.6, 1.1]	1.00 (0.99, 1.00)	0.4 (0.1, 0.9)
X	0.3 (0.7) [-0.7, 1.4]	0.97 (0.75, 1.00)	0.5 (0.0, 1.2)
Y	0.2 (0.8) [-1.1, 1.5]	0.99 (0.93, 1.00)	0.5 (0.1, 1.4)
Z	0.6 (0.6) [-0.4, 1.6]	1.00 (0.98, 1.00)	0.6 (0.2, 1.2)

UL3 cusp tip

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	0.2 (0.6) [-0.7, 1.1]	1.00 (0.99, 1.00)	0.4 (0.1, 0.8)
X	-0.1 (0.6) [-1.1, 0.9]	0.85 (0.10, 0.99)	0.4 (0.2, 0.8)
Y	-0.4 (0.5) [-1.2, 0.3]	1.00 (0.96, 1.00)	0.4 (0.0, 1.1)
Z	0.0 (0.4) [-0.7, 0.7]	1.00 (1.00, 1.00)	0.3 (0.2, 0.5)

UR3 root apex

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	0.4 (0.3) [-0.1, 0.8]	1.00 (1.00, 1.00)	0.3 (0.0, 0.7)
X	-0.5 (0.5) [-1.2, 0.3]	0.98 (0.82, 1.00)	0.4 (0.0, 1.0)
Y	-0.4 (0.6) [-1.3, 0.6]	0.99 (0.95, 1.00)	0.5 (0.5, 0.8)
Z	0.1 (0.4) [-0.6, 0.7]	1.00 (1.00, 1.00)	0.3 (0.1, 0.5)

UL3 root apex

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	0.0 (1.3) [-2.0, 2.0]	1.00 (0.97, 1.00)	0.8 (0.5, 1.6)
X	-0.2 (0.5) [-1.0, 0.6]	0.99 (0.88, 1.00)	0.3 (0.2, 0.7)
Y	0.0 (1.1) [-1.7, 1.7]	0.99 (0.90, 1.00)	0.7 (0.5, 1.3)
Z	0.0 (0.8) [-1.3, 1.4]	1.00 (0.99, 1.00)	0.5 (0.4, 1.0)

LR3 cusp tip

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	0.1 (0.5) [-0.7, 0.9]	1.00 (0.99, 1.00)	0.3 (0.1, 0.8)
X	0.0 (0.3) [-0.4, 0.4]	1.00 (0.97, 1.00)	0.2 (0.0, 0.3)
Y	0.4 (0.4) [-0.3, 1.0]	1.00 (0.98, 1.00)	0.4 (0.2, 0.7)
Z	0.3 (0.6) [-0.7, 1.3]	1.00 (0.99, 1.00)	0.5 (0.0, 1.2)

LL3 cusp tip

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	0.3 (0.8) [-1.0, 1.7]	1.00 (0.97, 1.00)	0.6 (0.0, 1.6)
X	0.9 (0.6) [-0.1, 1.8]	0.95 (0.57, 1.00)	0.7 (0.1, 1.4)
Y	-0.6 (0.5) [-1.4, 0.1]	0.99 (0.93, 1.00)	0.5 (0.0, 1.0)
Z	-0.1 (1.1) [-1.8, 1.6]	1.00 (0.98, 1.00)	0.7 (0.4, 1.5)

LR3 root apex

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	-0.1 (0.3) [-0.5, 0.4]	1.00 (1.00, 1.00)	0.2 (0.2, 0.4)
X	-0.2 (0.6) [-1.1, 0.8]	0.99 (0.88, 1.00)	0.4 (0.0, 1.0)
Y	-0.4 (1.3) [-2.5, 1.6]	0.98 (0.84, 1.00)	0.9 (0.1, 2.3)
Z	-0.8 (1.2) [-2.7, 1.1]	1.00 (0.96, 1.00)	0.9 (0.3, 2.5)

LL3 root apex

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	-0.5 (1.3) [-2.6, 1.6]	0.99 (0.93, 1.00)	0.9 (0.2, 2.3)
X	1.3 (3.7) [-4.6, 7.2]	0.68 (-0.31, 0.97)	2.5 (0.3, 6.9)
Y	-0.4 (1.3) [-2.5, 1.7]	0.98 (0.85, 1.00)	0.9 (0.1, 2.4)
Z	-1.4 (1.6) [-4.0, 1.1]	0.99 (0.90, 1.00)	1.4 (0.2, 3.6)

UR1 mesial-incisal edge

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	-0.2 (0.2) [-0.7, 0.3]	1.00 (1.00, 1.00)	0.2 (0.0, 0.4)
X	-0.2 (0.6) [-1.7, 1.3]	0.97 (0.66, 1.00)	0.4 (0.1, 0.8)
Y	0.6 (0.6) [-0.8, 2.0]	0.99 (0.91, 1.00)	0.6 (0.0, 1.1)
Z	0.2 (0.2) [-0.4, 0.7]	1.00 (1.00, 1.00)	0.2 (0.0, 0.4)

UR1 root apex

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	0.2 (1.0) [-2.3, 2.6]	1.00 (0.98, 1.00)	0.6 (0.4, 1.3)
X	-0.2 (0.8) [-2.2, 1.8]	0.93 (0.28, 1.00)	0.5 (0.1, 1.0)
Y	-0.6 (1.2) [-3.5, 2.3]	0.98 (0.77, 1.00)	0.8 (0.3, 1.9)
Z	-0.2 (0.6) [-1.5, 1.2]	1.00 (0.99, 1.00)	0.3 (0.2, 0.7)

LR1 mesial-uncisal edge

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	-0.4 (0.2) [-0.8, 0.0]	1.00 (0.99, 1.00)	0.3 (0.1, 0.7)
X	0.1 (0.4) [-0.6, 0.7]	0.99 (0.92, 1.00)	0.2 (0.2, 0.5)
Y	0.4 (0.3) [-0.2, 0.9]	1.00 (0.98, 1.00)	0.3 (0.0, 0.7)
Z	-0.3 (0.2) [-0.6, 0.1]	1.00 (1.00, 1.00)	0.2 (0.0, 0.5)

LR1 root apex

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	-0.1 (0.8) [-1.4, 1.1]	1.00 (0.98, 1.00)	0.5 (0.3, 1.1)
X	0.0 (0.6) [-1.0, 1.0]	0.98 (0.84, 1.00)	0.4 (0.0, 0.8)

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Y	-0.3 (2.3) [-3.9, 3.4]	0.93 (0.46, 1.00)	1.4 (0.6, 3.2)
Z	-0.3 (0.9) [-1.7, 1.2]	1.00 (0.98, 1.00)	0.6 (0.1, 1.6)

Maxilla: Distance in Each Plane

Anterior palatal foramen

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	2.0 (3.1) [-2.9, 6.9]	0.96 (0.69, 1.00)	2.4 (0.1, 6.6)
X	0.4 (0.4) [-0.3, 1.1]	0.89 (0.29, 0.99)	0.4 (0.0, 1.0)
Y	3.4 (7.4) [-8.5, 15.2]	0.59 (-0.44, 0.97)	5.1 (0.2, 14.5)
Z	3.9 (7.0) [-7.2, 14.9]	0.90 (0.29, 0.99)	5.1 (0.1, 14.3)

Anterior palate

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	2.0 (4.3) [-4.8, 8.8]	0.96 (0.63, 1.00)	3.0 (0.4, 8.3)
X	0.5 (0.7) [-0.7, 1.7]	0.75 (-0.18, 0.98)	0.6 (0.0, 1.6)
Y	3.6 (8.0) [-9.1, 16.3]	0.56 (-0.48, 0.96)	5.5 (0.1, 15.6)
Z	3.2 (6.9) [-7.8, 14.3]	0.91 (0.34, 0.99)	4.8 (0.4, 13.6)

Posterior palate

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	1.2 (1.8) [-1.7, 4.1]	0.97 (0.72, 1.00)	1.4 (0.5, 3.7)
X	-0.2 (0.3) [-0.7, 0.2]	0.93 (0.47, 1.00)	0.3 (0.2, 0.4)
Y	3.0 (6.6) [-7.5, 13.5]	0.26 (-0.71, 0.92)	4.6 (0.9, 12.8)
Z	3.8 (7.3) [-7.9, 15.4]	0.87 (0.19, 0.99)	5.2 (0.1, 14.7)

Maxillary alveolar crest

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	1.3 (3.2) [-3.8, 6.3]	0.98 (0.78, 1.00)	2.1 (0.3, 6.0)
X	0.1 (0.6) [-0.9, 1.1]	0.92 (0.39, 0.99)	0.4 (0.1, 1.0)
Y	2.8 (5.9) [-6.6, 12.1]	0.63 (-0.38, 0.97)	4.1 (0.1, 11.5)
Z	2.9 (6.5) [-7.4, 13.2]	0.92 (0.42, 0.99)	4.5 (0.2, 12.6)

Left greater palatine foramen

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	-14.4 (22.2) [-49.7, 20.9]	0.39 (-0.63, 0.94)	17.0 (0.5, 47.2)
X	-2.0 (3.6) [-7.7, 3.7]	-0.15 (-0.86, 0.84)	2.6 (0.6, 7.3)
Y	15.8 (27.7) [-28.3, 59.8]	-0.18 (-0.87, 0.83)	20.3 (0.1, 57.1)
Z	-5.6 (6.2) [-15.5, 4.3]	0.91 (0.37, 0.99)	5.5 (0.5, 13.5)

Right greater palatine foramen

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	-14.1 (22.3) [-49.6, 21.4]	0.38 (-0.63, 0.94)	16.9 (0.0, 47.2)
X	2.7 (4.4) [-4.3, 9.7]	0.10 (-0.78, 0.90)	3.3 (0.1, 9.2)
Y	15.8 (27.7) [-28.2, 59.8]	-0.18 (-0.87, 0.83)	20.3 (0.1, 57.1)
Z	-4.8 (5.5) [-13.5, 3.9]	0.93 (0.46, 1.00)	4.8 (0.1, 12.4)

Right zygomaticomaxillary arch

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	0.4 (4.6) [-6.9, 7.8]	0.94 (0.52, 1.00)	2.9 (0.5, 7.2)

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
X	0.3 (0.9) [-1.1, 1.8]	0.97 (0.74, 1.00)	0.6 (0.3, 1.1)
Y	3.6 (6.6) [-6.8, 14.1]	0.01 (-0.81, 0.88)	4.8 (0.2, 13.5)
Z	2.3 (8.7) [-11.6, 16.2]	0.87 (0.19, 0.99)	5.6 (0.0, 15.2)

Left zygomaticomaxillary suture

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	3.3 (4.9) [-4.5, 11.1]	0.89 (0.26, 0.99)	3.8 (0.4, 10.5)
X	-0.8 (1.2) [-2.7, 1.2]	0.58 (-0.46, 0.97)	0.9 (0.2, 2.4)
Y	1.5 (5.5) [-7.3, 10.2]	0.17 (-0.75, 0.91)	3.5 (0.9, 9.7)
Z	5.3 (8.3) [-7.8, 18.4]	0.87 (0.16, 0.99)	6.3 (1.2, 17.4)

Mandible: Distance in Each Plane

Right medial condyle

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	0.0 (0.5) [-0.8, 0.7]	0.77 (-0.13, 0.98)	0.3 (0.1, 0.7)
X	0.1 (0.3) [-0.4, 0.5]	1.00 (0.97, 1.00)	0.2 (0.0, 0.3)
Y	0.2 (0.8) [-1.1, 1.5]	0.99 (0.91, 1.00)	0.5 (0.0, 1.2)
Z	0.5 (1.0) [-1.1, 2.1]	1.00 (0.97, 1.00)	0.7 (0.2, 1.9)

Right lateral condyle

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	0.1 (0.6) [-0.8, 1.0]	0.99 (0.92, 1.00)	0.4 (0.3, 0.7)
X	-0.1 (0.5) [-0.9, 0.7]	1.00 (0.95, 1.00)	0.3 (0.0, 0.8)
Y	-0.1 (0.8) [-1.4, 1.1]	0.98 (0.85, 1.00)	0.5 (0.1, 1.1)
Z	0.5 (1.1) [-1.3, 2.3]	1.00 (0.96, 1.00)	0.8 (0.1, 2.0)

Right posterior condyle

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	-0.4 (0.9) [-1.7, 1.0]	0.89 (0.27, 0.99)	0.6 (0.4, 1.1)
X	0.2 (0.9) [-1.2, 1.5]	0.97 (0.77, 1.00)	0.5 (0.1, 1.0)
Y	0.4 (0.6) [-0.6, 1.4]	0.99 (0.91, 1.00)	0.5 (0.1, 1.3)
Z	0.2 (0.5) [-0.5, 1.0]	1.00 (0.99, 1.00)	0.3 (0.2, 0.8)

Right superior condyle

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	-0.7 (0.8) [-1.9, 0.5]	0.89 (0.25, 0.99)	0.7 (0.3, 1.6)
X	0.8 (0.7) [-0.4, 1.9]	0.95 (0.61, 1.00)	0.7 (0.2, 1.5)
Y	-0.3 (0.3) [-0.7, 0.1]	1.00 (0.96, 1.00)	0.3 (0.1, 0.5)
Z	-0.2 (0.5) [-1.0, 0.6]	1.00 (0.99, 1.00)	0.3 (0.1, 0.9)

Left medial condyle

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	0.3 (0.6) [-0.6, 1.2]	0.88 (0.24, 0.99)	0.4 (0.0, 1.1)
X	0.0 (0.5) [-0.9, 0.8]	0.96 (0.68, 1.00)	0.3 (0.1, 0.6)
Y	-0.4 (0.5) [-1.2, 0.3]	0.99 (0.90, 1.00)	0.4 (0.0, 1.0)
Z	0.2 (0.8) [-1.0, 1.4]	1.00 (0.99, 1.00)	0.5 (0.4, 1.1)

Left lateral condyle

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	-0.4 (0.5) [-1.2, 0.5]	0.97 (0.72, 1.00)	0.4 (0.1, 1.1)

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
X	-0.2 (0.3) [-0.6, 0.2]	0.99 (0.95, 1.00)	0.2 (0.0, 0.6)
Y	0.5 (0.8) [-0.7, 1.7]	0.97 (0.71, 1.00)	0.6 (0.0, 1.6)
Z	0.2 (0.4) [-0.4, 0.8]	1.00 (1.00, 1.00)	0.3 (0.1, 0.5)

Left posterior condyle

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	0.3 (1.2) [-1.6, 2.2]	0.83 (0.03, 0.99)	0.8 (0.4, 1.4)
X	0.4 (1.0) [-1.3, 2.0]	0.89 (0.27, 0.99)	0.7 (0.4, 1.5)
Y	0.1 (0.9) [-1.4, 1.5]	0.98 (0.79, 1.00)	0.6 (0.0, 1.1)
Z	0.0 (0.5) [-0.8, 0.8]	1.00 (1.00, 1.00)	0.3 (0.1, 0.7)

Left superior condyle

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	0.7 (0.6) [-0.2, 1.7]	0.22 (-0.73, 0.92)	0.6 (0.2, 1.6)
X	0.7 (0.6) [-0.2, 1.7]	0.84 (0.08, 0.99)	0.6 (0.3, 1.6)
Y	-0.1 (0.3) [-0.6, 0.3]	1.00 (0.96, 1.00)	0.2 (0.0, 0.4)
Z	0.5 (0.1) [0.4, 0.6]	1.00 (0.99, 1.00)	0.4 (0.4, 0.6)

Right mental foramen

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	-0.1 (0.7) [-1.2, 1.0]	1.00 (0.98, 1.00)	0.4 (0.0, 0.8)
X	0.4 (0.3) [-0.1, 0.9]	0.99 (0.94, 1.00)	0.3 (0.1, 0.8)
Y	0.1 (0.7) [-1.0, 1.1]	1.00 (0.97, 1.00)	0.4 (0.1, 0.8)
Z	0.1 (0.4) [-0.6, 0.7]	1.00 (1.00, 1.00)	0.3 (0.1, 0.5)

Left mental foramen

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	-0.1 (1.1) [-1.8, 1.6]	0.99 (0.95, 1.00)	0.6 (0.2, 1.5)
X	0.2 (1.1) [-1.5, 2.0]	0.90 (0.33, 0.99)	0.7 (0.7, 1.4)
Y	-0.2 (1.3) [-2.2, 1.8]	0.99 (0.87, 1.00)	0.8 (0.1, 2.0)
Z	-0.3 (0.3) [-0.8, 0.2]	1.00 (1.00, 1.00)	0.3 (0.1, 0.8)

Mid-mental

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	-0.1 (0.7) [-1.3, 1.1]	1.00 (0.97, 1.00)	0.5 (0.4, 1.0)
X	0.3 (0.5) [-0.5, 1.2]	0.98 (0.85, 1.00)	0.4 (0.0, 0.9)
Y	-0.1 (0.9) [-1.5, 1.4]	0.99 (0.94, 1.00)	0.6 (0.2, 1.4)
Z	-0.1 (0.3) [-0.6, 0.4]	1.00 (1.00, 1.00)	0.2 (0.1, 0.5)

Mandibular alveolar crest

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	-0.2 (0.3) [-0.6, 0.3]	1.00 (1.00, 1.00)	0.2 (0.1, 0.5)
X	0.0 (0.3) [-0.5, 0.6]	0.99 (0.95, 1.00)	0.2 (0.2, 0.4)
Y	0.0 (0.6) [-0.9, 0.9]	1.00 (0.95, 1.00)	0.4 (0.1, 0.8)
Z	-0.2 (0.4) [-0.8, 0.4]	1.00 (1.00, 1.00)	0.3 (0.0, 0.7)

Right lingula

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	-3.2 (3.7) [-9.1, 2.7]	0.10 (-0.78, 0.90)	3.2 (0.6, 8.6)
X	1.0 (0.9) [-0.4, 2.4]	0.93 (0.48, 1.00)	0.9 (0.1, 2.0)
Y	3.0 (4.3) [-3.8, 9.8]	0.51 (-0.53, 0.96)	3.4 (0.8, 9.1)

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Z	-0.6 (1.0) [-2.2, 0.9]	1.00 (0.97, 1.00)	0.8 (0.2, 1.6)

Left lingula

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	0.1 (0.7) [-0.9, 1.2]	0.97 (0.70, 1.00)	0.4 (0.1, 1.1)
X	-0.1 (0.5) [-0.8, 0.6]	0.98 (0.78, 1.00)	0.3 (0.0, 0.6)
Y	-0.2 (0.9) [-1.7, 1.3]	0.98 (0.84, 1.00)	0.6 (0.3, 1.4)
Z	0.2 (0.8) [-1.1, 1.5]	1.00 (0.98, 1.00)	0.5 (0.1, 1.1)

Right inferior alveolar foramen

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	1.1 (0.8) [-0.3, 2.4]	0.95 (0.58, 1.00)	0.9 (0.0, 2.0)
X	0.0 (0.5) [-0.7, 0.8]	1.00 (0.96, 1.00)	0.3 (0.2, 0.5)
Y	-1.3 (0.6) [-2.2, -0.3]	0.96 (0.66, 1.00)	1.0 (0.5, 1.9)
Z	0.4 (2.3) [-3.3, 4.1]	0.99 (0.87, 1.00)	1.4 (1.4, 2.8)

Left inferior alveolar foramen

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	-0.1 (0.9) [-1.5, 1.4]	0.91 (0.36, 0.99)	0.6 (0.7, 1.0)
X	0.2 (0.2) [-0.1, 0.5]	0.99 (0.92, 1.00)	0.2 (0.1, 0.4)
Y	0.2 (0.9) [-1.2, 1.7]	0.96 (0.66, 1.00)	0.6 (0.5, 1.2)
Z	-0.1 (1.1) [-1.8, 1.6]	1.00 (0.97, 1.00)	0.7 (0.4, 1.2)

Right coronoid notch

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	0.3 (0.4) [-0.3, 0.9]	1.00 (0.96, 1.00)	0.3 (0.2, 0.8)
X	-0.3 (0.3) [-0.8, 0.1]	1.00 (0.96, 1.00)	0.3 (0.1, 0.7)
Y	0.2 (0.3) [-0.3, 0.7]	0.99 (0.95, 1.00)	0.2 (0.1, 0.5)
Z	0.3 (0.5) [-0.5, 1.1]	1.00 (0.99, 1.00)	0.4 (0.1, 1.0)

Left coronoid notch

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	0.3 (0.4) [-0.3, 1.0]	0.99 (0.91, 1.00)	0.3 (0.2, 0.7)
X	0.6 (0.4) [0.1, 1.2]	0.97 (0.77, 1.00)	0.5 (0.3, 1.0)
Y	0.2 (0.3) [-0.2, 0.7]	0.99 (0.91, 1.00)	0.3 (0.1, 0.6)
Z	-0.2 (0.4) [-0.9, 0.4]	1.00 (1.00, 1.00)	0.3 (0.1, 0.8)

Right gonion

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	2.0 (1.3) [0.0, 4.1]	0.84 (0.06, 0.99)	1.6 (0.7, 3.5)
X	-0.8 (0.6) [-1.8, 0.1]	0.97 (0.76, 1.00)	0.7 (0.0, 1.2)
Y	-1.7 (1.4) [-3.9, 0.5]	0.95 (0.59, 1.00)	1.5 (0.1, 3.4)
Z	1.5 (1.4) [-0.8, 3.8]	0.98 (0.85, 1.00)	1.4 (0.4, 3.5)

Left gonion

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	0.9 (0.6) [-0.1, 1.9]	0.93 (0.47, 1.00)	0.8 (0.3, 1.5)
X	0.5 (1.5) [-1.9, 2.9]	0.45 (-0.58, 0.95)	1.0 (0.9, 1.7)
Y	-0.7 (0.9) [-2.2, 0.8]	0.98 (0.82, 1.00)	0.8 (0.6, 1.6)
Z	0.7 (0.6) [-0.2, 1.6]	1.00 (0.97, 1.00)	0.6 (0.1, 1.1)

Cranial base: Distance in Each Plane

Right anterior clinoid

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	-2.2 (5.2) [-10.6, 6.1]	0.80 (-0.05, 0.99)	3.6 (0.1, 10.1)
X	0.7 (2.3) [-3.0, 4.3]	0.14 (-0.76, 0.91)	1.5 (0.1, 4.0)
Y	-1.1 (2.4) [-4.9, 2.7]	0.71 (-0.26, 0.98)	1.6 (0.4, 4.6)
Z	-5.9 (11.6) [-24.4, 12.5]	0.74 (-0.20, 0.98)	8.2 (0.0, 23.3)

Left anterior clinoid

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	-2.3 (4.7) [-9.9, 5.2]	0.82 (0.02, 0.99)	3.3 (0.0, 9.4)
X	-0.4 (0.9) [-1.8, 0.9]	0.82 (0.01, 0.99)	0.6 (0.1, 1.7)
Y	-0.7 (1.3) [-2.7, 1.3]	0.80 (-0.06, 0.99)	0.9 (0.0, 2.5)
Z	-5.8 (12.0) [-24.9, 13.2]	0.73 (-0.22, 0.98)	8.4 (0.1, 23.8)

