8-2007

Cone beam computed tomographic simulation of panoramic radiology : third molar assessment and mandibular canal.

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CONE BEAM COMPUTED TOMOGRAPHIC SIMULATION OF PANORAMIC RADIOLOGY: THIRD MOLAR ASSESSMENT AND MANDIBULAR CANAL

By

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D.M.D., University of Pittsburgh School of Dental Medicine, 1999

A Thesis
Submitted to the Faculty of the
Graduate School of the University of Louisville
In Partial Fulfillment of the Requirements
for the Degree of

Master of Science

Program in Oral Biology
School of Dentistry
University of Louisville
Louisville, Kentucky

August, 2007

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A Thesis Approved on

May 15th, 2007

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DEDICATION

I would like to thank my family for their love and continued support throughout my educational and professional career in dentistry.

ACKNOWLEDGEMENTS

I am greatly indebted to the following for their assistance on this project:

To Dr. Allan G. Farman, thesis director, for his help and guidance in leading me through the research process. He is the backbone of this project and helped tremendously to direct this project.

To Dr. William C. Scarfe, thesis committee member, for his valued insight and contributions throughout the work on this project.

To Dr. James Scheetz, chief statistician, for his insight into the data analysis. Thanks for your time and knowledge with helping me in the statistical analysis.

To Dr. Chandiramani for her efforts obtaining my data in this research.

ABSTRACT

CONE BEAM COMPUTED TOMOGRAPHIC SIMULATION OF PANORAMIC RADIOLOGY: THIRD MOLAR ASSESSMENT AND MANDIBULAR CANAL

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The aim of the research is to determine if cone beam computerized tomography reconstructed panoramic radiography viewed in two different focal trough shapes, and three different focal trough widths changes the ability to identify high risk radiologic signs associated with an intimate anatomic relationship between third molars and the Inferior Alveolar Nerve. The basic assumption of this research is that a customized focal trough shape with a wider focal trough width at the third molar region will produce more high risk radiologic signs present when there is a relation between the third molar and the Inferior Alveolar Canal.

A retrospective sample of 50 mandibular third molar teeth being less than 3mm from the Inferior Alveolar Canal were picked from the files of the i-CAT CBVCT here at the University of Louisville Radiology Department. The 50 teeth were reconstructed into panoramic images with two different arch shapes (customized and average form), and three different focal trough widths at the third molar region (10, 20, and 40mm). Six high risk radiological panoramic signs of the third molar related to the Mandibular canal will

be evaluated at each tooth and determined to be present or absent by two independent observers. Each observer will also utilize the CBVCT cross sectional analysis of the mandible, measure the distance in mm, the mandibular canal to the closest part of the mandibular third molar tooth. With these observations we will be able to determine the presence or absence of the high risk radiological signs and actually see if the teeth that have the high risk radiological signs are associated with the Inferior Alveolar Nerve, related to the focal trough image layer widths. This analysis will be compared in the two focal trough image layer shapes to determine if a average form of dentition focal trough shape will present more radiographic markers than the customized focal trough shape.

A Ordinal Logistic Regression will be performed to evaluate the relative impact of the predictor variables (radiographic signs, arch forms, and focal trough widths) to the outcome variables (distance of tooth to nerve-groups). Descriptive analysis will also be performed on each tooth to describe the comparison of radiological signs present, group that each tooth falls in related to distance of mandibular nerve in mm to the root of the third molar, whether nerve is buccal, lingual, or central to the root of the tooth, and if the nerve runs through the root, or the root is notched by the nerve.

For all tooth images, radiographic signs will be determined whether they are present or absent using two observers as independent experts to determine accuracy.

Ordinal logistic regression analysis will be used to measure the outcome of radiographic signs present with three categories (Cat. 1, 0-1mm, Cat. 2, 1.001-2mm, Cat. 3, 2+mm). Intraclass correlation coefficient will be used as a measure of agreement to measure both inter and intra rater variability. With respect to intra-observer variability, inter-observer variability, there were significant differences in intra-observer and inter-observer variability.

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LITERATURE REVIEW

The Incidence of Third Molar Tooth Impaction

Impaction of teeth is defined as "confinement of a tooth in the alveolus and prevention of its eruption into normal position"(Stedmans Medical dictionary, 1990). Impaction of dental teeth is common, with up to 20% of the general population demonstrating some degree of failure of eruption of present teeth.. Approximately 50% of all impacted teeth are third molars (Nordenram, 1986). Numerous