Mid-clinoid

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	-2.6 (5.5) [-11.3, 6.1]	0.83 (0.05, 0.99)	3.8 (0.1, 10.8)
X	0.1 (0.7) [-1.1, 1.3]	0.82 (0.00, 0.99)	0.5 (0.0, 1.2)
Y	-0.9 (1.8) [-3.8, 2.0]	0.75 (-0.18, 0.98)	1.3 (0.2, 3.6)
Z	-5.9 (11.8) [-24.6, 12.9]	0.73 (-0.21, 0.98)	8.3 (0.1, 23.6)

Nasion

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	-6.8 (14.3) [-29.6, 15.9]	0.61 (-0.41, 0.97)	10.0 (0.2, 28.3)
X	0.2 (0.5) [-0.6, 1.0]	0.92 (0.41, 0.99)	0.4 (0.1, 0.7)
Y	1.1 (1.5) [-1.4, 3.5]	0.64 (-0.37, 0.97)	1.2 (0.0, 3.3)
Z	-7.2 (14.9) [-31.0, 16.5]	0.59 (-0.44, 0.97)	10.5 (0.1, 29.6)

1.2 Intra-Examiner Reliability for Examiner 2

Dental: Overall Distance

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
UR6 mesiolingual cusp tip	0.4 (0.5) [-0.3, 1.2]	1.00 (0.98, 1.00)	0.4 (0.1, 1.0)
UL6 mesiolingual cusp tip	0.3 (0.4) [-0.3, 0.8]	1.00 (0.99, 1.00)	0.3 (0.0, 0.8)
UR6 mesiobuccal root tip	-0.3 (0.4) [-0.9, 0.3]	1.00 (0.99, 1.00)	0.3 (0.1, 0.7)
UL6 mesiobuccal root tip	0.3 (0.3) [-0.2, 0.8]	1.00 (0.99, 1.00)	0.3 (0.0, 0.7)
LR6 central fossa	-0.2 (0.5) [-1.0, 0.5]	1.00 (0.99, 1.00)	0.3 (0.2, 0.7)
LL6 central fossa	0.5 (0.2) [0.1, 0.9]	1.00 (0.98, 1.00)	0.4 (0.2, 0.8)
LR6 mesial root apex	0.7 (1.6) [-1.9, 3.2]	0.98 (0.85, 1.00)	1.1 (0.3, 2.5)
LL6 mesial root apex	0.1 (1.2) [-1.7, 2.0]	0.99 (0.92, 1.00)	0.7 (0.4, 1.3)
UR3 cusp tip	-0.2 (1.0) [-1.7, 1.3]	1.00 (0.97, 1.00)	0.6 (0.0, 1.5)
UL3 cusp tip	5.1 (6.9) [-5.8, 16.0]	0.80 (-0.06, 0.99)	5.5 (0.1, 14.4)
UR3 root apex	-5.6 (9.6) [-20.9, 9.7]	0.81 (-0.03, 0.99)	7.1 (0.1, 19.9)
UL3 root apex	-0.3 (0.9) [-1.7, 1.1]	1.00 (0.98, 1.00)	0.6 (0.2, 1.2)
LR3 cusp tip	0.9 (1.8) [-1.9, 3.7]	0.99 (0.89, 1.00)	1.3 (0.0, 3.0)
LL3 cusp tip	-1.4 (3.1) [-6.3, 3.6]	0.95 (0.61, 1.00)	2.1 (0.2, 6.0)
LR3 root apex	-0.4 (1.5) [-2.8, 2.0]	0.99 (0.92, 1.00)	1.0 (0.1, 2.6)

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
LL3 root apex	0.5 (1.0) [-1.0, 2.1]	1.00 (0.96, 1.00)	0.7 (0.2, 1.7)
UR1 mesial-uncisal edge	0.2 (0.5) [-1.1, 1.5]	1.00 (0.99, 1.00)	0.3 (0.4, 0.5)
UR1 root apex	0.1 (0.9) [-2.2, 2.4]	1.00 (0.98, 1.00)	0.5 (0.4, 0.9)
LR1 mesial-uncisal edge	0.3 (0.5) [-0.5, 1.1]	1.00 (0.99, 1.00)	0.4 (0.1, 0.9)
LR1 root apex	-0.2 (0.1) [-0.5, 0.0]	1.00 (1.00, 1.00)	0.2 (0.1, 0.4)

Maxilla: Overall Distance

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Anterior palatal foramen	0.0 (1.1) [-1.7, 1.7]	1.00 (0.97, 1.00)	0.7 (0.4, 1.4)
Anterior palate	0.2 (0.6) [-0.8, 1.1]	1.00 (0.99, 1.00)	0.4 (0.3, 0.7)
Posterior palate	0.1 (0.6) [-0.8, 1.0]	1.00 (0.98, 1.00)	0.4 (0.3, 0.8)
Maxillary alveolar crest	0.8 (0.9) [-0.5, 2.2]	1.00 (0.97, 1.00)	0.8 (0.3, 1.6)
Left greater palatine foramen	1.1 (2.4) [-2.6, 4.9]	0.97 (0.73, 1.00)	1.7 (0.0, 4.3)
Right greater palatine foramen	0.5 (1.7) [-2.1, 3.2]	0.98 (0.86, 1.00)	1.1 (0.2, 2.5)
Right zygomaticomaxillary arch	-0.8 (0.3) [-1.3, -0.3]	1.00 (0.97, 1.00)	0.6 (0.6, 1.3)
Left zygomaticomaxillary suture	-0.2 (2.9) [-4.8, 4.5]	0.97 (0.75, 1.00)	1.8 (0.2, 3.9)

Mandible: Overall Distance

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Right medial condyle	0.6 (1.2) [-1.3, 2.5]	0.72 (-0.23, 0.98)	0.9 (0.3, 2.4)
Right lateral condyle	-0.2 (0.4) [-0.9, 0.5]	1.00 (0.96, 1.00)	0.3 (0.1, 0.6)
Right posterior condyle	-1.0 (0.7) [-2.1, 0.2]	0.85 (0.10, 0.99)	0.8 (0.4, 1.8)
Right superior condyle	0.8 (0.7) [-0.3, 1.9]	0.60 (-0.43, 0.97)	0.7 (0.1, 1.6)
Left medial condyle	0.4 (0.9) [-1.1, 1.8]	0.89 (0.27, 0.99)	0.6 (0.4, 1.2)
Left lateral condyle	0.0 (0.5) [-0.8, 0.9]	0.98 (0.83, 1.00)	0.3 (0.1, 0.8)
Left posterior condyle	0.3 (1.0) [-1.2, 1.8]	0.84 (0.06, 0.99)	0.6 (0.2, 1.8)
Left superior condyle	1.2 (1.3) [-0.9, 3.3]	0.58 (-0.45, 0.97)	1.2 (0.0, 2.6)
Right mental foramen	0.0 (1.3) [-2.1, 2.0]	0.99 (0.92, 1.00)	0.8 (0.3, 2.0)
Left mental foramen	-0.4 (0.4) [-1.0, 0.3]	1.00 (0.98, 1.00)	0.4 (0.2, 0.7)
Mid-mental			
Mandibular alveolar crest	-1.3 (1.4) [-3.4, 0.9]	0.99 (0.87, 1.00)	1.2 (0.3, 3.3)
Right lingula	0.5 (1.1) [-1.3, 2.3]	0.96 (0.65, 1.00)	0.8 (0.2, 2.1)
Left lingula	-0.1 (1.0) [-1.8, 1.5]	0.94 (0.52, 1.00)	0.6 (0.2, 1.6)
Right inferior alveolar foramen	-0.9 (2.7) [-5.2, 3.3]	0.71 (-0.25, 0.98)	1.8 (0.2, 5.0)
Left inferior alveolar foramen	0.4 (1.1) [-1.4, 2.1]	0.92 (0.44, 0.99)	0.7 (0.4, 1.4)
Right coronoid notch	0.2 (0.2) [-0.1, 0.5]	1.00 (0.99, 1.00)	0.2 (0.1, 0.4)
Left coronoid notch	0.0 (1.3) [-2.2, 2.1]	0.96 (0.65, 1.00)	0.8 (0.1, 1.9)
Right gonion	-1.1 (1.8) [-3.9, 1.7]	0.91 (0.35, 0.99)	1.3 (1.4, 2.6)
Left gonion	-2.8 (1.5) [-5.2, -0.4]	0.19 (-0.74, 0.91)	2.2 (1.7, 5.0)

Cranial Base: Overall Distance

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Right anterior clinoid	0.2 (0.2) [-0.1, 0.5]	1.00 (0.99, 1.00)	0.2 (0.1, 0.4)
Left anterior clinoid	-0.1 (0.5) [-0.9, 0.7]	1.00 (0.98, 1.00)	0.3 (0.1, 0.7)
Mid-clinoid			
Nasion	0.3 (0.2) [0.0, 0.6]	1.00 (1.00, 1.00)	0.2 (0.1, 0.6)

Dental: Distance in Each Plane

UR6 Mesiolingual cusp tip

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	0.4 (0.5) [-0.3, 1.2]	1.00 (0.98, 1.00)	0.4 (0.1, 1.0)
X	-0.1 (0.3) [-0.6, 0.4]	0.99 (0.94, 1.00)	0.2 (0.1, 0.5)
Y	-0.4 (0.7) [-1.5, 0.7]	0.99 (0.93, 1.00)	0.5 (0.0, 1.4)
Z	0.3 (0.8) [-1.0, 1.6]	1.00 (0.98, 1.00)	0.5 (0.3, 1.4)

UL6 Mesiolingual cusp tip

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	0.3 (0.4) [-0.3, 0.8]	1.00 (0.99, 1.00)	0.3 (0.0, 0.8)
X	0.0 (0.8) [-1.2, 1.3]	0.80 (-0.04, 0.99)	0.5 (0.1, 1.2)
Y	-0.1 (0.6) [-1.0, 0.8]	1.00 (0.97, 1.00)	0.3 (0.1, 0.7)
Z	0.2 (1.0) [-1.4, 1.7]	1.00 (0.98, 1.00)	0.6 (0.0, 1.6)

UR6 Mesiobuccal root apex

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	-0.3 (0.4) [-0.9, 0.3]	1.00 (0.99, 1.00)	0.3 (0.1, 0.7)
X	1.0 (0.9) [-0.5, 2.4]	0.88 (0.20, 0.99)	0.9 (0.1, 2.1)
Y	0.0 (1.2) [-1.8, 1.9]	0.99 (0.88, 1.00)	0.7 (0.6, 1.7)
Z	0.2 (0.2) [-0.1, 0.5]	1.00 (1.00, 1.00)	0.2 (0.1, 0.3)

UL6 Mesiobuccal root apex

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	0.3 (0.3) [-0.2, 0.8]	1.00 (0.99, 1.00)	0.3 (0.0, 0.7)
X	-0.7 (0.7) [-1.7, 0.4]	0.85 (0.09, 0.99)	0.6 (0.1, 1.6)
Y	-0.4 (0.5) [-1.2, 0.4]	1.00 (0.96, 1.00)	0.4 (0.3, 0.8)
Z	0.4 (0.2) [0.0, 0.8]	1.00 (1.00, 1.00)	0.3 (0.2, 0.7)

LR6 central fossa

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	-0.2 (0.5) [-1.0, 0.5]	1.00 (0.99, 1.00)	0.3 (0.2, 0.7)
X	-0.3 (0.8) [-1.6, 1.0]	0.98 (0.79, 1.00)	0.5 (0.1, 1.4)
Y	0.2 (0.2) [-0.1, 0.6]	1.00 (0.99, 1.00)	0.2 (0.0, 0.4)
Z	-0.2 (0.8) [-1.5, 1.1]	1.00 (0.98, 1.00)	0.5 (0.5, 0.9)

LL6 central fossa

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	0.5 (0.2) [0.1, 0.9]	1.00 (0.98, 1.00)	0.4 (0.2, 0.8)
X	0.8 (1.2) [-1.1, 2.6]	0.77 (-0.14, 0.98)	0.9 (0.2, 2.0)
Y	0.1 (0.3) [-0.4, 0.6]	1.00 (0.99, 1.00)	0.2 (0.2, 0.4)
Z	0.5 (0.6) [-0.4, 1.5]	1.00 (0.99, 1.00)	0.5 (0.3, 0.9)

LR6 mesial root apex

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	0.7 (1.6) [-1.9, 3.2]	0.98 (0.85, 1.00)	1.1 (0.3, 2.5)
X	-0.4 (1.2) [-2.3, 1.5]	0.94 (0.54, 1.00)	0.8 (0.8, 1.4)
Y	-0.3 (1.8) [-3.1, 2.5]	0.96 (0.67, 1.00)	1.1 (0.6, 2.6)
Z	0.4 (1.1) [-1.5, 2.2]	1.00 (0.97, 1.00)	0.7 (0.0, 1.9)

LL6 mesial root apex

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	0.1 (1.2) [-1.7, 2.0]	0.99 (0.92, 1.00)	0.7 (0.4, 1.3)
X	0.6 (1.5) [-1.8, 3.0]	0.91 (0.34, 0.99)	1.0 (0.4, 1.7)
Y	0.3 (0.8) [-1.0, 1.6]	0.99 (0.91, 1.00)	0.5 (0.5, 0.9)
Z	0.3 (0.8) [-1.0, 1.7]	1.00 (0.98, 1.00)	0.6 (0.1, 1.5)

UR3 cusp tip

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	-0.2 (1.0) [-1.7, 1.3]	1.00 (0.97, 1.00)	0.6 (0.0, 1.5)
X	-8.9 (18.8) [-38.7, 21.0]	0.02 (-0.81, 0.88)	13.1 (0.2, 37.0)
Y	0.2 (0.5) [-0.5, 0.9]	1.00 (0.98, 1.00)	0.3 (0.1, 0.7)
Z	-0.4 (1.7) [-3.1, 2.4]	0.99 (0.94, 1.00)	1.1 (0.2, 2.9)

UL3 cusp tip

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	5.1 (6.9) [-5.8, 16.0]	0.80 (-0.06, 0.99)	5.5 (0.1, 14.4)
X	7.8 (17.7) [-20.3, 35.9]	0.05 (-0.80, 0.89)	12.2 (0.1, 34.3)
Y	-5.1 (9.7) [-20.5, 10.4]	-0.04 (-0.83, 0.87)	6.9 (0.1, 19.6)
Z	3.1 (3.7) [-2.7, 8.9]	0.95 (0.62, 1.00)	3.1 (0.3, 7.4)

UR3 root apex

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	-5.6 (9.6) [-20.9, 9.7]	0.81 (-0.03, 0.99)	7.1 (0.1, 19.9)
X	1.1 (2.0) [-2.1, 4.4]	0.84 (0.07, 0.99)	1.5 (0.2, 4.0)
Y	7.1 (11.3) [-10.9, 25.1]	0.42 (-0.60, 0.95)	8.6 (0.1, 23.9)
Z	-2.1 (3.6) [-7.9, 3.7]	0.97 (0.74, 1.00)	2.7 (0.0, 7.5)

UL3 root apex

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	-0.3 (0.9) [-1.7, 1.1]	1.00 (0.98, 1.00)	0.6 (0.2, 1.2)
X	-0.7 (1.4) [-3.0, 1.6]	0.89 (0.24, 0.99)	1.0 (0.2, 2.8)
Y	0.2 (1.1) [-1.5, 1.9]	0.99 (0.87, 1.00)	0.7 (0.1, 1.6)
Z	-0.1 (0.4) [-0.8, 0.6]	1.00 (1.00, 1.00)	0.3 (0.0, 0.5)

LR3 cusp tip

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	0.9 (1.8) [-1.9, 3.7]	0.99 (0.89, 1.00)	1.3 (0.0, 3.0)
X	0.4 (2.5) [-3.5, 4.4]	0.51 (-0.53, 0.96)	1.5 (0.4, 4.1)
Y	-0.1 (0.2) [-0.4, 0.3]	1.00 (1.00, 1.00)	0.1 (0.1, 0.3)
Z	1.3 (3.0) [-3.4, 6.0]	0.98 (0.81, 1.00)	2.0 (0.2, 5.2)

LL3 cusp tip

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	-1.4 (3.1) [-6.3, 3.6]	0.95 (0.61, 1.00)	2.1 (0.2, 6.0)
X	1.3 (1.8) [-1.5, 4.1]	0.56 (-0.48, 0.96)	1.4 (0.1, 3.4)
Y	0.0 (0.5) [-0.8, 0.8]	1.00 (0.98, 1.00)	0.3 (0.0, 0.7)
Z	-1.7 (3.6) [-7.5, 4.0]	0.96 (0.65, 1.00)	2.5 (0.0, 7.1)

LR3 root apex

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	-0.4 (1.5) [-2.8, 2.0]	0.99 (0.92, 1.00)	1.0 (0.1, 2.6)

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
X	0.0 (2.8) [-4.4, 4.5]	0.83 (0.04, 0.99)	1.7 (0.2, 4.0)
Y	-0.7 (1.9) [-3.8, 2.3]	0.96 (0.65, 1.00)	1.3 (0.2, 2.9)
Z	-1.2 (1.5) [-3.6, 1.2]	0.99 (0.93, 1.00)	1.3 (0.4, 3.2)

LL3 root apex

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	0.5 (1.0) [-1.0, 2.1]	1.00 (0.96, 1.00)	0.7 (0.2, 1.7)
X	-0.3 (1.5) [-2.8, 2.2]	0.92 (0.42, 0.99)	1.0 (0.2, 1.8)
Y	0.2 (0.7) [-1.0, 1.3]	0.99 (0.95, 1.00)	0.5 (0.0, 1.2)
Z	0.9 (0.6) [-0.1, 1.9]	1.00 (0.97, 1.00)	0.7 (0.4, 1.8)

UR1 mesial-incisal edge

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	0.2 (0.5) [-1.1, 1.5]	1.00 (0.99, 1.00)	0.3 (0.4, 0.5)
X	-0.1 (0.2) [-0.6, 0.4]	1.00 (0.95, 1.00)	0.1 (0.1, 0.3)
Y	0.2 (0.8) [-1.8, 2.2]	1.00 (0.93, 1.00)	0.5 (0.3, 1.0)
Z	0.3 (0.7) [-1.3, 1.9]	1.00 (0.99, 1.00)	0.4 (0.2, 1.0)

UR1 root apex

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	0.1 (0.9) [-2.2, 2.4]	1.00 (0.98, 1.00)	0.5 (0.4, 0.9)
X	-0.4 (0.5) [-1.6, 0.9]	0.96 (0.55, 1.00)	0.4 (0.1, 0.9)
Y	-0.2 (1.2) [-3.2, 2.8]	0.99 (0.83, 1.00)	0.7 (0.2, 1.4)
Z	0.1 (0.7) [-1.7, 1.8]	1.00 (0.99, 1.00)	0.4 (0.0, 0.8)

LR1 mesial-uncisal edge

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	0.3 (0.5) [-0.5, 1.1]	1.00 (0.99, 1.00)	0.4 (0.1, 0.9)
X	-0.1 (0.2) [-0.4, 0.2]	1.00 (0.97, 1.00)	0.2 (0.0, 0.4)
Y	0.0 (0.3) [-0.5, 0.4]	1.00 (0.99, 1.00)	0.2 (0.1, 0.4)
Z	0.3 (0.4) [-0.4, 1.0]	1.00 (0.99, 1.00)	0.3 (0.0, 0.9)

LR1 root apex

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	-0.2 (0.1) [-0.5, 0.0]	1.00 (1.00, 1.00)	0.2 (0.1, 0.4)
X	0.3 (0.2) [0.0, 0.7]	0.99 (0.94, 1.00)	0.3 (0.1, 0.5)
Y	0.1 (0.4) [-0.5, 0.7]	1.00 (0.99, 1.00)	0.2 (0.1, 0.5)
Z	-0.2 (0.6) [-1.2, 0.7]	1.00 (0.99, 1.00)	0.4 (0.1, 0.9)

Maxilla: Distance in Each Plane

Anterior palatal foramen

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	0.0 (1.1) [-1.7, 1.7]	1.00 (0.97, 1.00)	0.7 (0.4, 1.4)
X	-0.1 (0.1) [-0.2, 0.0]	0.99 (0.94, 1.00)	0.1 (0.0, 0.2)
Y	-0.1 (1.2) [-2.0, 1.8]	0.99 (0.91, 1.00)	0.7 (0.5, 1.6)
Z	0.0 (0.5) [-0.9, 0.8]	1.00 (0.99, 1.00)	0.3 (0.2, 0.6)

Anterior palate

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	0.2 (0.6) [-0.8, 1.1]	1.00 (0.99, 1.00)	0.4 (0.3, 0.7)

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
X	0.2 (0.3) [-0.2, 0.6]	0.97 (0.75, 1.00)	0.2 (0.0, 0.6)
Y	-0.2 (0.4) [-0.8, 0.4]	1.00 (0.99, 1.00)	0.3 (0.1, 0.6)
Z	0.1 (0.6) [-0.8, 1.0]	1.00 (0.99, 1.00)	0.4 (0.3, 0.7)

Posterior palate

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	0.1 (0.6) [-0.8, 1.0]	1.00 (0.98, 1.00)	0.4 (0.3, 0.8)
X	0.3 (0.5) [-0.5, 1.1]	0.85 (0.10, 0.99)	0.4 (0.4, 0.8)
Y	-0.1 (0.9) [-1.4, 1.3]	0.99 (0.90, 1.00)	0.5 (0.0, 1.3)
Z	0.0 (0.6) [-1.0, 1.0]	1.00 (0.99, 1.00)	0.4 (0.2, 0.8)

Maxillary alveolar crest

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	0.8 (0.9) [-0.5, 2.2]	1.00 (0.97, 1.00)	0.8 (0.3, 1.6)
X	-0.2 (0.9) [-1.6, 1.3]	0.80 (-0.04, 0.99)	0.6 (0.3, 1.4)
Y	0.1 (0.9) [-1.4, 1.5]	0.99 (0.92, 1.00)	0.6 (0.5, 1.0)
Z	1.0 (0.6) [0.0, 1.9]	1.00 (0.97, 1.00)	0.8 (0.1, 1.5)

Left greater palatine foramen

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	1.1 (2.4) [-2.6, 4.9]	0.97 (0.73, 1.00)	1.7 (0.0, 4.3)
X	-0.5 (1.7) [-3.2, 2.2]	0.41 (-0.62, 0.95)	1.1 (0.2, 2.9)
Y	-0.9 (1.3) [-3.0, 1.2]	0.95 (0.61, 1.00)	1.0 (0.3, 2.8)
Z	0.9 (2.5) [-3.1, 4.8]	0.99 (0.88, 1.00)	1.6 (0.3, 4.3)

Right greater palatine foramen

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	0.5 (1.7) [-2.1, 3.2]	0.98 (0.86, 1.00)	1.1 (0.2, 2.5)
X	1.5 (3.1) [-3.5, 6.5]	-0.04 (-0.83, 0.87)	2.2 (0.3, 6.1)
Y	-1.0 (1.8) [-3.9, 1.9]	0.93 (0.49, 1.00)	1.3 (0.0, 3.7)
Z	0.3 (1.7) [-2.4, 3.0]	0.99 (0.94, 1.00)	1.1 (0.0, 2.3)

Right zygomaticomaxillary arch

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	-0.8 (0.3) [-1.3, -0.3]	1.00 (0.97, 1.00)	0.6 (0.6, 1.3)
X	1.1 (0.7) [0.0, 2.2]	0.90 (0.29, 0.99)	0.9 (0.4, 2.0)
Y	-0.5 (0.6) [-1.5, 0.5]	0.99 (0.89, 1.00)	0.5 (0.0, 1.4)
Z	-0.5 (0.5) [-1.3, 0.3]	1.00 (0.99, 1.00)	0.5 (0.1, 1.1)

Left zygomaticomaxillary suture

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	-0.2 (2.9) [-4.8, 4.5]	0.97 (0.75, 1.00)	1.8 (0.2, 3.9)
X	-0.3 (1.5) [-2.7, 2.0]	0.64 (-0.38, 0.97)	0.9 (0.3, 2.1)
Y	0.3 (0.8) [-1.0, 1.5]	0.98 (0.85, 1.00)	0.5 (0.1, 1.3)
Z	0.0 (3.5) [-5.5, 5.5]	0.98 (0.84, 1.00)	2.1 (1.9, 3.9)

Mandible: Distance in Each Plane

Right medial condyle

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	0.6 (1.2) [-1.3, 2.5]	0.72 (-0.23, 0.98)	0.9 (0.3, 2.4)
X	-0.2 (0.7) [-1.3, 1.0]	0.98 (0.84, 1.00)	0.5 (0.1, 1.2)
Y	-1.0 (1.6) [-3.4, 1.5]	0.95 (0.59, 1.00)	1.2 (0.1, 3.3)
Z	0.2 (1.0) [-1.3, 1.8]	1.00 (0.97, 1.00)	0.6 (0.4, 1.2)

Right lateral condyle

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	-0.2 (0.4) [-0.9, 0.5]	1.00 (0.96, 1.00)	0.3 (0.1, 0.6)
X	0.0 (0.3) [-0.5, 0.5]	1.00 (0.99, 1.00)	0.2 (0.0, 0.4)
Y	0.8 (0.8) [-0.6, 2.1]	0.98 (0.81, 1.00)	0.8 (0.4, 1.6)
Z	0.0 (0.5) [-0.8, 0.7]	1.00 (0.99, 1.00)	0.3 (0.2, 0.7)

Right posterior condyle

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	-1.0 (0.7) [-2.1, 0.2]	0.85 (0.10, 0.99)	0.8 (0.4, 1.8)
X	1.0 (0.5) [0.2, 1.7]	0.95 (0.58, 1.00)	0.7 (0.3, 1.3)
Y	0.6 (1.5) [-1.7, 3.0]	0.97 (0.72, 1.00)	1.0 (0.2, 2.7)
Z	0.1 (0.4) [-0.6, 0.7]	1.00 (1.00, 1.00)	0.3 (0.0, 0.5)

Right superior condyle

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	0.8 (0.7) [-0.3, 1.9]	0.60 (-0.43, 0.97)	0.7 (0.1, 1.6)
X	-0.9 (0.7) [-1.9, 0.2]	0.89 (0.26, 0.99)	0.7 (0.1, 1.7)
Y	0.2 (0.3) [-0.3, 0.6]	1.00 (0.97, 1.00)	0.2 (0.1, 0.5)
Z	0.2 (0.1) [0.1, 0.4]	1.00 (1.00, 1.00)	0.2 (0.1, 0.3)

Left medial condyle

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	0.4 (0.9) [-1.1, 1.8]	0.89 (0.27, 0.99)	0.6 (0.4, 1.2)
X	0.4 (0.7) [-0.7, 1.4]	0.93 (0.49, 1.00)	0.5 (0.6, 0.9)
Y	0.2 (0.5) [-0.6, 1.0]	0.99 (0.94, 1.00)	0.3 (0.0, 0.8)
Z	0.1 (0.9) [-1.4, 1.6]	1.00 (0.98, 1.00)	0.6 (0.2, 1.3)

Left lateral condyle

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	0.0 (0.5) [-0.8, 0.9]	0.98 (0.83, 1.00)	0.3 (0.1, 0.8)
X	0.1 (0.4) [-0.5, 0.8]	0.99 (0.92, 1.00)	0.3 (0.0, 0.7)
Y	0.0 (1.1) [-1.8, 1.8]	0.97 (0.76, 1.00)	0.7 (0.1, 1.5)
Z	-0.3 (0.6) [-1.2, 0.6]	1.00 (0.99, 1.00)	0.4 (0.2, 0.9)

Left posterior condyle

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	0.3 (1.0) [-1.2, 1.8]	0.84 (0.06, 0.99)	0.6 (0.2, 1.8)
X	0.4 (0.9) [-1.1, 1.8]	0.91 (0.35, 0.99)	0.6 (0.1, 1.5)
Y	0.1 (1.1) [-1.7, 1.9]	0.97 (0.74, 1.00)	0.7 (0.3, 1.6)
Z	-0.1 (0.2) [-0.4, 0.2]	1.00 (1.00, 1.00)	0.1 (0.0, 0.3)

Left superior condyle

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	1.2 (1.3) [-0.9, 3.3]	0.58 (-0.45, 0.97)	1.2 (0.0, 2.6)
X	1.4 (1.4) [-0.7, 3.6]	0.67 (-0.33, 0.97)	1.3 (0.2, 2.7)

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Y	0.6 (0.3) [0.1, 1.0]	0.98 (0.85, 1.00)	0.4 (0.3, 0.9)
Z	0.4 (0.6) [-0.5, 1.2]	1.00 (0.99, 1.00)	0.4 (0.0, 1.0)

Right mental foramen

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	0.0 (1.3) [-2.1, 2.0]	0.99 (0.92, 1.00)	0.8 (0.3, 2.0)
X	-0.4 (0.4) [-1.0, 0.2]	0.99 (0.92, 1.00)	0.4 (0.0, 0.9)
Y	0.3 (1.0) [-1.4, 1.9]	0.99 (0.92, 1.00)	0.7 (0.3, 1.6)
Z	0.0 (1.3) [-2.1, 2.0]	1.00 (0.97, 1.00)	0.8 (0.0, 1.6)

Left mental foramen

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	-0.4 (0.4) [-1.0, 0.3]	1.00 (0.98, 1.00)	0.4 (0.2, 0.7)
X	0.2 (1.0) [-1.3, 1.8]	0.93 (0.46, 1.00)	0.6 (0.1, 1.5)
Y	0.5 (0.3) [0.1, 0.9]	1.00 (0.96, 1.00)	0.4 (0.3, 0.9)
Z	-0.3 (1.0) [-1.9, 1.4]	1.00 (0.98, 1.00)	0.7 (0.1, 1.4)

Mandibular alveolar crest

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	-1.3 (1.4) [-3.4, 0.9]	0.99 (0.87, 1.00)	1.2 (0.3, 3.3)
X	-0.2 (0.6) [-1.1, 0.6]	0.98 (0.84, 1.00)	0.4 (0.0, 0.8)
Y	1.2 (1.3) [-0.9, 3.2]	0.95 (0.59, 1.00)	1.1 (0.1, 2.8)
Z	-0.7 (1.2) [-2.6, 1.3]	1.00 (0.96, 1.00)	0.9 (0.4, 1.9)

Right lingula

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	0.5 (1.1) [-1.3, 2.3]	0.96 (0.65, 1.00)	0.8 (0.2, 2.1)
X	0.0 (0.6) [-1.0, 1.0]	0.99 (0.87, 1.00)	0.4 (0.1, 0.8)
Y	-0.8 (1.1) [-2.5, 0.9]	0.96 (0.67, 1.00)	0.9 (0.2, 2.3)
Z	-0.1 (0.6) [-1.1, 1.0]	1.00 (0.99, 1.00)	0.4 (0.1, 1.0)

Left lingula

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	-0.1 (1.0) [-1.8, 1.5]	0.94 (0.52, 1.00)	0.6 (0.2, 1.6)
X	0.0 (0.6) [-1.0, 0.9]	0.98 (0.78, 1.00)	0.4 (0.3, 0.7)
Y	0.0 (1.2) [-1.9, 1.9]	0.98 (0.79, 1.00)	0.7 (0.1, 1.7)
Z	-0.3 (0.7) [-1.5, 0.9]	1.00 (0.98, 1.00)	0.5 (0.1, 0.9)

Right inferior alveolar foramen

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	-0.9 (2.7) [-5.2, 3.3]	0.71 (-0.25, 0.98)	1.8 (0.2, 5.0)
X	-0.1 (1.2) [-1.9, 1.8]	0.97 (0.74, 1.00)	0.7 (0.0, 1.5)
Y	0.8 (2.8) [-3.7, 5.3]	0.86 (0.15, 0.99)	1.8 (0.0, 5.0)
Z	-1.2 (3.8) [-7.3, 4.8]	0.96 (0.67, 1.00)	2.5 (0.4, 6.9)

Left inferior alveolar foramen

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	0.4 (1.1) [-1.4, 2.1]	0.92 (0.44, 0.99)	0.7 (0.4, 1.4)
X	-0.8 (1.3) [-2.9, 1.2]	0.75 (-0.19, 0.98)	1.0 (0.2, 2.5)
Y	-1.0 (1.4) [-3.3, 1.4]	0.91 (0.37, 0.99)	1.1 (0.0, 2.6)
Z	0.6 (1.5) [-1.7, 3.0]	0.99 (0.95, 1.00)	1.0 (0.5, 2.0)

Right coronoid notch

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	-0.6 (0.9) [-2.0, 0.8]	0.99 (0.87, 1.00)	0.7 (0.5, 1.6)
X	0.0 (0.7) [-1.2, 1.1]	0.99 (0.91, 1.00)	0.4 (0.2, 1.1)
Y	0.6 (0.3) [0.1, 1.0]	0.98 (0.86, 1.00)	0.4 (0.1, 0.8)
Z	-1.4 (1.3) [-3.5, 0.7]	0.99 (0.92, 1.00)	1.3 (0.2, 2.8)

Left coronoid notch

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	0.0 (1.3) [-2.2, 2.1]	0.96 (0.65, 1.00)	0.8 (0.1, 1.9)
X	0.3 (0.9) [-1.1, 1.7]	0.95 (0.61, 1.00)	0.6 (0.1, 1.5)
Y	0.1 (0.8) [-1.1, 1.3]	0.96 (0.65, 1.00)	0.5 (0.0, 1.2)
Z	-1.2 (1.6) [-3.8, 1.4]	0.99 (0.92, 1.00)	1.3 (0.0, 3.2)

Right gonion

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	-1.1 (1.8) [-3.9, 1.7]	0.91 (0.35, 0.99)	1.3 (1.4, 2.6)
X	0.1 (0.4) [-0.6, 0.8]	1.00 (0.96, 1.00)	0.3 (0.0, 0.6)
Y	1.1 (2.1) [-2.3, 4.6]	0.94 (0.52, 1.00)	1.5 (1.9, 2.8)
Z	-1.0 (0.9) [-2.5, 0.4]	0.99 (0.94, 1.00)	0.9 (0.1, 2.0)

Left gonion

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	-2.8 (1.5) [-5.2, -0.4]	0.19 (-0.74, 0.91)	2.2 (1.7, 5.0)
X	-1.3 (2.1) [-4.6, 2.0]	-0.03 (-0.83, 0.87)	1.6 (0.0, 4.4)
Y	2.3 (0.6) [1.3, 3.4]	0.87 (0.20, 0.99)	1.7 (1.8, 2.9)
Z	-1.8 (0.7) [-2.9, -0.6]	0.98 (0.86, 1.00)	1.3 (1.0, 2.4)

Cranial base: Distance in Each Plane

Right anterior clinoid

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	0.2 (0.2) [-0.1, 0.5]	1.00 (0.99, 1.00)	0.2 (0.1, 0.4)
X	-0.2 (0.4) [-0.8, 0.3]	0.98 (0.80, 1.00)	0.3 (0.3, 0.5)
Y	0.4 (0.1) [0.2, 0.6]	0.99 (0.94, 1.00)	0.3 (0.2, 0.5)
Z	-0.1 (0.1) [-0.3, 0.1]	1.00 (1.00, 1.00)	0.1 (0.0, 0.3)

Left anterior clinoid

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	-0.1 (0.5) [-0.9, 0.7]	1.00 (0.98, 1.00)	0.3 (0.1, 0.7)
X	0.4 (0.4) [-0.3, 1.0]	0.95 (0.61, 1.00)	0.4 (0.1, 0.9)
Y	-0.2 (0.2) [-0.5, 0.1]	0.99 (0.92, 1.00)	0.2 (0.0, 0.5)
Z	-0.1 (0.5) [-0.9, 0.7]	1.00 (1.00, 1.00)	0.3 (0.2, 0.6)

Nasion

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	0.3 (0.2) [0.0, 0.6]	1.00 (1.00, 1.00)	0.2 (0.1, 0.6)
X	-0.1 (0.8) [-1.4, 1.1]	0.79 (-0.07, 0.98)	0.5 (0.2, 1.0)
Y	0.2 (0.3) [-0.3, 0.6]	0.99 (0.94, 1.00)	0.2 (0.0, 0.5)
Z	0.2 (0.2) [0.0, 0.5]	1.00 (1.00, 1.00)	0.2 (0.1, 0.5)

1.3 Inter-Examiner Reliability for Examiner 1 and Examiner 2

Dental: Overall Distance

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
UR6 mesiolingual cusp tip	0.0 (0.5) [-0.9, 0.8]	1.00 (0.99, 1.00)	0.3 (0.2, 0.7)
UL6 mesiolingual cusp tip	0.3 (0.5) [-0.5, 1.1]	1.00 (0.98, 1.00)	0.4 (0.0, 1.0)
UR6 mesiobuccal root tip	-0.1 (0.6) [-1.0, 0.8]	1.00 (0.99, 1.00)	0.4 (0.2, 0.6)
UL6 mesiobuccal root tip	-0.8 (0.2) [-1.1, -0.4]	1.00 (0.98, 1.00)	0.5 (0.5, 1.0)
LR6 central fossa	-0.1 (0.2) [-0.5, 0.3]	1.00 (1.00, 1.00)	0.2 (0.1, 0.3)
LL6 central fossa	-0.3 (0.3) [-0.8, 0.1]	1.00 (0.99, 1.00)	0.3 (0.0, 0.7)
LR6 mesial root apex	1.0 (1.6) [-1.5, 3.5]	0.98 (0.81, 1.00)	1.2 (0.2, 3.3)
LL6 mesial root apex	1.0 (1.3) [-1.0, 3.0]	0.98 (0.86, 1.00)	1.0 (0.4, 2.6)
UR3 cusp tip	1.1 (0.4) [0.4, 1.8]	0.99 (0.95, 1.00)	0.9 (0.9, 1.8)
UL3 cusp tip	1.1 (0.9) [-0.4, 2.6]	0.99 (0.94, 1.00)	1.0 (0.1, 2.3)
UR3 root apex	1.1 (1.0) [-0.5, 2.8]	0.99 (0.95, 1.00)	1.0 (0.3, 2.6)
UL3 root apex	-0.4 (0.7) [-1.5, 0.8]	1.00 (0.99, 1.00)	0.5 (0.5, 0.9)
LR3 cusp tip	0.7 (1.2) [-1.2, 2.6]	0.99 (0.94, 1.00)	0.9 (0.0, 2.2)
LL3 cusp tip	3.4 (3.4) [-2.1, 8.8]	0.91 (0.34, 0.99)	3.2 (0.4, 7.1)
LR3 root apex	0.9 (1.7) [-1.8, 3.6]	0.99 (0.86, 1.00)	1.2 (0.2, 3.3)
LL3 root apex	-0.7 (2.0) [-3.9, 2.6]	0.98 (0.84, 1.00)	1.3 (0.5, 3.6)
UR1 mesial-incisal edge	0.0 (0.4) [-1.1, 1.1]	1.00 (1.00, 1.00)	0.2 (0.1, 0.5)
UR1 root apex	-0.7 (0.9) [-2.8, 1.4]	1.00 (0.97, 1.00)	0.7 (0.3, 1.3)
LR1 mesial-incisal edge	-0.5 (0.4) [-1.1, 0.2]	1.00 (0.99, 1.00)	0.4 (0.0, 0.9)
LR1 root apex	-0.1 (0.8) [-1.4, 1.2]	1.00 (0.98, 1.00)	0.5 (0.1, 1.2)

Maxilla: Overall Distance

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Anterior palatal foramen	2.0 (3.4) [-3.4, 7.4]	0.96 (0.65, 1.00)	2.5 (0.2, 7.1)
Anterior palate	3.2 (4.6) [-4.1, 10.5]	0.93 (0.48, 1.00)	3.6 (0.6, 10.1)
Posterior palate	0.8 (2.3) [-2.8, 4.5]	0.96 (0.67, 1.00)	1.5 (0.1, 4.1)
Maxillary alveolar crest	1.2 (3.3) [-4.0, 6.3]	0.98 (0.79, 1.00)	2.2 (0.4, 6.0)
Left greater palatine foramen	-0.6 (5.1) [-8.7, 7.6]	0.89 (0.27, 0.99)	3.2 (0.2, 6.2)
Right greater palatine foramen	1.1 (2.9) [-3.5, 5.8]	0.95 (0.60, 1.00)	1.9 (0.3, 5.3)
Right zygomaticomaxillary arch	1.4 (4.0) [-5.0, 7.9]	0.95 (0.57, 1.00)	2.7 (1.3, 7.1)
Left zygomaticomaxillary suture	2.9 (4.6) [-4.5, 10.2]	0.91 (0.37, 0.99)	3.5 (0.9, 9.6)

Mandible: Overall Distance

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Right medial condyle	-0.6 (1.8) [-3.4, 2.3]	0.34 (-0.66, 0.94)	1.2 (0.2, 3.2)
Right lateral condyle	0.5 (0.7) [-0.6, 1.7]	0.98 (0.83, 1.00)	0.6 (0.1, 1.3)
Right posterior condyle	0.3 (1.8) [-2.5, 3.2]	0.74 (-0.20, 0.98)	1.1 (0.4, 2.2)
Right superior condyle	-0.6 (1.1) [-2.4, 1.2]	0.82 (-0.01, 0.99)	0.8 (0.7, 1.3)
Left medial condyle	-0.3 (1.4) [-2.6, 2.0]	0.71 (-0.26, 0.98)	0.9 (0.2, 1.7)
Left lateral condyle	-0.1 (0.7) [-1.2, 1.0]	0.97 (0.70, 1.00)	0.4 (0.3, 0.8)
Left posterior condyle	1.0 (1.2) [-0.9, 2.9]	0.73 (-0.21, 0.98)	1.0 (0.5, 2.3)
Left superior condyle	0.0 (0.8) [-1.2, 1.1]	0.73 (-0.23, 0.98)	0.5 (0.3, 1.1)
Right mental foramen	0.3 (0.6) [-0.6, 1.1]	1.00 (0.98, 1.00)	0.4 (0.1, 1.0)
Left mental foramen	-0.1 (0.1) [-0.3, 0.0]	1.00 (1.00, 1.00)	0.1 (0.0, 0.3)
Mid-mental	0.0 (0.2) [-0.3, 0.3]	1.00 (1.00, 1.00)	0.1 (0.0, 0.2)
Mandibular alveolar crest	0.2 (0.7) [-0.8, 1.3]	1.00 (0.98, 1.00)	0.4 (0.2, 1.1)
Right lingula	-0.4 (0.7) [-1.5, 0.7]	0.98 (0.85, 1.00)	0.5 (0.4, 1.2)
Left lingula	-0.2 (0.1) [-0.4, 0.1]	1.00 (0.96, 1.00)	0.2 (0.0, 0.3)

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Right inferior alveolar foramen	0.5 (2.4) [-3.3, 4.3]	0.80 (-0.06, 0.99)	1.5 (0.1, 4.0)
Left inferior alveolar foramen	-1.4 (0.6) [-2.4, -0.5]	0.78 (-0.11, 0.98)	1.1 (0.8, 2.0)
Right coronoid notch	-2.8 (5.2) [-11.1, 5.5]	0.79 (-0.09, 0.98)	3.8 (0.2, 10.6)
Left coronoid notch	-0.1 (1.1) [-1.9, 1.7]	0.97 (0.71, 1.00)	0.7 (0.0, 1.7)
Right gonion	2.4 (2.2) [-1.1, 5.9]	0.69 (-0.29, 0.98)	2.2 (0.5, 5.6)
Left gonion	0.6 (1.4) [-1.6, 2.9]	0.79 (-0.09, 0.98)	1.0 (0.1, 1.8)

Cranial Base: Overall Distance

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Right anterior clinoid	-2.8 (5.2) [-11.1, 5.5]	0.79 (-0.09, 0.98)	3.8 (0.2, 10.6)
Left anterior clinoid	-2.7 (4.8) [-10.3, 5.0]	0.82 (0.00, 0.99)	3.5 (0.4, 9.8)
Mid-clinoid	-2.9 (5.5) [-11.7, 5.9]	0.83 (0.03, 0.99)	4.0 (0.2, 11.2)
Nasion	-6.8 (14.3) [-29.5, 16.0]	0.61 (-0.41, 0.97)	10.0 (0.2, 28.2)

Dental: Distance in Each Plane

UR6 Mesiolingual cusp tip

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	0.0 (0.5) [-0.9, 0.8]	1.00 (0.99, 1.00)	0.3 (0.2, 0.7)
X	-0.3 (0.9) [-1.7, 1.1]	0.96 (0.64, 1.00)	0.6 (0.0, 1.6)
Y	-0.2 (0.5) [-1.0, 0.7]	1.00 (0.96, 1.00)	0.4 (0.0, 0.9)
Z	-0.4 (0.6) [-1.4, 0.6]	1.00 (0.99, 1.00)	0.5 (0.0, 1.3)

UL6 Mesiolingual cusp tip

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	0.3 (0.5) [-0.5, 1.1]	1.00 (0.98, 1.00)	0.4 (0.0, 1.0)
X	0.1 (0.2) [-0.3, 0.5]	0.98 (0.80, 1.00)	0.2 (0.0, 0.5)
Y	-0.4 (0.5) [-1.1, 0.3]	1.00 (0.95, 1.00)	0.4 (0.3, 0.7)
Z	0.1 (0.7) [-1.1, 1.3]	1.00 (0.99, 1.00)	0.5 (0.2, 1.0)

UR6 Mesiobuccal root apex

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	-0.1 (0.6) [-1.0, 0.8]	1.00 (0.99, 1.00)	0.4 (0.2, 0.6)
X	-0.7 (1.2) [-2.6, 1.2]	0.89 (0.27, 0.99)	0.9 (0.2, 2.3)
Y	0.7 (1.1) [-1.0, 2.4]	0.98 (0.84, 1.00)	0.8 (0.2, 2.2)
Z	0.0 (0.3) [-0.5, 0.4]	1.00 (1.00, 1.00)	0.2 (0.0, 0.5)

UL6 Mesiobuccal root apex

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	-0.8 (0.2) [-1.1, -0.4]	1.00 (0.98, 1.00)	0.5 (0.5, 1.0)
X	0.8 (0.9) [-0.6, 2.2]	0.74 (-0.19, 0.98)	0.8 (0.0, 2.0)
Y	0.8 (0.2) [0.4, 1.2]	0.99 (0.92, 1.00)	0.6 (0.5, 1.1)
Z	-0.7 (0.2) [-1.0, -0.5]	1.00 (0.99, 1.00)	0.5 (0.5, 0.9)

LR6 central fossa

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	-0.1 (0.2) [-0.5, 0.3]	1.00 (1.00, 1.00)	0.2 (0.1, 0.3)
X	-0.2 (0.7) [-1.3, 0.8]	0.98 (0.84, 1.00)	0.5 (0.2, 1.2)
Y	0.3 (0.3) [-0.1, 0.7]	1.00 (0.98, 1.00)	0.3 (0.1, 0.7)
Z	0.2 (0.4) [-0.4, 0.8]	1.00 (1.00, 1.00)	0.3 (0.1, 0.6)

LL6 central fossa

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	-0.3 (0.3) [-0.8, 0.1]	1.00 (0.99, 1.00)	0.3 (0.0, 0.7)
X	0.0 (0.5) [-0.8, 0.9]	0.96 (0.66, 1.00)	0.3 (0.3, 0.6)
Y	0.4 (0.6) [-0.6, 1.4]	0.99 (0.94, 1.00)	0.5 (0.1, 1.2)
Z	-0.1 (0.6) [-1.0, 0.9]	1.00 (0.99, 1.00)	0.4 (0.3, 0.8)

LR6 mesial root apex

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	1.0 (1.6) [-1.5, 3.5]	0.98 (0.81, 1.00)	1.2 (0.2, 3.3)
X	-1.0 (1.8) [-3.9, 1.8]	0.82 (0.00, 0.99)	1.3 (0.2, 3.7)
Y	-1.0 (1.4) [-3.3, 1.3]	0.96 (0.65, 1.00)	1.1 (0.1, 3.0)
Z	0.1 (1.0) [-1.5, 1.7]	1.00 (0.98, 1.00)	0.6 (0.0, 1.3)

LL6 mesial root apex

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	1.0 (1.3) [-1.0, 3.0]	0.98 (0.86, 1.00)	1.0 (0.4, 2.6)
X	0.9 (1.1) [-0.8, 2.7]	0.91 (0.35, 0.99)	0.9 (0.0, 2.5)
Y	-0.8 (1.1) [-2.6, 1.0]	0.97 (0.77, 1.00)	0.9 (0.8, 1.8)
Z	0.3 (0.7) [-0.7, 1.4]	1.00 (0.99, 1.00)	0.5 (0.1, 1.3)

UR3 cusp tip

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	1.1 (0.4) [0.4, 1.8]	0.99 (0.95, 1.00)	0.9 (0.9, 1.8)
X	-0.2 (0.5) [-1.0, 0.7]	0.98 (0.84, 1.00)	0.3 (0.1, 0.9)
Y	-0.7 (0.9) [-2.2, 0.8]	0.98 (0.86, 1.00)	0.8 (0.6, 1.6)
Z	0.9 (0.6) [-0.1, 1.9]	1.00 (0.97, 1.00)	0.8 (0.3, 1.6)

UL3 cusp tip

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	1.1 (0.9) [-0.4, 2.6]	0.99 (0.94, 1.00)	1.0 (0.1, 2.3)
X	0.6 (0.7) [-0.6, 1.8]	0.66 (-0.34, 0.97)	0.6 (0.2, 1.3)
Y	-1.0 (0.6) [-2.0, -0.1]	0.99 (0.86, 1.00)	0.8 (0.3, 1.7)
Z	0.5 (1.0) [-1.1, 2.2]	1.00 (0.98, 1.00)	0.7 (0.1, 2.1)

UR3 root apex

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	1.1 (1.0) [-0.5, 2.8]	0.99 (0.95, 1.00)	1.0 (0.3, 2.6)
X	-0.4 (0.7) [-1.6, 0.8]	0.97 (0.72, 1.00)	0.5 (0.2, 1.0)
Y	-0.9 (0.9) [-2.4, 0.5]	0.98 (0.82, 1.00)	0.9 (0.1, 2.2)
Z	0.7 (0.8) [-0.6, 2.0]	1.00 (0.98, 1.00)	0.7 (0.1, 1.6)

UL3 root apex

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	-0.4 (0.7) [-1.5, 0.8]	1.00 (0.99, 1.00)	0.5 (0.5, 0.9)
X	-0.5 (0.7) [-1.7, 0.6]	0.96 (0.68, 1.00)	0.6 (0.5, 1.1)
Y	1.0 (1.3) [-1.1, 3.1]	0.97 (0.70, 1.00)	1.1 (0.5, 2.7)
Z	0.1 (0.5) [-0.7, 0.9]	1.00 (1.00, 1.00)	0.3 (0.0, 0.8)

LR3 cusp tip

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	0.7 (1.2) [-1.2, 2.6]	0.99 (0.94, 1.00)	0.9 (0.0, 2.2)
X	-0.2 (0.4) [-0.8, 0.4]	0.99 (0.93, 1.00)	0.3 (0.0, 0.5)

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Y	0.7 (0.5) [-0.1, 1.5]	0.99 (0.94, 1.00)	0.6 (0.2, 1.4)
Z	1.3 (1.3) [-0.9, 3.4]	0.99 (0.92, 1.00)	1.2 (0.0, 2.8)

LL3 cusp tip

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	3.4 (3.4) [-2.1, 8.8]	0.91 (0.34, 0.99)	3.2 (0.4, 7.1)
X	-0.9 (2.4) [-4.7, 2.8]	0.47 (-0.56, 0.95)	1.6 (0.3, 3.5)
Y	-0.1 (0.6) [-1.1, 0.9]	1.00 (0.97, 1.00)	0.4 (0.3, 0.8)
Z	4.0 (4.6) [-3.3, 11.3]	0.90 (0.32, 0.99)	4.0 (0.2, 8.1)

LR3 root apex

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	0.9 (1.7) [-1.8, 3.6]	0.99 (0.86, 1.00)	1.2 (0.2, 3.3)
X	1.1 (2.4) [-2.7, 4.9]	0.81 (-0.01, 0.99)	1.7 (0.3, 4.7)
Y	-1.0 (1.8) [-3.7, 1.8]	0.96 (0.65, 1.00)	1.3 (0.1, 3.5)
Z	0.5 (1.1) [-1.3, 2.3]	1.00 (0.97, 1.00)	0.8 (0.1, 2.2)

LL3 root apex

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	-0.7 (2.0) [-3.9, 2.6]	0.98 (0.84, 1.00)	1.3 (0.5, 3.6)
X	1.7 (2.7) [-2.6, 6.0]	0.79 (-0.07, 0.98)	2.1 (0.2, 5.7)
Y	-0.2 (1.2) [-2.0, 1.7]	0.99 (0.87, 1.00)	0.7 (0.1, 1.4)
Z	-1.3 (2.0) [-4.5, 1.8]	0.99 (0.89, 1.00)	1.5 (0.0, 4.3)

UR1 mesial-incisal edge

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	0.0 (0.4) [-1.1, 1.1]	1.00 (1.00, 1.00)	0.2 (0.1, 0.5)
X	0.1 (0.2) [-0.4, 0.7]	1.00 (0.94, 1.00)	0.2 (0.1, 0.3)
Y	-0.6 (1.2) [-3.6, 2.3]	0.99 (0.83, 1.00)	0.8 (0.0, 2.0)
Z	-0.3 (0.2) [-0.7, 0.1]	1.00 (1.00, 1.00)	0.2 (0.1, 0.4)

UR1 root apex

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	-0.7 (0.9) [-2.8, 1.4]	1.00 (0.97, 1.00)	0.7 (0.3, 1.3)
X	0.2 (0.4) [-0.8, 1.2]	0.98 (0.70, 1.00)	0.3 (0.0, 0.7)
Y	1.0 (1.2) [-2.1, 4.1]	0.98 (0.68, 1.00)	1.0 (0.2, 2.4)
Z	-0.4 (0.9) [-2.5, 1.7]	1.00 (0.99, 1.00)	0.6 (0.5, 1.2)

LR1 mesial-uncisal edge

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	-0.5 (0.4) [-1.1, 0.2]	1.00 (0.99, 1.00)	0.4 (0.0, 0.9)
X	0.0 (0.5) [-0.7, 0.8]	0.99 (0.89, 1.00)	0.3 (0.2, 0.6)
Y	0.5 (0.5) [-0.4, 1.3]	1.00 (0.95, 1.00)	0.5 (0.1, 1.1)
Z	-0.2 (0.5) [-1.1, 0.6]	1.00 (0.99, 1.00)	0.4 (0.0, 1.0)

LR1 root apex

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	-0.1 (0.8) [-1.4, 1.2]	1.00 (0.98, 1.00)	0.5 (0.1, 1.2)
X	0.2 (0.7) [-1.0, 1.3]	0.98 (0.80, 1.00)	0.5 (0.3, 0.9)
Y	-0.3 (2.2) [-3.9, 3.2]	0.93 (0.47, 1.00)	1.4 (1.2, 3.0)
Z	-0.3 (1.5) [-2.6, 2.1]	1.00 (0.96, 1.00)	0.9 (0.0, 1.7)

Maxilla: Distance in Each Plane

Anterior palatal foramen

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	2.0 (3.4) [-3.4, 7.4]	0.96 (0.65, 1.00)	2.5 (0.2, 7.1)
X	-0.1 (0.4) [-0.8, 0.5]	0.94 (0.56, 1.00)	0.3 (0.2, 0.5)
Y	2.8 (7.1) [-8.5, 14.2]	0.64 (-0.37, 0.97)	4.8 (0.5, 13.5)
Z	3.6 (7.2) [-7.9, 15.0]	0.90 (0.29, 0.99)	5.1 (0.0, 14.3)

Anterior palate

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	3.2 (4.6) [-4.1, 10.5]	0.93 (0.48, 1.00)	3.6 (0.6, 10.1)
X	0.3 (0.5) [-0.4, 1.1]	0.90 (0.33, 0.99)	0.4 (0.2, 0.7)
Y	3.7 (7.9) [-8.9, 16.3]	0.56 (-0.48, 0.96)	5.5 (0.3, 15.6)
Z	4.6 (7.3) [-7.0, 16.2]	0.88 (0.21, 0.99)	5.5 (0.6, 15.5)

Posterior palate

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	0.8 (2.3) [-2.8, 4.5]	0.96 (0.67, 1.00)	1.5 (0.1, 4.1)
X	-0.2 (0.2) [-0.6, 0.2]	0.95 (0.60, 1.00)	0.2 (0.1, 0.5)
Y	2.9 (6.3) [-7.2, 13.0]	0.35 (-0.66, 0.94)	4.4 (0.0, 12.4)
Z	3.2 (7.8) [-9.2, 15.5]	0.87 (0.17, 0.99)	5.3 (0.2, 14.8)

Maxillary alveolar crest

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	1.2 (3.3) [-4.0, 6.3]	0.98 (0.79, 1.00)	2.2 (0.4, 6.0)
X	0.3 (0.8) [-0.9, 1.5]	0.81 (-0.02, 0.99)	0.5 (0.0, 1.2)
Y	1.6 (5.9) [-7.8, 11.0]	0.67 (-0.33, 0.97)	3.8 (0.8, 10.4)
Z	2.1 (6.6) [-8.5, 12.6]	0.93 (0.47, 1.00)	4.3 (0.1, 11.9)

Left greater palatine foramen

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	-0.6 (5.1) [-8.7, 7.6]	0.89 (0.27, 0.99)	3.2 (0.2, 6.2)
X	-0.2 (2.5) [-4.2, 3.9]	0.03 (-0.81, 0.88)	1.6 (0.2, 3.3)
Y	3.7 (5.1) [-4.4, 11.8]	0.26 (-0.71, 0.93)	4.1 (0.5, 10.8)
Z	1.7 (9.3) [-13.1, 16.5]	0.86 (0.14, 0.99)	5.8 (0.2, 15.2)

Right greater palatine foramen

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	1.1 (2.9) [-3.5, 5.8]	0.95 (0.60, 1.00)	1.9 (0.3, 5.3)
X	-1.5 (3.9) [-7.7, 4.7]	-0.56 (-0.95, 0.62)	2.6 (0.3, 7.3)
Y	3.3 (5.4) [-5.3, 11.8]	0.40 (-0.62, 0.94)	4.0 (0.3, 11.0)
Z	3.3 (7.6) [-8.8, 15.3]	0.87 (0.20, 0.99)	5.2 (0.2, 14.5)

Right zygomaticomaxillary arch

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	1.4 (4.0) [-5.0, 7.9]	0.95 (0.57, 1.00)	2.7 (1.3, 7.1)
X	-0.6 (1.4) [-2.8, 1.6]	0.90 (0.30, 0.99)	0.9 (0.2, 2.0)
Y	3.3 (6.0) [-6.2, 12.8]	0.09 (-0.78, 0.90)	4.4 (0.1, 12.3)
Z	2.8 (7.1) [-8.5, 14.1]	0.91 (0.37, 0.99)	4.8 (1.1, 13.3)

Left zygomaticomaxillary suture

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	2.9 (4.6) [-4.5, 10.2]	0.91 (0.37, 0.99)	3.5 (0.9, 9.6)
X	0.7 (1.7) [-2.0, 3.4]	0.46 (-0.57, 0.95)	1.1 (0.1, 3.1)
Y	0.9 (4.3) [-5.9, 7.7]	0.41 (-0.61, 0.95)	2.7 (0.8, 7.3)
Z	3.5 (6.5) [-6.8, 13.8]	0.93 (0.48, 1.00)	4.7 (0.6, 13.0)

Mandible: Distance in Each Plane

Right medial condyle

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	-0.6 (1.8) [-3.4, 2.3]	0.34 (-0.66, 0.94)	1.2 (0.2, 3.2)
X	0.5 (0.9) [-0.9, 2.0]	0.97 (0.70, 1.00)	0.7 (0.1, 1.8)
Y	0.3 (2.5) [-3.7, 4.3]	0.91 (0.37, 0.99)	1.6 (0.3, 4.0)
Z	0.1 (1.0) [-1.4, 1.7]	1.00 (0.98, 1.00)	0.6 (0.0, 1.5)

Right lateral condyle

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	0.5 (0.7) [-0.6, 1.7]	0.98 (0.83, 1.00)	0.6 (0.1, 1.3)
X	-0.6 (1.0) [-2.2, 1.0]	0.98 (0.79, 1.00)	0.8 (0.0, 2.1)
Y	-0.2 (2.3) [-3.9, 3.4]	0.90 (0.33, 0.99)	1.4 (0.4, 3.2)
Z	-0.4 (0.6) [-1.4, 0.6]	1.00 (0.98, 1.00)	0.5 (0.2, 1.2)

Right posterior condyle

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	0.3 (1.8) [-2.5, 3.2]	0.74 (-0.20, 0.98)	1.1 (0.4, 2.2)
X	-0.4 (1.8) [-3.2, 2.5]	0.89 (0.25, 0.99)	1.1 (0.9, 2.2)
Y	-0.2 (1.4) [-2.5, 2.0]	0.98 (0.78, 1.00)	0.9 (0.3, 2.2)
Z	-0.4 (0.4) [-1.1, 0.2]	1.00 (0.99, 1.00)	0.4 (0.0, 1.0)

Right superior condyle

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	-0.6 (1.1) [-2.4, 1.2]	0.82 (-0.01, 0.99)	0.8 (0.7, 1.3)
X	0.5 (1.2) [-1.3, 2.3]	0.93 (0.46, 1.00)	0.8 (0.8, 1.4)
Y	0.2 (0.2) [-0.1, 0.5]	1.00 (0.98, 1.00)	0.2 (0.0, 0.4)
Z	-0.2 (0.9) [-1.6, 1.1]	1.00 (0.98, 1.00)	0.6 (0.3, 1.2)

Left medial condyle

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	-0.3 (1.4) [-2.6, 2.0]	0.71 (-0.26, 0.98)	0.9 (0.2, 1.7)
X	-0.6 (1.0) [-2.2, 1.1]	0.84 (0.07, 0.99)	0.8 (0.6, 1.7)
Y	-0.7 (1.3) [-2.8, 1.4]	0.95 (0.59, 1.00)	0.9 (0.7, 1.9)
Z	0.0 (0.8) [-1.3, 1.3]	1.00 (0.99, 1.00)	0.5 (0.1, 1.2)

Left lateral condyle

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	-0.1 (0.7) [-1.2, 1.0]	0.97 (0.70, 1.00)	0.4 (0.3, 0.8)
X	0.3 (0.4) [-0.4, 0.9]	0.99 (0.88, 1.00)	0.3 (0.3, 0.7)
Y	1.1 (1.5) [-1.2, 3.5]	0.89 (0.27, 0.99)	1.2 (0.6, 3.0)
Z	-0.3 (0.5) [-1.2, 0.5]	1.00 (0.99, 1.00)	0.4 (0.2, 0.8)

Left posterior condyle

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	1.0 (1.2) [-0.9, 2.9]	0.73 (-0.21, 0.98)	1.0 (0.5, 2.3)
X	1.0 (1.3) [-1.1, 3.1]	0.78 (-0.09, 0.98)	1.1 (0.6, 2.6)
Y	-0.2 (0.7) [-1.4, 0.9]	0.98 (0.84, 1.00)	0.5 (0.1, 1.3)
Z	-0.3 (0.5) [-1.1, 0.5]	1.00 (0.99, 1.00)	0.4 (0.2, 0.9)

Left superior condyle

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	0.0 (0.8) [-1.2, 1.1]	0.73 (-0.23, 0.98)	0.5 (0.3, 1.1)
X	0.0 (0.8) [-1.2, 1.3]	0.91 (0.35, 0.99)	0.5 (0.3, 1.2)
Y	0.2 (0.2) [-0.1, 0.6]	1.00 (0.96, 1.00)	0.2 (0.1, 0.5)
Z	0.2 (0.6) [-0.7, 1.1]	1.00 (0.99, 1.00)	0.4 (0.0, 0.9)

Right mental foramen

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	0.3 (0.6) [-0.6, 1.1]	1.00 (0.98, 1.00)	0.4 (0.1, 1.0)
X	-0.2 (0.5) [-0.9, 0.6]	0.99 (0.95, 1.00)	0.3 (0.1, 0.7)
Y	-0.2 (0.8) [-1.5, 1.1]	0.99 (0.95, 1.00)	0.5 (0.3, 1.1)
Z	0.2 (0.7) [-0.8, 1.3]	1.00 (0.99, 1.00)	0.4 (0.3, 0.7)

Left mental foramen

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	-0.1 (0.1) [-0.3, 0.0]	1.00 (1.00, 1.00)	0.1 (0.0, 0.3)
X	0.7 (1.1) [-1.1, 2.4]	0.88 (0.24, 0.99)	0.8 (0.1, 1.7)
Y	-0.2 (0.6) [-1.1, 0.7]	1.00 (0.97, 1.00)	0.4 (0.2, 0.9)
Z	-0.5 (0.9) [-1.9, 0.9]	1.00 (0.98, 1.00)	0.6 (0.1, 1.3)

Mid-mental

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	0.0 (0.2) [-0.3, 0.3]	1.00 (1.00, 1.00)	0.1 (0.0, 0.2)
X	0.2 (0.5) [-0.6, 1.1]	0.99 (0.88, 1.00)	0.4 (0.2, 0.8)
Y	-0.2 (0.7) [-1.3, 0.9]	1.00 (0.96, 1.00)	0.4 (0.2, 1.0)
Z	-0.1 (0.6) [-1.1, 0.9]	1.00 (0.99, 1.00)	0.4 (0.3, 0.9)

Mandibular alveolar crest

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	0.2 (0.7) [-0.8, 1.3]	1.00 (0.98, 1.00)	0.4 (0.2, 1.1)
X	0.1 (0.4) [-0.6, 0.7]	0.99 (0.93, 1.00)	0.3 (0.1, 0.5)
Y	0.0 (0.8) [-1.2, 1.2]	0.99 (0.91, 1.00)	0.5 (0.5, 0.8)
Z	0.3 (0.5) [-0.6, 1.1]	1.00 (0.99, 1.00)	0.4 (0.1, 1.0)

Right lingula

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	-0.4 (0.7) [-1.5, 0.7]	0.98 (0.85, 1.00)	0.5 (0.4, 1.2)
X	0.0 (1.0) [-1.7, 1.6]	0.97 (0.71, 1.00)	0.6 (0.0, 1.4)
Y	0.4 (0.4) [-0.2, 1.0]	0.99 (0.92, 1.00)	0.4 (0.1, 0.8)
Z	-0.5 (0.4) [-1.2, 0.1]	1.00 (0.99, 1.00)	0.5 (0.1, 1.1)

Left lingula

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	-0.2 (0.1) [-0.4, 0.1]	1.00 (0.96, 1.00)	0.2 (0.0, 0.3)

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
X	-0.1 (0.4) [-0.8, 0.6]	0.98 (0.81, 1.00)	0.3 (0.2, 0.5)
Y	0.1 (0.5) [-0.7, 0.9]	1.00 (0.96, 1.00)	0.3 (0.1, 0.5)
Z	-0.2 (0.1) [-0.4, 0.0]	1.00 (1.00, 1.00)	0.1 (0.0, 0.3)

Right inferior alveolar foramen

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	0.5 (2.4) [-3.3, 4.3]	0.80 (-0.06, 0.99)	1.5 (0.1, 4.0)
X	0.2 (0.7) [-0.9, 1.4]	0.99 (0.87, 1.00)	0.5 (0.3, 0.9)
Y	-0.7 (2.3) [-4.4, 3.0]	0.89 (0.25, 0.99)	1.5 (0.2, 4.0)
Z	0.4 (3.6) [-5.3, 6.2]	0.97 (0.72, 1.00)	2.2 (0.2, 5.7)

Left inferior alveolar foramen

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	-1.4 (0.6) [-2.4, -0.5]	0.78 (-0.11, 0.98)	1.1 (0.8, 2.0)
X	0.9 (1.3) [-1.1, 3.0]	0.73 (-0.22, 0.98)	1.0 (0.4, 2.0)
Y	1.8 (1.2) [-0.1, 3.6]	0.80 (-0.06, 0.99)	1.4 (0.8, 3.1)
Z	-2.1 (1.1) [-3.7, -0.4]	0.99 (0.87, 1.00)	1.6 (0.9, 3.0)

Right coronoid notch

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	0.0 (0.5) [-0.9, 0.8]	1.00 (0.96, 1.00)	0.3 (0.1, 0.8)
X	0.1 (0.4) [-0.6, 0.7]	1.00 (0.98, 1.00)	0.2 (0.0, 0.6)
Y	0.0 (0.3) [-0.4, 0.5]	1.00 (0.97, 1.00)	0.2 (0.1, 0.3)
Z	0.2 (0.7) [-1.0, 1.3]	1.00 (0.99, 1.00)	0.5 (0.2, 1.2)

Left coronoid notch

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	-0.1 (1.1) [-1.9, 1.7]	0.97 (0.71, 1.00)	0.7 (0.0, 1.7)
X	-0.2 (0.5) [-1.0, 0.6]	0.99 (0.90, 1.00)	0.3 (0.0, 0.9)
Y	0.2 (0.7) [-0.9, 1.3]	0.96 (0.69, 1.00)	0.4 (0.0, 1.1)
Z	0.4 (1.3) [-1.7, 2.4]	1.00 (0.97, 1.00)	0.8 (0.1, 2.0)

Right gonion

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	2.4 (2.2) [-1.1, 5.9]	0.69 (-0.29, 0.98)	2.2 (0.5, 5.6)
X	0.1 (0.7) [-1.1, 1.2]	0.99 (0.91, 1.00)	0.4 (0.1, 0.9)
Y	-2.9 (2.4) [-6.8, 1.0]	0.82 (0.00, 0.99)	2.6 (0.5, 6.2)
Z	1.6 (2.0) [-1.6, 4.8]	0.98 (0.80, 1.00)	1.7 (0.3, 4.6)

Left gonion

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	0.6 (1.4) [-1.6, 2.9]	0.79 (-0.09, 0.98)	1.0 (0.1, 1.8)
X	0.4 (2.6) [-3.7, 4.6]	-0.16 (-0.87, 0.83)	1.6 (0.1, 4.1)
Y	-0.6 (1.4) [-2.9, 1.7]	0.96 (0.67, 1.00)	1.0 (0.3, 2.3)
Z	-0.4 (0.9) [-1.8, 1.1]	1.00 (0.97, 1.00)	0.6 (0.3, 1.3)

Cranial base: Distance in Each Plane

Right anterior clinoid

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Distance	-2.8 (5.2) [-11.1, 5.5]	0.79 (-0.09, 0.98)	3.8 (0.2, 10.6)

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
X	1.1 (2.3) [-2.6, 4.8]	0.09 (-0.79, 0.90)	1.6 (0.1, 4.5)
Y	-1.2 (2.0) [-4.4, 2.0]	0.76 (-0.16, 0.98)	1.5 (0.2, 4.1)
Z	-6.4 (11.7) [-25.0, 12.3]	0.73 (-0.22, 0.98)	8.5 (0.1, 23.9)

Left anterior clinoid

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	-2.7 (4.8) [-10.3, 5.0]	0.82 (0.00, 0.99)	3.5 (0.4, 9.8)
X	-0.6 (0.8) [-1.8, 0.7]	0.81 (-0.02, 0.99)	0.6 (0.1, 1.7)
Y	-0.7 (1.1) [-2.4, 1.0]	0.80 (-0.05, 0.99)	0.8 (0.2, 2.3)
Z	-6.4 (12.0) [-25.5, 12.6]	0.71 (-0.25, 0.98)	8.6 (0.3, 24.4)

Mid-clinoid

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	-2.9 (5.5) [-11.7, 5.9]	0.83 (0.03, 0.99)	4.0 (0.2, 11.2)
X	0.3 (0.8) [-1.1, 1.6]	0.77 (-0.14, 0.98)	0.6 (0.1, 1.4)
Y	-0.9 (1.5) [-3.4, 1.5]	0.78 (-0.11, 0.98)	1.2 (0.0, 3.2)
Z	-6.4 (11.8) [-25.2, 12.4]	0.72 (-0.23, 0.98)	8.5 (0.2, 24.1)

Nasion

Measure	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	-6.8 (14.3) [-29.5, 16.0]	0.61 (-0.41, 0.97)	10.0 (0.2, 28.2)
X	0.1 (0.3) [-0.4, 0.7]	0.97 (0.74, 1.00)	0.2 (0.1, 0.5)
Y	1.2 (1.6) [-1.4, 3.7]	0.64 (-0.38, 0.97)	1.3 (0.1, 3.5)
Z	-7.2 (15.0) [-31.0, 16.6]	0.59 (-0.45, 0.97)	10.5 (0.1, 29.6)

APPENDIX 2: RESULTS

2.1 Accuracy and Reliability for Examiner 1 (E1)

E1 Dental: Distance in Each Plane

UR6 Mesiolingual cusp tip

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	23	0.0 (0.3) [-0.2, 0.1]	1.00 (1.00, 1.00)	0.2 (0.0, 0.6)
X	23	-0.3 (0.5) [-0.5, -0.1]	0.98 (0.95, 0.99)	0.4 (0.0, 1.7)
Y	23	0.1 (0.3) [-0.1, 0.2]	1.00 (1.00, 1.00)	0.2 (0.0, 0.9)
Z	23	-0.1 (0.5) [-0.3, 0.1]	1.00 (1.00, 1.00)	0.4 (0.0, 1.1)

UL6 Mesiolingual cusp tip

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	24	0.0 (0.4) [-0.2, 0.1]	1.00 (1.00, 1.00)	0.2 (0.0, 0.7)
X	24	0.2 (0.5) [0.0, 0.4]	0.98 (0.96, 0.99)	0.4 (0.0, 1.1)
Y	24	0.0 (0.4) [-0.2, 0.1]	1.00 (1.00, 1.00)	0.3 (0.0, 0.9)
Z	24	-0.1 (0.4) [-0.3, 0.0]	1.00 (1.00, 1.00)	0.3 (0.0, 1.0)

LR6 central fossa

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	23	0.0 (0.2) [-0.1, 0.1]	1.00 (1.00, 1.00)	0.2 (0.0, 0.4)
X	23	0.1 (0.3) [-0.1, 0.2]	0.99 (0.99, 1.00)	0.2 (0.0, 0.7)
Y	23	0.0 (0.3) [-0.2, 0.1]	1.00 (1.00, 1.00)	0.2 (0.0, 0.6)
Z	23	0.1 (0.3) [-0.1, 0.2]	1.00 (1.00, 1.00)	0.2 (0.0, 0.7)

LL6 central fossa

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	27	0.1 (0.3) [0.0, 0.2]	1.00 (1.00, 1.00)	0.2 (0.0, 0.7)
X	27	0.0 (0.4) [-0.2, 0.1]	0.99 (0.97, 0.99)	0.3 (0.0, 1.0)
Y	27	0.0 (0.3) [-0.1, 0.1]	1.00 (1.00, 1.00)	0.2 (0.0, 0.5)
Z	27	0.1 (0.2) [0.0, 0.2]	1.00 (1.00, 1.00)	0.2 (0.0, 0.7)

UR3 cusp tip

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	26	-0.2 (0.3) [-0.3, 0.0]	1.00 (1.00, 1.00)	0.3 (0.0, 0.8)
X	26	0.1 (0.5) [-0.1, 0.3]	0.98 (0.96, 0.99)	0.4 (0.0, 1.1)
Y	26	0.0 (0.4) [-0.2, 0.2]	1.00 (1.00, 1.00)	0.3 (0.0, 0.8)
Z	26	-0.2 (0.3) [-0.3, 0.0]	1.00 (1.00, 1.00)	0.2 (0.0, 0.6)

UL3 cusp tip

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	25	-0.4 (0.4) [-0.6, -0.2]	1.00 (1.00, 1.00)	0.4 (0.0, 1.1)
X	25	0.0 (0.7) [-0.3, 0.3]	0.98 (0.95, 0.99)	0.5 (0.1, 1.3)
Y	25	0.0 (0.3) [-0.2, 0.1]	1.00 (1.00, 1.00)	0.2 (0.0, 0.6)
Z	25	-0.5 (0.5) [-0.7, -0.3]	1.00 (0.99, 1.00)	0.5 (0.0, 1.3)

LR3 cusp tip

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	19	0.0 (0.4) [-0.2, 0.2]	1.00 (1.00, 1.00)	0.3 (0.0, 0.9)
X	19	0.2 (0.8) [-0.1, 0.6]	0.95 (0.87, 0.98)	0.5 (0.0, 1.9)
Y	19	0.0 (0.4) [-0.2, 0.2]	1.00 (1.00, 1.00)	0.2 (0.0, 0.7)
Z	19	0.0 (0.4) [-0.2, 0.2]	1.00 (1.00, 1.00)	0.3 (0.0, 1.0)

LL3 cusp tip

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	17	0.2 (0.3) [0.1, 0.4]	1.00 (1.00, 1.00)	0.3 (0.0, 0.7)
X	17	0.2 (0.5) [-0.1, 0.5]	0.96 (0.90, 0.99)	0.4 (0.0, 1.6)
Y	17	-0.1 (0.3) [-0.2, 0.0]	1.00 (1.00, 1.00)	0.2 (0.0, 0.5)
Z	17	0.2 (0.4) [0.0, 0.4]	1.00 (1.00, 1.00)	0.3 (0.0, 0.8)

UR1 mesial-uncisal edge

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	24	-0.2 (0.2) [-0.3, -0.1]	1.00 (1.00, 1.00)	0.2 (0.0, 0.6)
X	24	0.0 (0.3) [-0.1, 0.2]	0.99 (0.98, 1.00)	0.2 (0.0, 0.9)
Y	24	-0.1 (0.3) [-0.2, 0.1]	1.00 (1.00, 1.00)	0.3 (0.0, 0.8)
Z	24	-0.2 (0.2) [-0.3, -0.1]	1.00 (1.00, 1.00)	0.2 (0.0, 0.7)

LR1 mesial-uncisal edge

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	21	0.0 (0.2) [-0.1, 0.1]	1.00 (1.00, 1.00)	0.2 (0.0, 0.4)
X	21	0.0 (0.3) [-0.2, 0.1]	0.99 (0.98, 1.00)	0.2 (0.0, 0.8)
Y	21	0.1 (0.2) [0.0, 0.2]	1.00 (1.00, 1.00)	0.2 (0.0, 0.4)
Z	21	0.0 (0.3) [-0.1, 0.1]	1.00 (1.00, 1.00)	0.2 (0.0, 0.5)

E1 Maxilla: Distance in Each Plane

Anterior palatal foramen

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	31	-0.1 (0.3) [-0.2, 0.0]	1.00 (1.00, 1.00)	0.2 (0.0, 0.6)
X	31	-0.1 (0.4) [-0.2, 0.1]	0.99 (0.97, 0.99)	0.3 (0.0, 0.9)
Y	31	0.0 (0.4) [-0.1, 0.2]	1.00 (1.00, 1.00)	0.3 (0.0, 0.9)
Z	31	-0.1 (0.3) [-0.2, 0.0]	1.00 (1.00, 1.00)	0.2 (0.0, 1.0)

Anterior palate

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	29	-0.2 (0.5) [-0.4, 0.0]	1.00 (1.00, 1.00)	0.4 (0.0, 1.1)
X	29	0.2 (0.5) [0.0, 0.3]	0.98 (0.95, 0.99)	0.3 (0.0, 1.4)
Y	29	-0.1 (0.6) [-0.3, 0.1]	1.00 (1.00, 1.00)	0.4 (0.0, 1.6)
Z	29	-0.2 (0.5) [-0.4, 0.0]	1.00 (1.00, 1.00)	0.4 (0.0, 1.1)

Posterior palate

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	31	0.3 (0.5) [0.2, 0.5]	1.00 (0.99, 1.00)	0.4 (0.0, 1.4)
X	31	-0.2 (0.4) [-0.3, 0.0]	0.99 (0.97, 0.99)	0.3 (0.0, 0.8)
Y	31	-0.1 (0.6) [-0.3, 0.1]	1.00 (0.99, 1.00)	0.4 (0.0, 1.7)
Z	31	0.3 (0.4) [0.2, 0.5]	1.00 (1.00, 1.00)	0.4 (0.1, 1.1)

Maxillary alveolar crest

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	27	-0.6 (0.3) [-0.7, -0.5]	1.00 (0.99, 1.00)	0.5 (0.1, 1.1)
X	27	0.0 (0.4) [-0.2, 0.2]	0.99 (0.98, 1.00)	0.3 (0.0, 0.9)
Y	27	0.1 (0.7) [-0.2, 0.4]	1.00 (0.99, 1.00)	0.5 (0.0, 1.9)
Z	27	-0.6 (0.4) [-0.8, -0.4]	1.00 (0.99, 1.00)	0.5 (0.0, 1.6)

Left greater palatine foramen

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	30	0.4 (0.7) [0.1, 0.7]	0.99 (0.99, 1.00)	0.6 (0.0, 1.9)
X	30	0.2 (0.4) [0.0, 0.3]	0.99 (0.98, 1.00)	0.3 (0.0, 1.3)
Y	30	-0.3 (0.4) [-0.4, -0.1]	1.00 (1.00, 1.00)	0.3 (0.0, 1.0)
Z	30	0.3 (0.8) [0.0, 0.6]	1.00 (0.99, 1.00)	0.6 (0.0, 1.7)

Right greater palatine foramen

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	29	0.2 (0.5) [0.0, 0.4]	1.00 (1.00, 1.00)	0.4 (0.0, 1.2)
X	29	-0.2 (0.3) [-0.3, -0.1]	0.99 (0.98, 1.00)	0.3 (0.0, 0.9)
Y	29	0.0 (0.4) [-0.2, 0.1]	1.00 (1.00, 1.00)	0.3 (0.0, 0.9)
Z	29	0.1 (0.5) [-0.1, 0.3]	1.00 (1.00, 1.00)	0.4 (0.0, 1.3)

Right tuberosity

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	29	0.0 (0.3) [-0.1, 0.1]	1.00 (1.00, 1.00)	0.2 (0.0, 0.5)
X	29	0.2 (0.7) [0.0, 0.5]	0.97 (0.94, 0.99)	0.5 (0.0, 1.8)
Y	29	-0.2 (0.5) [-0.4, 0.0]	1.00 (1.00, 1.00)	0.4 (0.0, 1.6)
Z	29	0.0 (0.3) [-0.1, 0.1]	1.00 (1.00, 1.00)	0.2 (0.0, 0.5)

Left tuberosity

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	28	-0.1 (0.3) [-0.2, 0.0]	1.00 (1.00, 1.00)	0.2 (0.0, 0.6)
X	28	0.0 (0.7) [-0.3, 0.2]	0.97 (0.93, 0.99)	0.5 (0.0, 1.4)

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Y	28	0.0 (0.5) [-0.2, 0.2]	1.00 (1.00, 1.00)	0.3 (0.0, 1.2)
Z	28	-0.1 (0.3) [-0.2, 0.1]	1.00 (1.00, 1.00)	0.2 (0.0, 0.8)

Right zygomaticomaxillary arch

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	29	-0.3 (0.8) [-0.6, 0.0]	0.99 (0.99, 1.00)	0.6 (0.0, 1.9)
X	29	-0.2 (0.8) [-0.5, 0.1]	0.97 (0.94, 0.99)	0.6 (0.0, 2.4)
Y	29	0.7 (0.7) [0.5, 1.0]	0.99 (0.98, 1.00)	0.7 (0.1, 2.4)
Z	29	-0.3 (1.0) [-0.7, 0.1]	0.99 (0.99, 1.00)	0.7 (0.1, 3.0)

Left zygomaticomaxillary suture

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	29	-0.5 (0.7) [-0.7, -0.2]	0.99 (0.99, 1.00)	0.6 (0.0, 1.8)
X	29	0.0 (0.7) [-0.3, 0.3]	0.98 (0.95, 0.99)	0.5 (0.0, 1.5)
Y	29	0.7 (0.7) [0.4, 0.9]	0.99 (0.99, 1.00)	0.7 (0.1, 1.9)
Z	29	-0.4 (0.9) [-0.7, -0.1]	0.99 (0.99, 1.00)	0.7 (0.1, 2.9)

Right infraorbital foramen

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	30	0.0 (0.3) [-0.1, 0.2]	1.00 (1.00, 1.00)	0.2 (0.0, 0.7)
X	30	0.0 (0.4) [-0.2, 0.2]	0.99 (0.98, 0.99)	0.3 (0.0, 1.2)
Y	30	-0.1 (0.4) [-0.3, 0.0]	1.00 (1.00, 1.00)	0.3 (0.0, 0.9)
Z	30	0.0 (0.3) [-0.1, 0.1]	1.00 (1.00, 1.00)	0.2 (0.0, 0.6)

Left infraorbital foramen

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	31	-0.2 (0.3) [-0.3, -0.1]	1.00 (1.00, 1.00)	0.3 (0.0, 0.8)
X	31	0.0 (0.4) [-0.1, 0.2]	0.99 (0.98, 0.99)	0.3 (0.0, 0.8)
Y	31	-0.3 (0.4) [-0.4, -0.1]	1.00 (1.00, 1.00)	0.3 (0.0, 1.1)
Z	31	-0.3 (0.4) [-0.4, -0.1]	1.00 (1.00, 1.00)	0.3 (0.0, 1.1)

E1 Mandible: Distance in Each Plane

Right medial condyle

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	29	0.2 (0.4) [0.0, 0.4]	0.99 (0.98, 1.00)	0.3 (0.0, 1.0)
X	29	-0.1 (0.4) [-0.2, 0.1]	0.99 (0.98, 1.00)	0.3 (0.0, 0.9)
Y	29	-0.4 (0.7) [-0.7, -0.1]	0.99 (0.99, 1.00)	0.6 (0.0, 2.0)
Z	29	0.2 (0.5) [0.0, 0.4]	1.00 (1.00, 1.00)	0.3 (0.0, 1.2)

Right lateral condyle

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	29	-0.5 (0.4) [-0.7, -0.3]	0.99 (0.97, 0.99)	0.5 (0.0, 1.4)
X	29	0.3 (0.5) [0.1, 0.5]	0.99 (0.98, 0.99)	0.4 (0.1, 1.6)
Y	29	0.0 (0.8) [-0.3, 0.2]	1.00 (0.99, 1.00)	0.5 (0.0, 1.8)
Z	29	-0.6 (0.9) [-1.0, -0.3]	0.99 (0.99, 1.00)	0.7 (0.0, 2.4)

Right posterior condyle

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	28	-0.4 (0.7) [-0.7, -0.1]	0.98 (0.96, 0.99)	0.6 (0.0, 2.0)
X	28	0.4 (0.7) [0.1, 0.7]	0.97 (0.93, 0.99)	0.5 (0.0, 2.0)
Y	28	-0.2 (0.7) [-0.5, 0.0]	1.00 (0.99, 1.00)	0.5 (0.0, 1.4)

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Z	28	0.0 (0.5) [-0.2, 0.2]	1.00 (1.00, 1.00)	0.3 (0.0, 1.1)

Right superior condyle

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	29	-0.2 (0.8) [-0.5, 0.1]	0.98 (0.96, 0.99)	0.6 (0.0, 1.6)
X	29	0.2 (0.7) [0.0, 0.5]	0.98 (0.96, 0.99)	0.5 (0.0, 1.6)
Y	29	-0.2 (0.4) [-0.4, -0.1]	1.00 (1.00, 1.00)	0.3 (0.0, 1.3)
Z	29	-0.1 (0.7) [-0.4, 0.1]	1.00 (0.99, 1.00)	0.5 (0.0, 1.3)

Left medial condyle

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	30	0.4 (0.4) [0.2, 0.5]	0.99 (0.98, 0.99)	0.4 (0.0, 1.0)
X	30	0.3 (0.3) [0.2, 0.4]	0.99 (0.98, 1.00)	0.3 (0.0, 1.0)
Y	30	-0.1 (0.5) [-0.2, 0.1]	1.00 (1.00, 1.00)	0.3 (0.1, 1.4)
Z	30	0.2 (0.5) [0.0, 0.4]	1.00 (1.00, 1.00)	0.4 (0.0, 1.3)

Left lateral condyle

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	30	-0.2 (0.4) [-0.4, -0.1]	0.99 (0.99, 1.00)	0.3 (0.0, 1.1)
X	30	-0.2 (0.4) [-0.4, -0.1]	0.99 (0.98, 1.00)	0.3 (0.0, 1.0)
Y	30	-0.2 (0.6) [-0.5, 0.0]	1.00 (0.99, 1.00)	0.5 (0.0, 1.7)
Z	30	0.0 (0.4) [-0.2, 0.1]	1.00 (1.00, 1.00)	0.3 (0.0, 1.0)

Left posterior condyle

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	30	0.0 (0.7) [-0.3, 0.2]	0.99 (0.97, 0.99)	0.5 (0.0, 1.4)
X	30	-0.1 (0.6) [-0.3, 0.2]	0.98 (0.96, 0.99)	0.4 (0.0, 1.4)
Y	30	-0.2 (0.7) [-0.4, 0.1]	1.00 (0.99, 1.00)	0.5 (0.0, 1.7)
Z	30	0.1 (0.3) [0.0, 0.3]	1.00 (1.00, 1.00)	0.2 (0.0, 0.7)

Left superior condyle

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	30	-0.1 (0.5) [-0.3, 0.1]	0.98 (0.97, 0.99)	0.4 (0.0, 1.1)
X	30	-0.1 (0.5) [-0.3, 0.1]	0.99 (0.97, 0.99)	0.4 (0.1, 1.1)
Y	30	-0.1 (0.3) [-0.2, 0.0]	1.00 (1.00, 1.00)	0.2 (0.0, 0.7)
Z	30	0.0 (0.4) [-0.2, 0.1]	1.00 (1.00, 1.00)	0.3 (0.0, 0.8)

Right mental foramen

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	30	0.0 (0.4) [-0.2, 0.1]	1.00 (1.00, 1.00)	0.3 (0.1, 0.9)
X	30	0.2 (0.5) [0.0, 0.4]	0.98 (0.97, 0.99)	0.4 (0.1, 1.3)
Y	30	0.1 (0.5) [-0.1, 0.3]	1.00 (1.00, 1.00)	0.4 (0.0, 1.3)
Z	30	0.1 (0.3) [0.0, 0.2]	1.00 (1.00, 1.00)	0.3 (0.0, 0.9)

Left mental foramen

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	30	0.0 (0.5) [-0.1, 0.2]	1.00 (1.00, 1.00)	0.3 (0.0, 0.9)
X	30	0.0 (0.5) [-0.1, 0.2]	0.98 (0.97, 0.99)	0.3 (0.0, 1.2)
Y	30	0.0 (0.5) [-0.2, 0.2]	1.00 (1.00, 1.00)	0.3 (0.0, 1.2)
Z	30	0.0 (0.4) [-0.1, 0.2]	1.00 (1.00, 1.00)	0.3 (0.0, 0.9)

Mid-mental

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	30	0.0 (0.3) [-0.1, 0.1]	1.00 (1.00, 1.00)	0.2 (0.0, 0.8)
X	30	0.1 (0.3) [0.0, 0.2]	0.99 (0.98, 1.00)	0.2 (0.0, 0.7)
Y	30	0.1 (0.4) [-0.1, 0.2]	1.00 (1.00, 1.00)	0.3 (0.0, 1.0)
Z	30	0.1 (0.3) [0.0, 0.2]	1.00 (1.00, 1.00)	0.2 (0.0, 0.6)

Mandibular alveolar crest

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	26	-0.5 (0.5) [-0.7, -0.3]	1.00 (0.99, 1.00)	0.5 (0.0, 1.6)
X	26	0.1 (0.4) [-0.1, 0.2]	0.99 (0.98, 0.99)	0.3 (0.0, 1.0)
Y	26	0.3 (0.6) [0.0, 0.5]	0.99 (0.99, 1.00)	0.5 (0.0, 2.3)
Z	26	-0.4 (0.5) [-0.6, -0.2]	1.00 (0.99, 1.00)	0.4 (0.0, 1.6)

Right lingula

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	27	0.0 (0.4) [-0.1, 0.2]	1.00 (1.00, 1.00)	0.3 (0.0, 0.7)
X	27	0.2 (0.5) [0.0, 0.4]	0.99 (0.98, 1.00)	0.3 (0.0, 1.1)
Y	27	-0.2 (0.4) [-0.4, -0.1]	1.00 (1.00, 1.00)	0.4 (0.0, 1.5)
Z	27	0.0 (0.5) [-0.2, 0.2]	1.00 (1.00, 1.00)	0.3 (0.0, 1.0)

Left lingula

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	25	0.0 (0.3) [-0.1, 0.2]	1.00 (1.00, 1.00)	0.2 (0.0, 0.6)
X	25	-0.1 (0.5) [-0.3, 0.1]	0.98 (0.96, 0.99)	0.4 (0.0, 1.2)
Y	25	-0.1 (0.3) [-0.3, 0.0]	1.00 (1.00, 1.00)	0.2 (0.0, 0.6)
Z	25	0.0 (0.5) [-0.2, 0.2]	1.00 (1.00, 1.00)	0.4 (0.0, 1.3)

Right inferior alveolar foramen

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	28	0.1 (0.5) [-0.1, 0.3]	1.00 (0.99, 1.00)	0.4 (0.0, 1.0)
X	28	-0.4 (0.7) [-0.7, -0.2]	0.97 (0.94, 0.99)	0.6 (0.1, 1.6)
Y	28	0.0 (0.5) [-0.2, 0.3]	1.00 (1.00, 1.00)	0.4 (0.0, 1.5)
Z	28	-0.4 (0.7) [-0.7, -0.1]	1.00 (0.99, 1.00)	0.6 (0.1, 2.3)

Left inferior alveolar foramen

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	30	0.1 (0.4) [-0.1, 0.3]	1.00 (1.00, 1.00)	0.3 (0.0, 0.8)
X	30	0.5 (0.5) [0.3, 0.6]	0.97 (0.95, 0.99)	0.5 (0.1, 2.0)
Y	30	0.1 (0.5) [-0.1, 0.3]	1.00 (1.00, 1.00)	0.4 (0.0, 1.5)
Z	30	-0.2 (0.5) [-0.4, -0.1]	1.00 (1.00, 1.00)	0.4 (0.0, 1.3)

Right coronoid notch

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	30	-0.1 (0.4) [-0.2, 0.0]	1.00 (0.99, 1.00)	0.3 (0.0, 0.7)
X	30	0.1 (0.4) [0.0, 0.3]	0.99 (0.99, 1.00)	0.3 (0.0, 1.0)
Y	30	-0.2 (0.4) [-0.3, 0.0]	1.00 (1.00, 1.00)	0.3 (0.0, 1.0)
Z	30	-0.1 (0.7) [-0.4, 0.2]	1.00 (0.99, 1.00)	0.5 (0.0, 1.9)

Left coronoid notch

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	31	0.1 (0.3) [-0.1, 0.2]	1.00 (1.00, 1.00)	0.2 (0.0, 0.7)
X	31	0.1 (0.4) [-0.1, 0.2]	0.99 (0.99, 1.00)	0.3 (0.0, 0.8)

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Y	31	-0.1 (0.4) [-0.3, 0.0]	1.00 (1.00, 1.00)	0.3 (0.0, 1.1)
Z	31	-0.1 (0.6) [-0.3, 0.1]	1.00 (1.00, 1.00)	0.4 (0.0, 1.3)

Right gonion

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	29	0.1 (0.7) [-0.2, 0.4]	1.00 (0.99, 1.00)	0.5 (0.0, 1.5)
X	29	-0.3 (0.6) [-0.6, -0.1]	0.99 (0.98, 1.00)	0.5 (0.0, 1.8)
Y	29	0.2 (0.8) [-0.2, 0.5]	1.00 (0.99, 1.00)	0.6 (0.0, 2.0)
Z	29	0.1 (0.6) [-0.1, 0.4]	1.00 (1.00, 1.00)	0.4 (0.0, 1.6)

Left gonion

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	30	0.7 (1.0) [0.3, 1.1]	0.99 (0.98, 0.99)	0.8 (0.1, 3.0)
X	30	0.3 (0.6) [0.0, 0.5]	0.99 (0.97, 0.99)	0.5 (0.0, 1.3)
Y	30	-0.6 (1.1) [-1.0, -0.1]	0.99 (0.98, 1.00)	0.9 (0.0, 3.0)
Z	30	0.5 (0.7) [0.3, 0.8]	0.99 (0.99, 1.00)	0.6 (0.0, 2.1)

Right anterior gonial angle

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	30	-0.2 (0.8) [-0.5, 0.1]	1.00 (0.99, 1.00)	0.6 (0.1, 1.8)
X	30	-0.3 (1.0) [-0.7, 0.1]	0.97 (0.93, 0.98)	0.7 (0.1, 3.3)
Y	30	0.2 (0.7) [-0.1, 0.5]	1.00 (0.99, 1.00)	0.5 (0.0, 2.3)
Z	30	-0.5 (1.8) [-1.2, 0.2]	0.98 (0.96, 0.99)	1.3 (0.2, 6.3)

Left anterior gonial angle

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	31	0.2 (0.5) [0.1, 0.4]	1.00 (1.00, 1.00)	0.4 (0.0, 1.4)
X	31	0.2 (0.6) [0.0, 0.4]	0.99 (0.98, 0.99)	0.4 (0.0, 1.6)
Y	31	0.0 (0.5) [-0.2, 0.2]	1.00 (1.00, 1.00)	0.4 (0.0, 1.2)
Z	31	0.5 (1.1) [0.1, 0.9]	0.99 (0.98, 1.00)	0.9 (0.0, 3.0)

E1 Cranial base: Distance in Each Plane

Right anterior clinoid

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	31	0.2 (0.3) [0.1, 0.3]	1.00 (1.00, 1.00)	0.3 (0.0, 0.8)
X	31	-0.1 (0.5) [-0.2, 0.1]	0.98 (0.96, 0.99)	0.3 (0.0, 1.3)
Y	31	0.0 (0.5) [-0.2, 0.2]	1.00 (1.00, 1.00)	0.3 (0.0, 1.1)
Z	31	0.2 (0.3) [0.1, 0.3]	1.00 (1.00, 1.00)	0.3 (0.0, 0.8)

Left anterior clinoid

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	31	0.2 (0.3) [0.0, 0.3]	1.00 (1.00, 1.00)	0.3 (0.0, 0.9)
X	31	0.0 (0.4) [-0.2, 0.1]	0.99 (0.98, 1.00)	0.3 (0.0, 0.7)
Y	31	-0.1 (0.5) [-0.2, 0.1]	1.00 (1.00, 1.00)	0.3 (0.0, 1.3)
Z	31	0.3 (0.3) [0.2, 0.4]	1.00 (1.00, 1.00)	0.3 (0.0, 0.8)

Mid-clinoid

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	31	0.2 (0.3) [0.1, 0.3]	1.00 (1.00, 1.00)	0.3 (0.0, 0.7)
X	31	-0.1 (0.3) [-0.2, 0.0]	0.99 (0.98, 1.00)	0.2 (0.0, 0.7)

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Y	31	0.0 (0.4) [-0.2, 0.1]	1.00 (1.00, 1.00)	0.3 (0.0, 0.8)
Z	31	0.3 (0.2) [0.2, 0.3]	1.00 (1.00, 1.00)	0.2 (0.0, 0.8)

Nasion

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	31	-0.2 (0.3) [-0.3, -0.1]	1.00 (1.00, 1.00)	0.3 (0.0, 0.8)
X	31	-0.1 (0.4) [-0.2, 0.1]	0.99 (0.97, 0.99)	0.3 (0.0, 0.8)
Y	31	-0.1 (0.4) [-0.2, 0.1]	1.00 (1.00, 1.00)	0.3 (0.0, 0.9)
Z	31	-0.2 (0.4) [-0.3, -0.1]	1.00 (1.00, 1.00)	0.3 (0.0, 0.8)

2.2 Accuracy and Reliability for Examiner 2 (E2)

E2 Dental: Distance in Each Plane

UR6 Mesiolingual cusp tip

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	23	-0.2 (0.4) [-0.4, 0.0]	1.00 (1.00, 1.00)	0.3 (0.0, 1.0)
X	23	-0.1 (0.6) [-0.3, 0.2]	0.98 (0.96, 0.99)	0.4 (0.1, 1.3)
Y	23	0.4 (0.4) [0.3, 0.6]	1.00 (1.00, 1.00)	0.4 (0.0, 1.1)
Z	23	0.0 (0.5) [-0.2, 0.3]	1.00 (1.00, 1.00)	0.4 (0.1, 1.1)

UL6 Mesiolingual cusp tip

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	24	-0.3 (0.5) [-0.5, -0.1]	1.00 (0.99, 1.00)	0.4 (0.0, 1.2)
X	24	0.1 (0.5) [-0.2, 0.3]	0.98 (0.96, 0.99)	0.4 (0.0, 1.1)
Y	24	0.4 (0.4) [0.3, 0.6]	1.00 (0.99, 1.00)	0.4 (0.1, 1.1)
Z	24	-0.1 (0.6) [-0.3, 0.2]	1.00 (1.00, 1.00)	0.4 (0.1, 1.4)

LR6 central fossa

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	23	0.2 (0.3) [0.1, 0.3]	1.00 (1.00, 1.00)	0.3 (0.0, 1.0)
X	23	0.2 (0.4) [0.0, 0.3]	0.99 (0.98, 1.00)	0.3 (0.0, 1.5)
Y	23	-0.5 (0.4) [-0.6, -0.3]	1.00 (0.99, 1.00)	0.4 (0.0, 1.1)
Z	23	0.0 (0.4) [-0.2, 0.1]	1.00 (1.00, 1.00)	0.3 (0.0, 0.9)

LL6 central fossa

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	27	0.1 (0.4) [0.0, 0.3]	1.00 (1.00, 1.00)	0.3 (0.1, 0.8)
X	27	0.0 (0.5) [-0.2, 0.2]	0.98 (0.96, 0.99)	0.4 (0.0, 1.0)
Y	27	-0.3 (0.3) [-0.5, -0.2]	1.00 (1.00, 1.00)	0.3 (0.0, 1.0)
Z	27	-0.1 (0.4) [-0.2, 0.1]	1.00 (1.00, 1.00)	0.3 (0.0, 1.0)

UR3 cusp tip

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	26	-0.8 (0.5) [-1.0, -0.6]	0.99 (0.99, 1.00)	0.7 (0.1, 1.7)
X	26	0.2 (0.7) [0.0, 0.5]	0.96 (0.92, 0.98)	0.5 (0.1, 1.8)
Y	26	0.5 (0.5) [0.3, 0.8]	0.99 (0.99, 1.00)	0.5 (0.1, 1.2)
Z	26	-0.6 (0.4) [-0.8, -0.4]	1.00 (0.99, 1.00)	0.5 (0.0, 1.6)

UL3 cusp tip

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	25	-1.2 (0.6) [-1.4, -0.9]	0.99 (0.97, 0.99)	0.9 (0.1, 2.3)
X	25	-0.3 (0.8) [-0.6, 0.1]	0.97 (0.93, 0.99)	0.6 (0.0, 2.1)
Y	25	0.7 (0.4) [0.5, 0.9]	0.99 (0.99, 1.00)	0.6 (0.1, 1.4)
Z	25	-0.9 (0.6) [-1.2, -0.7]	0.99 (0.98, 1.00)	0.8 (0.0, 2.2)

LR3 cusp tip

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	19	-0.2 (0.6) [-0.6, 0.1]	1.00 (0.99, 1.00)	0.5 (0.0, 1.4)
X	19	0.3 (0.9) [-0.2, 0.7]	0.93 (0.82, 0.97)	0.6 (0.3, 2.1)
Y	19	-0.4 (0.5) [-0.6, -0.1]	1.00 (0.99, 1.00)	0.4 (0.1, 1.3)
Z	19	-0.5 (0.6) [-0.8, -0.2]	1.00 (0.99, 1.00)	0.5 (0.1, 1.8)

LL3 cusp tip

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	17	0.1 (0.4) [-0.1, 0.3]	1.00 (1.00, 1.00)	0.3 (0.0, 1.2)
X	17	-0.2 (0.9) [-0.7, 0.2]	0.91 (0.78, 0.97)	0.6 (0.0, 2.2)
Y	17	-0.3 (0.4) [-0.6, -0.1]	1.00 (0.99, 1.00)	0.4 (0.0, 1.3)
Z	17	0.0 (0.5) [-0.3, 0.2]	1.00 (1.00, 1.00)	0.3 (0.0, 0.9)

UR1 mesial-uncisal edge

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	24	-0.2 (0.3) [-0.3, -0.1]	1.00 (1.00, 1.00)	0.3 (0.0, 0.8)
X	24	-0.2 (0.5) [-0.4, 0.0]	0.98 (0.95, 0.99)	0.4 (0.0, 1.6)
Y	24	0.3 (0.4) [0.2, 0.5]	1.00 (0.99, 1.00)	0.4 (0.0, 1.1)
Z	24	-0.1 (0.4) [-0.2, 0.1]	1.00 (1.00, 1.00)	0.2 (0.0, 0.7)

LR1 mesial-uncisal edge

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	21	0.1 (0.4) [0.0, 0.3]	1.00 (1.00, 1.00)	0.3 (0.0, 0.8)
X	21	-0.2 (0.4) [-0.4, 0.0]	0.99 (0.97, 0.99)	0.3 (0.0, 1.0)
Y	21	-0.2 (0.4) [-0.4, -0.1]	1.00 (0.99, 1.00)	0.3 (0.0, 1.2)
Z	21	0.0 (0.4) [-0.1, 0.2]	1.00 (1.00, 1.00)	0.2 (0.0, 0.8)

E2 Maxilla: Distance in Each Plane

Anterior palatal foramen

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	31	-0.2 (0.5) [-0.4, 0.0]	1.00 (1.00, 1.00)	0.3 (0.0, 1.2)
X	31	-0.1 (0.5) [-0.3, 0.1]	0.98 (0.97, 0.99)	0.3 (0.0, 1.0)
Y	31	0.4 (0.5) [0.2, 0.6]	1.00 (0.99, 1.00)	0.5 (0.1, 1.5)
Z	31	-0.1 (0.4) [-0.2, 0.1]	1.00 (1.00, 1.00)	0.3 (0.0, 1.0)

Anterior palate

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	29	-0.7 (0.6) [-1.0, -0.5]	0.99 (0.99, 1.00)	0.7 (0.0, 1.8)
X	29	0.1 (0.4) [-0.1, 0.2]	0.98 (0.97, 0.99)	0.3 (0.0, 0.9)
Y	29	0.0 (0.5) [-0.2, 0.2]	1.00 (1.00, 1.00)	0.3 (0.1, 1.2)
Z	29	-0.8 (0.6) [-1.0, -0.5]	0.99 (0.99, 1.00)	0.7 (0.1, 1.7)

Posterior palate

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	31	0.4 (0.5) [0.2, 0.6]	1.00 (0.99, 1.00)	0.4 (0.0, 1.3)
X	31	-0.1 (0.5) [-0.3, 0.1]	0.98 (0.95, 0.99)	0.4 (0.0, 1.0)
Y	31	0.0 (0.4) [-0.1, 0.2]	1.00 (1.00, 1.00)	0.3 (0.0, 0.9)
Z	31	0.5 (0.5) [0.3, 0.6]	1.00 (0.99, 1.00)	0.5 (0.0, 1.4)

Maxillary alveolar crest

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	27	-0.7 (0.6) [-0.9, -0.4]	1.00 (0.99, 1.00)	0.6 (0.0, 1.9)
X	27	-0.1 (0.6) [-0.3, 0.2]	0.98 (0.96, 0.99)	0.4 (0.0, 1.3)
Y	27	0.9 (1.0) [0.5, 1.3]	0.99 (0.97, 0.99)	0.9 (0.0, 2.8)
Z	27	-0.3 (0.4) [-0.5, -0.2]	1.00 (1.00, 1.00)	0.4 (0.0, 1.1)

Left greater palatine foramen

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	30	0.2 (0.5) [0.0, 0.4]	1.00 (0.99, 1.00)	0.4 (0.0, 1.0)
X	30	0.4 (0.4) [0.3, 0.6]	0.97 (0.95, 0.99)	0.4 (0.0, 1.4)
Y	30	-0.1 (0.5) [-0.3, 0.1]	1.00 (1.00, 1.00)	0.4 (0.0, 1.3)
Z	30	0.0 (0.7) [-0.2, 0.3]	1.00 (0.99, 1.00)	0.5 (0.0, 1.7)

Right greater palatine foramen

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	29	0.0 (0.5) [-0.2, 0.2]	1.00 (1.00, 1.00)	0.4 (0.0, 0.9)
X	29	-0.6 (0.6) [-0.8, -0.4]	0.96 (0.91, 0.98)	0.6 (0.0, 1.8)
Y	29	-0.2 (0.4) [-0.3, 0.0]	1.00 (1.00, 1.00)	0.3 (0.0, 1.4)
Z	29	-0.2 (0.7) [-0.5, 0.0]	1.00 (0.99, 1.00)	0.5 (0.1, 1.7)

Right tuberosity

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	29	0.1 (0.4) [-0.1, 0.3]	1.00 (1.00, 1.00)	0.3 (0.0, 1.1)
X	29	-0.5 (0.7) [-0.8, -0.2]	0.95 (0.90, 0.98)	0.6 (0.0, 2.4)
Y	29	0.3 (0.7) [0.1, 0.5]	1.00 (0.99, 1.00)	0.5 (0.0, 1.9)
Z	29	0.0 (0.4) [-0.1, 0.2]	1.00 (1.00, 1.00)	0.3 (0.0, 0.8)

Left tuberosity

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	28	0.1 (0.3) [-0.1, 0.2]	1.00 (1.00, 1.00)	0.2 (0.0, 0.7)
X	28	0.6 (0.8) [0.3, 0.9]	0.94 (0.88, 0.97)	0.7 (0.0, 2.3)
Y	28	0.5 (0.6) [0.2, 0.7]	1.00 (0.99, 1.00)	0.5 (0.0, 1.8)
Z	28	0.1 (0.4) [-0.1, 0.2]	1.00 (1.00, 1.00)	0.3 (0.0, 1.1)

Right zygomaticomaxillary arch

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	29	-0.1 (1.0) [-0.5, 0.2]	0.99 (0.98, 1.00)	0.7 (0.0, 2.1)
X	29	0.0 (0.7) [-0.3, 0.3]	0.98 (0.95, 0.99)	0.5 (0.0, 2.2)
Y	29	1.0 (1.0) [0.6, 1.4]	0.98 (0.97, 0.99)	1.0 (0.1, 3.2)
Z	29	0.1 (1.4) [-0.4, 0.6]	0.99 (0.98, 0.99)	1.0 (0.1, 2.9)

Left zygomaticomaxillary suture

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	29	0.0 (0.8) [-0.3, 0.3]	0.99 (0.99, 1.00)	0.6 (0.0, 1.8)
X	29	-0.4 (0.7) [-0.6, -0.1]	0.97 (0.94, 0.99)	0.5 (0.0, 1.6)

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Y	29	0.8 (0.7) [0.5, 1.1]	0.99 (0.98, 1.00)	0.7 (0.2, 2.1)
Z	29	0.4 (1.0) [0.0, 0.8]	0.99 (0.99, 1.00)	0.7 (0.0, 2.4)

Right infraorbital foramen

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	30	-0.3 (0.4) [-0.4, -0.2]	1.00 (1.00, 1.00)	0.3 (0.0, 0.8)
X	30	0.4 (0.5) [0.2, 0.6]	0.97 (0.95, 0.99)	0.5 (0.0, 1.6)
Y	30	0.0 (0.3) [-0.2, 0.1]	1.00 (1.00, 1.00)	0.2 (0.0, 0.8)
Z	30	-0.2 (0.4) [-0.3, 0.0]	1.00 (1.00, 1.00)	0.3 (0.0, 1.1)

Left infraorbital foramen

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	31	-0.2 (0.4) [-0.4, -0.1]	1.00 (1.00, 1.00)	0.3 (0.0, 1.0)
X	31	0.0 (0.5) [-0.2, 0.2]	0.99 (0.98, 0.99)	0.3 (0.0, 1.1)
Y	31	-0.1 (0.5) [-0.3, 0.0]	1.00 (1.00, 1.00)	0.3 (0.0, 1.1)
Z	31	-0.3 (0.5) [-0.5, -0.1]	1.00 (1.00, 1.00)	0.4 (0.0, 1.3)

E2 Mandible: Distance in Each Plane

Right medial condyle

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	29	0.4 (0.4) [0.2, 0.5]	0.99 (0.98, 0.99)	0.4 (0.0, 1.2)
X	29	-0.2 (0.4) [-0.4, -0.1]	0.99 (0.97, 0.99)	0.3 (0.0, 1.0)
Y	29	-0.3 (0.7) [-0.6, -0.1]	1.00 (0.99, 1.00)	0.5 (0.0, 2.9)
Z	29	0.3 (0.5) [0.1, 0.4]	1.00 (1.00, 1.00)	0.4 (0.1, 1.4)

Right lateral condyle

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	29	-0.5 (0.5) [-0.7, -0.4]	0.98 (0.97, 0.99)	0.5 (0.0, 1.6)
X	29	0.5 (0.5) [0.3, 0.6]	0.98 (0.97, 0.99)	0.5 (0.1, 1.7)
Y	29	0.1 (1.0) [-0.3, 0.5]	0.99 (0.98, 1.00)	0.7 (0.0, 2.3)
Z	29	-0.4 (0.7) [-0.7, -0.1]	1.00 (0.99, 1.00)	0.6 (0.0, 2.2)

Right posterior condyle

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	28	-0.3 (0.6) [-0.5, -0.1]	0.99 (0.98, 0.99)	0.5 (0.0, 1.9)
X	28	0.5 (0.6) [0.2, 0.7]	0.97 (0.93, 0.99)	0.6 (0.0, 1.9)
Y	28	-0.3 (0.7) [-0.5, 0.0]	1.00 (0.99, 1.00)	0.5 (0.0, 2.1)
Z	28	0.3 (0.5) [0.1, 0.5]	1.00 (1.00, 1.00)	0.4 (0.0, 1.5)

Right superior condyle

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	29	-0.3 (0.7) [-0.5, 0.0]	0.98 (0.96, 0.99)	0.5 (0.0, 1.5)
X	29	0.2 (0.7) [0.0, 0.5]	0.98 (0.96, 0.99)	0.5 (0.0, 1.5)
Y	29	-0.5 (0.4) [-0.7, -0.4]	1.00 (0.99, 1.00)	0.5 (0.1, 1.8)
Z	29	-0.2 (0.7) [-0.5, 0.1]	1.00 (0.99, 1.00)	0.5 (0.0, 1.8)

Left medial condyle

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	30	0.5 (0.4) [0.4, 0.7]	0.98 (0.96, 0.99)	0.5 (0.0, 1.3)
X	30	0.4 (0.4) [0.3, 0.6]	0.98 (0.97, 0.99)	0.4 (0.0, 1.1)
Y	30	0.1 (0.5) [-0.1, 0.3]	1.00 (1.00, 1.00)	0.4 (0.0, 1.6)

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Z	30	0.3 (0.6) [0.1, 0.6]	1.00 (0.99, 1.00)	0.5 (0.0, 1.8)

Left lateral condyle

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	30	-0.3 (0.4) [-0.5, -0.2]	0.99 (0.98, 1.00)	0.4 (0.0, 1.2)
X	30	-0.3 (0.4) [-0.5, -0.2]	0.99 (0.98, 0.99)	0.4 (0.0, 1.3)
Y	30	-0.1 (0.7) [-0.3, 0.2]	1.00 (0.99, 1.00)	0.5 (0.1, 1.6)
Z	30	0.1 (0.5) [-0.1, 0.3]	1.00 (1.00, 1.00)	0.3 (0.0, 1.2)

Left posterior condyle

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	30	-0.1 (0.7) [-0.3, 0.2]	0.98 (0.97, 0.99)	0.5 (0.0, 1.6)
X	30	-0.2 (0.7) [-0.4, 0.1]	0.98 (0.96, 0.99)	0.5 (0.1, 1.6)
Y	30	0.0 (0.7) [-0.3, 0.2]	1.00 (0.99, 1.00)	0.5 (0.0, 1.9)
Z	30	0.3 (0.3) [0.2, 0.4]	1.00 (1.00, 1.00)	0.3 (0.1, 0.8)

Left superior condyle

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	30	-0.1 (0.6) [-0.3, 0.1]	0.98 (0.96, 0.99)	0.4 (0.0, 1.3)
X	30	-0.1 (0.6) [-0.3, 0.1]	0.98 (0.96, 0.99)	0.4 (0.1, 1.2)
Y	30	-0.5 (0.4) [-0.6, -0.3]	1.00 (0.99, 1.00)	0.4 (0.0, 1.3)
Z	30	0.0 (0.5) [-0.2, 0.2]	1.00 (1.00, 1.00)	0.3 (0.0, 1.2)

Right mental foramen

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	30	0.2 (0.7) [-0.1, 0.4]	1.00 (0.99, 1.00)	0.5 (0.0, 1.2)
X	30	0.3 (0.5) [0.1, 0.5]	0.98 (0.96, 0.99)	0.4 (0.0, 1.5)
Y	30	-0.5 (0.9) [-0.8, -0.1]	0.99 (0.98, 1.00)	0.7 (0.0, 2.3)
Z	30	-0.1 (0.5) [-0.3, 0.1]	1.00 (1.00, 1.00)	0.4 (0.0, 1.5)

Left mental foramen

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	30	0.2 (0.4) [0.0, 0.3]	1.00 (1.00, 1.00)	0.3 (0.0, 1.1)
X	30	0.1 (0.5) [-0.1, 0.3]	0.98 (0.96, 0.99)	0.4 (0.0, 1.3)
Y	30	-0.4 (0.7) [-0.7, -0.2]	1.00 (0.99, 1.00)	0.5 (0.0, 1.9)
Z	30	-0.2 (0.5) [-0.3, 0.0]	1.00 (1.00, 1.00)	0.4 (0.0, 1.1)

Mid-mental

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	30	0.2 (0.5) [0.0, 0.4]	1.00 (1.00, 1.00)	0.3 (0.0, 1.1)
X	30	0.2 (0.4) [0.1, 0.4]	0.98 (0.97, 0.99)	0.3 (0.0, 1.2)
Y	30	-0.4 (0.7) [-0.7, -0.2]	0.99 (0.99, 1.00)	0.6 (0.0, 1.8)
Z	30	-0.1 (0.4) [-0.3, 0.0]	1.00 (1.00, 1.00)	0.3 (0.0, 1.3)

Mandibular alveolar crest

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	26	-0.1 (0.5) [-0.3, 0.1]	1.00 (1.00, 1.00)	0.3 (0.0, 0.9)
X	26	0.0 (0.5) [-0.2, 0.2]	0.98 (0.97, 0.99)	0.3 (0.0, 1.2)
Y	26	-0.1 (0.8) [-0.4, 0.3]	0.99 (0.98, 1.00)	0.6 (0.0, 2.4)
Z	26	-0.1 (0.4) [-0.3, 0.0]	1.00 (1.00, 1.00)	0.3 (0.0, 1.0)

Right lingula

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	27	0.2 (0.4) [0.0, 0.3]	1.00 (0.99, 1.00)	0.3 (0.0, 1.1)
X	27	0.2 (0.6) [-0.1, 0.4]	0.98 (0.96, 0.99)	0.5 (0.0, 1.7)
Y	27	-0.3 (0.4) [-0.4, -0.1]	1.00 (1.00, 1.00)	0.3 (0.0, 1.2)
Z	27	0.3 (0.5) [0.1, 0.5]	1.00 (1.00, 1.00)	0.4 (0.0, 1.4)

Left lingula

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	25	0.2 (0.5) [0.0, 0.4]	1.00 (0.99, 1.00)	0.4 (0.1, 1.3)
X	25	-0.2 (0.5) [-0.4, 0.0]	0.98 (0.96, 0.99)	0.4 (0.0, 1.3)
Y	25	-0.4 (0.6) [-0.7, -0.1]	1.00 (0.99, 1.00)	0.5 (0.0, 2.1)
Z	25	0.2 (0.6) [0.0, 0.5]	1.00 (0.99, 1.00)	0.4 (0.1, 1.4)

Right inferior alveolar foramen

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	28	0.2 (0.6) [0.0, 0.4]	1.00 (0.99, 1.00)	0.4 (0.0, 1.6)
X	28	-0.1 (0.5) [-0.3, 0.1]	0.99 (0.98, 1.00)	0.4 (0.0, 1.1)
Y	28	-0.1 (0.7) [-0.4, 0.2]	1.00 (0.99, 1.00)	0.5 (0.0, 1.9)
Z	28	0.2 (0.6) [0.0, 0.4]	1.00 (1.00, 1.00)	0.4 (0.0, 1.8)

Left inferior alveolar foramen

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	30	0.3 (0.4) [0.1, 0.4]	1.00 (0.99, 1.00)	0.4 (0.0, 1.0)
X	30	-0.1 (0.6) [-0.3, 0.2]	0.98 (0.95, 0.99)	0.4 (0.0, 1.6)
Y	30	-0.3 (0.6) [-0.5, 0.0]	1.00 (0.99, 1.00)	0.5 (0.0, 2.1)
Z	30	0.4 (0.6) [0.2, 0.6]	1.00 (0.99, 1.00)	0.5 (0.0, 1.8)

Right coronoid notch

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	30	0.3 (0.5) [0.1, 0.5]	0.99 (0.99, 1.00)	0.4 (0.1, 1.6)
X	30	0.1 (0.4) [0.0, 0.3]	0.99 (0.99, 1.00)	0.3 (0.0, 1.0)
Y	30	-0.5 (0.4) [-0.7, -0.4]	1.00 (0.99, 1.00)	0.5 (0.1, 1.3)
Z	30	0.3 (0.8) [0.0, 0.6]	1.00 (0.99, 1.00)	0.6 (0.0, 1.9)

Left coronoid notch

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	31	0.2 (0.3) [0.1, 0.3]	1.00 (0.99, 1.00)	0.3 (0.0, 1.0)
X	31	0.0 (0.4) [-0.1, 0.2]	0.99 (0.98, 1.00)	0.3 (0.0, 0.9)
Y	31	-0.3 (0.4) [-0.5, -0.2]	1.00 (1.00, 1.00)	0.4 (0.0, 1.2)
Z	31	0.2 (0.6) [-0.1, 0.4]	1.00 (1.00, 1.00)	0.4 (0.0, 1.6)

Right gonion

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	29	-1.3 (1.6) [-1.9, -0.7]	0.97 (0.95, 0.99)	1.4 (0.0, 4.3)
X	29	0.1 (0.7) [-0.2, 0.4]	0.99 (0.97, 0.99)	0.5 (0.0, 1.7)
Y	29	1.4 (1.8) [0.7, 2.1]	0.98 (0.95, 0.99)	1.6 (0.1, 5.4)
Z	29	-0.5 (1.2) [-0.9, 0.0]	0.99 (0.98, 1.00)	0.9 (0.1, 2.6)

Left gonion

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	30	0.4 (1.1) [0.0, 0.8]	0.99 (0.98, 1.00)	0.8 (0.0, 2.5)
X	30	-0.3 (0.6) [-0.5, -0.1]	0.99 (0.97, 0.99)	0.5 (0.1, 1.7)

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Y	30	-0.5 (1.1) [-0.9, -0.1]	0.99 (0.98, 1.00)	0.9 (0.2, 2.8)
Z	30	0.9 (1.1) [0.4, 1.3]	0.99 (0.98, 0.99)	1.0 (0.2, 2.9)

Right anterior gonial angle

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	30	-0.5 (0.7) [-0.7, -0.2]	1.00 (0.99, 1.00)	0.6 (0.0, 1.6)
X	30	-0.1 (0.9) [-0.4, 0.2]	0.98 (0.95, 0.99)	0.6 (0.0, 2.2)
Y	30	0.5 (0.6) [0.3, 0.8]	1.00 (0.99, 1.00)	0.6 (0.0, 1.7)
Z	30	-0.2 (1.4) [-0.7, 0.3]	0.99 (0.98, 1.00)	1.0 (0.1, 4.0)

Left anterior gonial angle

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	31	0.4 (0.6) [0.1, 0.6]	1.00 (0.99, 1.00)	0.5 (0.0, 1.8)
X	31	-0.4 (1.0) [-0.8, 0.0]	0.96 (0.91, 0.98)	0.8 (0.0, 4.3)
Y	31	-0.1 (0.7) [-0.3, 0.2]	1.00 (0.99, 1.00)	0.5 (0.0, 1.8)
Z	31	1.4 (1.6) [0.8, 2.0]	0.97 (0.95, 0.99)	1.5 (0.0, 6.5)

E2 Cranial base: Distance in Each Plane

Right anterior clinoid

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	31	0.5 (0.4) [0.4, 0.7]	1.00 (0.99, 1.00)	0.5 (0.0, 1.5)
X	31	-0.2 (0.5) [-0.3, 0.0]	0.98 (0.96, 0.99)	0.3 (0.0, 1.2)
Y	31	0.1 (0.5) [-0.1, 0.3]	1.00 (1.00, 1.00)	0.3 (0.0, 1.5)
Z	31	0.6 (0.4) [0.4, 0.7]	1.00 (0.99, 1.00)	0.5 (0.0, 1.4)

Left anterior clinoid

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	31	0.4 (0.3) [0.3, 0.5]	1.00 (0.99, 1.00)	0.4 (0.1, 1.3)
X	31	0.2 (0.4) [0.0, 0.3]	0.99 (0.98, 1.00)	0.3 (0.0, 1.3)
Y	31	0.0 (0.4) [-0.2, 0.1]	1.00 (1.00, 1.00)	0.3 (0.0, 1.1)
Z	31	0.5 (0.4) [0.3, 0.6]	1.00 (0.99, 1.00)	0.4 (0.0, 1.3)

Mid-clinoid

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	31	0.4 (0.3) [0.3, 0.6]	1.00 (0.99, 1.00)	0.4 (0.0, 1.0)
X	31	0.0 (0.2) [-0.1, 0.1]	1.00 (0.99, 1.00)	0.2 (0.0, 0.6)
Y	31	0.0 (0.4) [-0.1, 0.2]	1.00 (1.00, 1.00)	0.3 (0.0, 1.3)
Z	31	0.5 (0.3) [0.4, 0.6]	1.00 (0.99, 1.00)	0.4 (0.0, 1.2)

Nasion

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	31	-0.5 (0.3) [-0.6, -0.4]	1.00 (1.00, 1.00)	0.4 (0.0, 1.0)
X	31	-0.1 (0.5) [-0.3, 0.0]	0.98 (0.96, 0.99)	0.3 (0.0, 1.1)
Y	31	0.0 (0.3) [-0.1, 0.1]	1.00 (1.00, 1.00)	0.2 (0.0, 0.8)
Z	31	-0.5 (0.3) [-0.6, -0.4]	1.00 (1.00, 1.00)	0.4 (0.0, 1.1)

2.3 Reproducibility for Examiner 1 (E1) and Examiner 2 (E2)

E1 vs E2 Dental: Distance in Each Plane

UR6 Mesiolingual cusp tip

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	23	0.2 (0.3) [0.0, 0.3]	1.00 (1.00, 1.00)	0.3 (0.0, 0.7)
X	23	-0.2 (0.5) [-0.4, 0.0]	0.98 (0.96, 0.99)	0.4 (0.0, 1.6)
Y	23	-0.4 (0.4) [-0.5, -0.2]	1.00 (1.00, 1.00)	0.4 (0.0, 1.0)
Z	23	-0.1 (0.4) [-0.3, 0.0]	1.00 (1.00, 1.00)	0.3 (0.0, 1.3)

UL6 Mesiolingual cusp tip

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	24	0.2 (0.4) [0.0, 0.4]	1.00 (1.00, 1.00)	0.4 (0.0, 1.0)
X	24	0.1 (0.4) [0.0, 0.3]	0.99 (0.98, 1.00)	0.3 (0.0, 1.1)
Y	24	-0.5 (0.3) [-0.6, -0.3]	1.00 (0.99, 1.00)	0.4 (0.1, 1.1)
Z	24	-0.1 (0.6) [-0.3, 0.2]	1.00 (1.00, 1.00)	0.4 (0.1, 1.4)

UR6 Mesiobuccal root apex

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	28	0.0 (0.5) [-0.2, 0.2]	1.00 (1.00, 1.00)	0.3 (0.1, 0.8)
X	28	0.1 (0.6) [-0.1, 0.3]	0.99 (0.97, 0.99)	0.4 (0.0, 1.5)
Y	28	0.3 (0.5) [0.1, 0.5]	1.00 (1.00, 1.00)	0.4 (0.0, 1.2)
Z	28	0.1 (0.4) [-0.1, 0.3]	1.00 (1.00, 1.00)	0.3 (0.0, 0.9)

UL6 Mesiobuccal root apex

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	28	-0.1 (0.5) [-0.3, 0.1]	1.00 (1.00, 1.00)	0.4 (0.0, 1.0)
X	28	0.3 (0.4) [0.1, 0.5]	0.99 (0.97, 0.99)	0.4 (0.0, 1.1)
Y	28	0.3 (0.4) [0.2, 0.4]	1.00 (1.00, 1.00)	0.3 (0.0, 1.0)
Z	28	-0.1 (0.5) [-0.3, 0.1]	1.00 (1.00, 1.00)	0.3 (0.0, 0.9)

LR6 central fossa

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	23	-0.2 (0.3) [-0.3, 0.0]	1.00 (1.00, 1.00)	0.2 (0.0, 0.8)
X	23	-0.1 (0.5) [-0.3, 0.1]	0.99 (0.98, 1.00)	0.3 (0.0, 1.2)
Y	23	0.4 (0.3) [0.3, 0.6]	1.00 (0.99, 1.00)	0.4 (0.0, 1.0)
Z	23	0.1 (0.3) [-0.1, 0.2]	1.00 (1.00, 1.00)	0.2 (0.0, 0.6)

LL6 central fossa

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	27	-0.1 (0.4) [-0.2, 0.1]	1.00 (1.00, 1.00)	0.2 (0.0, 0.7)
X	27	0.0 (0.5) [-0.3, 0.2]	0.98 (0.95, 0.99)	0.4 (0.0, 1.1)
Y	27	0.3 (0.3) [0.2, 0.5]	1.00 (1.00, 1.00)	0.3 (0.0, 0.9)
Z	27	0.2 (0.4) [0.0, 0.3]	1.00 (1.00, 1.00)	0.3 (0.0, 1.2)

LR6 mesial root apex

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	28	0.9 (0.7) [0.6, 1.2]	0.99 (0.98, 1.00)	0.8 (0.1, 2.2)
X	28	-0.7 (0.7) [-1.0, -0.4]	0.95 (0.90, 0.98)	0.7 (0.1, 2.1)
Y	28	-0.9 (0.7) [-1.2, -0.6]	0.99 (0.98, 0.99)	0.8 (0.1, 2.6)
Z	28	0.2 (0.7) [-0.1, 0.4]	1.00 (0.99, 1.00)	0.5 (0.0, 1.6)

LL6 mesial root apex

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	26	0.7 (0.5) [0.5, 0.9]	0.99 (0.99, 1.00)	0.6 (0.0, 1.4)
X	26	0.3 (0.7) [0.0, 0.6]	0.95 (0.90, 0.98)	0.6 (0.0, 2.0)
Y	26	-0.9 (0.7) [-1.2, -0.6]	0.99 (0.98, 1.00)	0.8 (0.0, 3.0)
Z	26	0.0 (0.5) [-0.2, 0.2]	1.00 (1.00, 1.00)	0.3 (0.0, 1.1)

UR3 cusp tip

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	26	0.6 (0.5) [0.4, 0.9]	1.00 (0.99, 1.00)	0.6 (0.0, 1.6)
X	26	-0.1 (0.5) [-0.3, 0.1]	0.98 (0.96, 0.99)	0.4 (0.0, 1.4)
Y	26	-0.5 (0.5) [-0.7, -0.3]	0.99 (0.98, 1.00)	0.5 (0.1, 1.5)
Z	26	0.4 (0.4) [0.3, 0.6]	1.00 (1.00, 1.00)	0.4 (0.0, 1.3)

UL3 cusp tip

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	25	0.8 (0.5) [0.6, 1.0]	0.99 (0.99, 1.00)	0.6 (0.1, 1.7)
X	25	0.3 (0.5) [0.1, 0.5]	0.98 (0.97, 0.99)	0.4 (0.0, 1.4)
Y	25	-0.7 (0.4) [-0.9, -0.6]	0.99 (0.99, 1.00)	0.6 (0.0, 1.4)
Z	25	0.4 (0.5) [0.3, 0.6]	1.00 (1.00, 1.00)	0.4 (0.1, 1.6)

UR3 root apex

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	29	0.1 (0.6) [-0.1, 0.3]	1.00 (1.00, 1.00)	0.4 (0.0, 1.2)
X	29	0.2 (0.6) [0.0, 0.4]	0.98 (0.96, 0.99)	0.4 (0.0, 1.4)
Y	29	0.0 (0.6) [-0.2, 0.2]	1.00 (0.99, 1.00)	0.4 (0.0, 1.2)
Z	29	0.1 (0.5) [-0.1, 0.3]	1.00 (1.00, 1.00)	0.4 (0.0, 1.1)

UL3 root apex

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	28	0.1 (0.4) [-0.1, 0.3]	1.00 (1.00, 1.00)	0.3 (0.0, 0.8)
X	28	0.0 (0.5) [-0.2, 0.2]	0.98 (0.96, 0.99)	0.4 (0.0, 1.1)
Y	28	0.1 (0.7) [-0.2, 0.4]	1.00 (0.99, 1.00)	0.5 (0.0, 1.6)
Z	28	0.2 (0.4) [0.0, 0.3]	1.00 (1.00, 1.00)	0.3 (0.0, 0.8)

LR3 cusp tip

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	19	0.2 (0.6) [-0.1, 0.5]	1.00 (0.99, 1.00)	0.5 (0.0, 1.3)
X	19	-0.1 (0.5) [-0.3, 0.2]	0.98 (0.94, 0.99)	0.4 (0.0, 1.3)
Y	19	0.4 (0.4) [0.2, 0.5]	1.00 (0.99, 1.00)	0.4 (0.0, 0.9)
Z	19	0.4 (0.7) [0.1, 0.8]	1.00 (0.99, 1.00)	0.6 (0.0, 1.9)

LL3 cusp tip

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	17	0.1 (0.5) [-0.1, 0.3]	1.00 (1.00, 1.00)	0.3 (0.0, 1.2)
X	17	0.4 (0.6) [0.1, 0.7]	0.95 (0.86, 0.98)	0.5 (0.0, 2.1)
Y	17	0.3 (0.4) [0.1, 0.4]	1.00 (0.99, 1.00)	0.3 (0.0, 1.0)
Z	17	0.2 (0.5) [0.0, 0.4]	1.00 (1.00, 1.00)	0.4 (0.0, 1.3)

LR3 root apex

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	28	0.3 (0.5) [0.1, 0.5]	1.00 (1.00, 1.00)	0.4 (0.1, 1.1)
X	28	0.2 (0.5) [0.1, 0.4]	0.98 (0.96, 0.99)	0.4 (0.0, 1.3)

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Y	28	-0.5 (0.8) [-0.8, -0.2]	0.99 (0.98, 0.99)	0.7 (0.0, 1.9)
Z	28	0.0 (0.6) [-0.2, 0.2]	1.00 (1.00, 1.00)	0.4 (0.0, 1.7)

LL3 root apex

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	29	0.3 (0.4) [0.2, 0.5]	1.00 (1.00, 1.00)	0.4 (0.0, 1.2)
X	29	-0.1 (0.5) [-0.3, 0.1]	0.98 (0.97, 0.99)	0.3 (0.0, 1.0)
Y	29	-0.6 (0.8) [-0.9, -0.3]	0.99 (0.98, 1.00)	0.7 (0.0, 2.3)
Z	29	0.0 (0.6) [-0.2, 0.2]	1.00 (1.00, 1.00)	0.4 (0.0, 1.0)

UR1 mesial-uncisal edge

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	24	0.0 (0.3) [-0.1, 0.2]	1.00 (1.00, 1.00)	0.2 (0.0, 0.6)
X	24	0.2 (0.4) [0.0, 0.4]	0.98 (0.95, 0.99)	0.3 (0.0, 1.5)
Y	24	-0.4 (0.4) [-0.6, -0.3]	0.99 (0.99, 1.00)	0.4 (0.0, 1.3)
Z	24	-0.2 (0.4) [-0.3, 0.0]	1.00 (1.00, 1.00)	0.3 (0.0, 0.9)

UR1 root apex

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	29	0.0 (0.3) [-0.1, 0.1]	1.00 (1.00, 1.00)	0.2 (0.0, 0.6)
X	29	-0.1 (0.4) [-0.2, 0.1]	0.99 (0.98, 1.00)	0.3 (0.0, 0.8)
Y	29	0.1 (0.5) [0.0, 0.3]	1.00 (0.99, 1.00)	0.3 (0.0, 1.6)
Z	29	0.1 (0.3) [-0.1, 0.2]	1.00 (1.00, 1.00)	0.2 (0.0, 0.6)

LR1 mesial-uncisal edge

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	21	-0.2 (0.3) [-0.3, 0.0]	1.00 (1.00, 1.00)	0.2 (0.0, 0.7)
X	21	0.1 (0.3) [0.0, 0.3]	0.99 (0.98, 1.00)	0.2 (0.0, 0.7)
Y	21	0.4 (0.3) [0.2, 0.5]	1.00 (0.99, 1.00)	0.3 (0.0, 1.2)
Z	21	0.0 (0.2) [-0.1, 0.1]	1.00 (1.00, 1.00)	0.2 (0.0, 0.5)

LR1 root apex

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	26	0.0 (0.3) [-0.1, 0.1]	1.00 (1.00, 1.00)	0.2 (0.0, 0.7)
X	26	-0.1 (0.3) [-0.2, 0.1]	0.99 (0.98, 1.00)	0.2 (0.0, 0.8)
Y	26	-0.4 (0.6) [-0.6, -0.1]	0.99 (0.98, 1.00)	0.5 (0.0, 1.5)
Z	26	-0.3 (0.6) [-0.5, 0.0]	1.00 (0.99, 1.00)	0.5 (0.0, 2.0)

E1 vs E2 Maxilla: Distance in Each Plane

Anterior palatal foramen

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	31	0.1 (0.4) [0.0, 0.3]	1.00 (1.00, 1.00)	0.3 (0.0, 0.8)
X	31	0.0 (0.3) [-0.1, 0.1]	0.99 (0.98, 1.00)	0.2 (0.0, 0.7)
Y	31	-0.4 (0.5) [-0.6, -0.2]	1.00 (0.99, 1.00)	0.5 (0.1, 1.4)
Z	31	0.0 (0.3) [-0.1, 0.1]	1.00 (1.00, 1.00)	0.2 (0.0, 0.8)

Anterior palate

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	29	0.5 (0.7) [0.3, 0.8]	1.00 (0.99, 1.00)	0.6 (0.0, 1.7)
X	29	0.1 (0.4) [-0.1, 0.2]	0.98 (0.97, 0.99)	0.3 (0.0, 0.8)

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Y	29	-0.1 (0.5) [-0.3, 0.2]	1.00 (1.00, 1.00)	0.4 (0.0, 1.3)
Z	29	0.5 (0.7) [0.3, 0.8]	1.00 (0.99, 1.00)	0.6 (0.0, 1.6)

Posterior palate

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	31	0.0 (0.6) [-0.2, 0.2]	1.00 (0.99, 1.00)	0.4 (0.0, 1.3)
X	31	-0.1 (0.4) [-0.2, 0.1]	0.99 (0.97, 0.99)	0.3 (0.0, 0.9)
Y	31	-0.1 (0.5) [-0.3, 0.0]	1.00 (1.00, 1.00)	0.4 (0.1, 1.3)
Z	31	-0.1 (0.6) [-0.4, 0.1]	1.00 (1.00, 1.00)	0.4 (0.0, 1.2)

Maxillary alveolar crest

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	27	0.1 (0.4) [-0.1, 0.3]	1.00 (1.00, 1.00)	0.3 (0.1, 0.9)
X	27	0.1 (0.4) [-0.1, 0.2]	0.99 (0.98, 1.00)	0.3 (0.0, 0.8)
Y	27	-0.8 (1.0) [-1.2, -0.4]	0.99 (0.97, 0.99)	0.9 (0.0, 3.0)
Z	27	-0.2 (0.5) [-0.4, 0.0]	1.00 (1.00, 1.00)	0.4 (0.0, 1.2)

Left greater palatine foramen

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	30	0.3 (0.8) [0.0, 0.6]	0.99 (0.99, 1.00)	0.6 (0.0, 1.6)
X	30	-0.3 (0.4) [-0.4, -0.1]	0.99 (0.97, 0.99)	0.3 (0.0, 1.2)
Y	30	-0.1 (0.4) [-0.3, 0.0]	1.00 (1.00, 1.00)	0.3 (0.0, 0.9)
Z	30	0.3 (0.9) [0.0, 0.6]	0.99 (0.99, 1.00)	0.7 (0.1, 2.2)

Right greater palatine foramen

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	29	0.2 (0.8) [-0.1, 0.4]	1.00 (0.99, 1.00)	0.5 (0.0, 1.7)
X	29	0.4 (0.5) [0.2, 0.6]	0.98 (0.95, 0.99)	0.4 (0.0, 1.3)
Y	29	0.1 (0.5) [0.0, 0.3]	1.00 (1.00, 1.00)	0.3 (0.0, 1.1)
Z	29	0.4 (0.8) [0.0, 0.7]	1.00 (0.99, 1.00)	0.6 (0.0, 2.2)

Right tuberosity

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	29	-0.1 (0.3) [-0.2, 0.0]	1.00 (1.00, 1.00)	0.2 (0.0, 0.7)
X	29	0.7 (0.9) [0.4, 1.1]	0.92 (0.83, 0.96)	0.8 (0.1, 2.8)
Y	29	-0.5 (0.8) [-0.8, -0.2]	0.99 (0.99, 1.00)	0.7 (0.0, 2.4)
Z	29	-0.1 (0.4) [-0.2, 0.1]	1.00 (1.00, 1.00)	0.3 (0.0, 0.9)

Left tuberosity

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	28	-0.1 (0.4) [-0.3, 0.0]	1.00 (1.00, 1.00)	0.3 (0.0, 0.8)
X	28	-0.6 (0.7) [-0.9, -0.3]	0.94 (0.88, 0.97)	0.7 (0.1, 2.3)
Y	28	-0.5 (0.6) [-0.7, -0.2]	1.00 (0.99, 1.00)	0.5 (0.1, 1.8)
Z	28	-0.1 (0.4) [-0.3, 0.0]	1.00 (1.00, 1.00)	0.3 (0.0, 1.0)

Right zygomaticomaxillary arch

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	29	-0.1 (1.0) [-0.5, 0.3]	0.99 (0.98, 1.00)	0.7 (0.0, 2.5)
X	29	-0.2 (0.7) [-0.4, 0.1]	0.98 (0.96, 0.99)	0.5 (0.0, 2.3)
Y	29	-0.3 (0.7) [-0.6, 0.0]	1.00 (0.99, 1.00)	0.5 (0.1, 2.2)
Z	29	-0.4 (1.3) [-0.9, 0.1]	0.99 (0.98, 0.99)	1.0 (0.1, 3.5)

Left zygomaticomaxillary suture

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	29	-0.5 (1.0) [-0.8, -0.1]	0.99 (0.98, 0.99)	0.8 (0.1, 3.0)
X	29	0.4 (0.8) [0.1, 0.7]	0.96 (0.92, 0.98)	0.6 (0.0, 2.1)
Y	29	-0.1 (0.6) [-0.4, 0.1]	1.00 (0.99, 1.00)	0.4 (0.0, 1.3)
Z	29	-0.8 (1.2) [-1.3, -0.4]	0.99 (0.97, 0.99)	1.0 (0.1, 3.5)

Right infraorbital foramen

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	30	0.3 (0.4) [0.2, 0.5]	1.00 (1.00, 1.00)	0.3 (0.0, 0.9)
X	30	-0.4 (0.5) [-0.6, -0.2]	0.98 (0.96, 0.99)	0.4 (0.0, 1.2)
Y	30	-0.1 (0.4) [-0.3, 0.0]	1.00 (1.00, 1.00)	0.3 (0.0, 0.8)
Z	30	0.2 (0.5) [0.0, 0.4]	1.00 (1.00, 1.00)	0.4 (0.0, 1.2)

Left infraorbital foramen

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	31	0.1 (0.3) [-0.1, 0.2]	1.00 (1.00, 1.00)	0.2 (0.0, 0.5)
X	31	0.0 (0.5) [-0.1, 0.2]	0.99 (0.98, 0.99)	0.3 (0.0, 1.2)
Y	31	-0.1 (0.4) [-0.3, 0.0]	1.00 (1.00, 1.00)	0.3 (0.0, 1.3)
Z	31	0.0 (0.4) [-0.1, 0.2]	1.00 (1.00, 1.00)	0.3 (0.0, 0.9)

E1 vs E2 Mandible: Distance in Each Plane

Right medial condyle

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	29	-0.2 (0.4) [-0.3, 0.0]	0.99 (0.99, 1.00)	0.3 (0.0, 0.8)
X	29	0.2 (0.3) [0.0, 0.3]	0.99 (0.99, 1.00)	0.3 (0.0, 0.7)
Y	29	0.0 (0.7) [-0.3, 0.2]	1.00 (0.99, 1.00)	0.5 (0.0, 1.4)
Z	29	0.0 (0.5) [-0.2, 0.1]	1.00 (1.00, 1.00)	0.3 (0.0, 1.1)

Right lateral condyle

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	29	0.0 (0.3) [-0.1, 0.2]	1.00 (0.99, 1.00)	0.2 (0.0, 0.7)
X	29	-0.1 (0.3) [-0.2, 0.0]	1.00 (0.99, 1.00)	0.2 (0.0, 0.6)
Y	29	-0.1 (0.7) [-0.4, 0.1]	1.00 (0.99, 1.00)	0.5 (0.0, 2.1)
Z	29	-0.2 (0.8) [-0.5, 0.1]	1.00 (0.99, 1.00)	0.6 (0.1, 1.7)

Right posterior condyle

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	28	0.0 (0.6) [-0.3, 0.2]	0.99 (0.98, 1.00)	0.4 (0.0, 1.4)
X	28	-0.1 (0.6) [-0.3, 0.2]	0.98 (0.96, 0.99)	0.4 (0.1, 1.1)
Y	28	0.0 (0.9) [-0.3, 0.3]	0.99 (0.99, 1.00)	0.6 (0.1, 1.6)
Z	28	-0.3 (0.3) [-0.5, -0.2]	1.00 (1.00, 1.00)	0.3 (0.0, 1.0)

Right superior condyle

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	29	0.0 (0.7) [-0.2, 0.3]	0.99 (0.97, 0.99)	0.5 (0.0, 1.4)
X	29	0.0 (0.7) [-0.3, 0.3]	0.98 (0.96, 0.99)	0.5 (0.0, 1.7)
Y	29	0.3 (0.3) [0.2, 0.4]	1.00 (1.00, 1.00)	0.3 (0.0, 0.9)
Z	29	0.1 (0.4) [-0.1, 0.2]	1.00 (1.00, 1.00)	0.3 (0.0, 0.9)

Left medial condyle

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Distance	30	-0.2 (0.4) [-0.3, 0.0]	0.99 (0.99, 1.00)	0.3 (0.1, 0.8)
X	30	-0.1 (0.3) [-0.2, 0.0]	0.99 (0.99, 1.00)	0.2 (0.0, 0.8)
Y	30	-0.1 (0.5) [-0.3, 0.1]	1.00 (1.00, 1.00)	0.4 (0.0, 1.2)
Z	30	-0.2 (0.4) [-0.3, 0.0]	1.00 (1.00, 1.00)	0.3 (0.0, 0.8)

Left lateral condyle

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	30	0.1 (0.3) [0.0, 0.2]	1.00 (0.99, 1.00)	0.2 (0.0, 0.7)
X	30	0.1 (0.3) [0.0, 0.2]	1.00 (0.99, 1.00)	0.3 (0.0, 0.7)
Y	30	-0.2 (0.7) [-0.4, 0.1]	1.00 (0.99, 1.00)	0.5 (0.0, 1.5)
Z	30	-0.1 (0.5) [-0.3, 0.1]	1.00 (1.00, 1.00)	0.3 (0.0, 1.5)

Left posterior condyle

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	30	0.1 (0.6) [-0.2, 0.3]	0.99 (0.98, 0.99)	0.4 (0.0, 1.3)
X	30	0.1 (0.6) [-0.1, 0.3]	0.98 (0.97, 0.99)	0.4 (0.0, 1.3)
Y	30	-0.1 (0.7) [-0.4, 0.1]	1.00 (0.99, 1.00)	0.5 (0.0, 1.5)
Z	30	-0.2 (0.3) [-0.3, -0.1]	1.00 (1.00, 1.00)	0.2 (0.0, 0.7)

Left superior condyle

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	30	0.0 (0.4) [-0.2, 0.2]	0.99 (0.98, 0.99)	0.3 (0.0, 0.9)
X	30	0.0 (0.4) [-0.1, 0.2]	0.99 (0.98, 0.99)	0.3 (0.0, 0.9)
Y	30	0.3 (0.3) [0.2, 0.4]	1.00 (1.00, 1.00)	0.3 (0.0, 0.9)
Z	30	0.0 (0.3) [-0.1, 0.1]	1.00 (1.00, 1.00)	0.2 (0.0, 0.6)

Right mental foramen

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	30	-0.2 (0.6) [-0.4, 0.0]	1.00 (0.99, 1.00)	0.5 (0.1, 1.2)
X	30	-0.1 (0.4) [-0.2, 0.1]	0.99 (0.98, 1.00)	0.3 (0.0, 1.0)
Y	30	0.6 (0.8) [0.3, 0.9]	0.99 (0.98, 1.00)	0.7 (0.0, 2.0)
Z	30	0.2 (0.5) [0.1, 0.4]	1.00 (1.00, 1.00)	0.4 (0.0, 1.5)

Left mental foramen

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	30	-0.1 (0.5) [-0.3, 0.0]	1.00 (1.00, 1.00)	0.3 (0.0, 0.9)
X	30	-0.1 (0.6) [-0.3, 0.1]	0.98 (0.95, 0.99)	0.4 (0.0, 1.3)
Y	30	0.4 (0.8) [0.1, 0.7]	0.99 (0.99, 1.00)	0.6 (0.0, 2.2)
Z	30	0.2 (0.5) [0.0, 0.4]	1.00 (1.00, 1.00)	0.4 (0.0, 1.4)

Mid-mental

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	30	-0.2 (0.4) [-0.3, 0.0]	1.00 (1.00, 1.00)	0.3 (0.0, 1.0)
X	30	-0.1 (0.3) [-0.2, 0.0]	0.99 (0.98, 1.00)	0.2 (0.0, 0.7)
Y	30	0.5 (0.6) [0.3, 0.7]	1.00 (0.99, 1.00)	0.5 (0.0, 1.4)
Z	30	0.2 (0.4) [0.1, 0.4]	1.00 (1.00, 1.00)	0.3 (0.0, 1.2)

Mandibular alveolar crest

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	26	-0.4 (0.7) [-0.7, -0.1]	0.99 (0.99, 1.00)	0.6 (0.0, 1.8)
X	26	0.1 (0.4) [-0.1, 0.2]	0.99 (0.98, 1.00)	0.3 (0.1, 0.9)

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Y	26	0.4 (0.7) [-0.1, 0.6]	0.99 (0.98, 1.00)	0.6 (0.0, 2.4)
Z	26	-0.2 (0.6) [-0.5, 0.0]	1.00 (0.99, 1.00)	0.5 (0.0, 1.9)

Right lingula

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	27	-0.1 (0.4) [-0.3, 0.0]	1.00 (1.00, 1.00)	0.3 (0.0, 1.0)
X	27	0.0 (0.4) [-0.2, 0.1]	0.99 (0.98, 1.00)	0.3 (0.0, 1.1)
Y	27	0.0 (0.4) [-0.1, 0.2]	1.00 (1.00, 1.00)	0.3 (0.0, 1.3)
Z	27	-0.2 (0.3) [-0.4, -0.1]	1.00 (1.00, 1.00)	0.3 (0.0, 1.0)

Left lingula

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	25	-0.2 (0.5) [-0.4, 0.0]	1.00 (0.99, 1.00)	0.4 (0.0, 1.1)
X	25	0.0 (0.5) [-0.2, 0.2]	0.98 (0.96, 0.99)	0.3 (0.0, 1.3)
Y	25	0.3 (0.5) [0.0, 0.5]	1.00 (1.00, 1.00)	0.4 (0.0, 1.5)
Z	25	-0.2 (0.4) [-0.3, 0.0]	1.00 (1.00, 1.00)	0.3 (0.0, 1.0)

Right inferior alveolar foramen

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	28	-0.1 (0.6) [-0.3, 0.1]	1.00 (0.99, 1.00)	0.4 (0.0, 1.2)
X	28	-0.4 (0.8) [-0.7, -0.1]	0.97 (0.94, 0.99)	0.6 (0.0, 2.4)
Y	28	0.2 (0.7) [-0.1, 0.4]	1.00 (0.99, 1.00)	0.5 (0.0, 1.5)
Z	28	-0.6 (0.6) [-0.8, -0.3]	1.00 (0.99, 1.00)	0.6 (0.0, 1.9)

Left inferior alveolar foramen

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	30	-0.2 (0.6) [-0.4, 0.0]	1.00 (0.99, 1.00)	0.4 (0.0, 1.4)
X	30	0.5 (0.7) [0.3, 0.8]	0.96 (0.92, 0.98)	0.6 (0.1, 2.3)
Y	30	0.4 (0.8) [0.1, 0.6]	1.00 (0.99, 1.00)	0.6 (0.0, 2.4)
Z	30	-0.6 (0.6) [-0.8, -0.4]	1.00 (0.99, 1.00)	0.6 (0.0, 1.8)

Right coronoid notch

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	30	-0.4 (0.5) [-0.5, -0.2]	0.99 (0.99, 1.00)	0.4 (0.0, 1.4)
X	30	0.0 (0.4) [-0.1, 0.2]	0.99 (0.99, 1.00)	0.3 (0.0, 0.8)
Y	30	0.4 (0.4) [0.2, 0.5]	1.00 (1.00, 1.00)	0.4 (0.0, 1.3)
Z	30	-0.4 (0.9) [-0.7, -0.1]	0.99 (0.99, 1.00)	0.7 (0.0, 2.6)

Left coronoid notch

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	31	-0.2 (0.3) [-0.3, -0.1]	1.00 (1.00, 1.00)	0.2 (0.0, 0.7)
X	31	0.0 (0.4) [-0.1, 0.2]	0.99 (0.99, 1.00)	0.3 (0.0, 0.9)
Y	31	0.2 (0.4) [0.0, 0.3]	1.00 (1.00, 1.00)	0.3 (0.0, 1.3)
Z	31	-0.3 (0.5) [-0.4, -0.1]	1.00 (1.00, 1.00)	0.4 (0.0, 1.2)

Right gonion

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	29	1.4 (1.3) [0.9, 1.9]	0.98 (0.95, 0.99)	1.3 (0.0, 3.9)
X	29	-0.4 (0.7) [-0.7, -0.2]	0.98 (0.97, 0.99)	0.6 (0.1, 1.9)
Y	29	-1.3 (1.5) [-1.9, -0.7]	0.98 (0.96, 0.99)	1.4 (0.1, 4.8)
Z	29	0.6 (0.8) [0.3, 0.9]	0.99 (0.99, 1.00)	0.7 (0.0, 2.2)

Left gonion

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	30	0.3 (1.1) [-0.1, 0.7]	0.99 (0.98, 1.00)	0.8 (0.2, 2.3)
X	30	0.6 (0.6) [0.4, 0.8]	0.98 (0.96, 0.99)	0.6 (0.0, 1.9)
Y	30	0.0 (1.1) [-0.4, 0.4]	0.99 (0.99, 1.00)	0.7 (0.0, 2.0)
Z	30	-0.3 (0.8) [-0.6, 0.0]	1.00 (0.99, 1.00)	0.6 (0.0, 1.8)

Right anterior gonial angle

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	30	0.3 (0.9) [-0.1, 0.6]	1.00 (0.99, 1.00)	0.6 (0.1, 1.9)
X	30	-0.2 (1.2) [-0.7, 0.3]	0.95 (0.90, 0.98)	0.9 (0.1, 3.5)
Y	30	-0.3 (0.8) [-0.6, 0.0]	1.00 (0.99, 1.00)	0.6 (0.1, 2.2)
Z	30	-0.2 (2.1) [-1.0, 0.5]	0.98 (0.95, 0.99)	1.5 (0.0, 6.6)

Left anterior gonial angle

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	31	-0.1 (0.6) [-0.3, 0.1]	1.00 (1.00, 1.00)	0.4 (0.0, 1.3)
X	31	0.5 (1.1) [0.1, 0.9]	0.95 (0.89, 0.97)	0.8 (0.0, 4.1)
Y	31	0.1 (0.7) [-0.2, 0.3]	1.00 (1.00, 1.00)	0.5 (0.0, 1.8)
Z	31	-0.9 (1.4) [-1.4, -0.4]	0.98 (0.97, 0.99)	1.2 (0.0, 5.9)

E1 vs E2 Cranial base: Distance in Each Plane

Right anterior clinoid

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	31	-0.3 (0.3) [-0.4, -0.2]	1.00 (1.00, 1.00)	0.3 (0.0, 1.0)
X	31	0.1 (0.4) [0.0, 0.2]	0.99 (0.97, 0.99)	0.3 (0.0, 0.9)
Y	31	-0.1 (0.4) [-0.2, 0.1]	1.00 (1.00, 1.00)	0.3 (0.0, 0.9)
Z	31	-0.3 (0.3) [-0.4, -0.2]	1.00 (1.00, 1.00)	0.3 (0.0, 0.9)

Left anterior clinoid

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	31	-0.2 (0.4) [-0.4, -0.1]	1.00 (1.00, 1.00)	0.3 (0.0, 1.2)
X	31	-0.2 (0.5) [-0.4, 0.0]	0.98 (0.97, 0.99)	0.3 (0.0, 1.3)
Y	31	0.0 (0.4) [-0.2, 0.1]	1.00 (1.00, 1.00)	0.3 (0.0, 0.8)
Z	31	-0.2 (0.4) [-0.3, 0.0]	1.00 (1.00, 1.00)	0.3 (0.0, 1.1)

Mid-clinoid

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	31	-0.2 (0.3) [-0.3, -0.1]	1.00 (1.00, 1.00)	0.2 (0.0, 0.8)
X	31	0.0 (0.3) [-0.1, 0.0]	0.99 (0.99, 1.00)	0.2 (0.0, 0.6)
Y	31	-0.1 (0.3) [-0.2, 0.1]	1.00 (1.00, 1.00)	0.2 (0.0, 0.8)
Z	31	-0.3 (0.2) [-0.3, -0.2]	1.00 (1.00, 1.00)	0.2 (0.0, 0.8)

Nasion

Measure	n	Mean Diff. (SD) [95% CI]	ICC (95% CI)	D. Error (Min, Max)
Overall Distance	31	0.3 (0.4) [0.1, 0.4]	1.00 (1.00, 1.00)	0.3 (0.0, 0.9)
X	31	0.0 (0.3) [-0.1, 0.2]	0.99 (0.99, 1.00)	0.2 (0.0, 0.6)
Y	31	-0.1 (0.3) [-0.2, 0.0]	1.00 (1.00, 1.00)	0.2 (0.0, 0.6)
Z	31	0.3 (0.4) [0.2, 0.4]	1.00 (1.00, 1.00)	0.3 (0.0, 1.0)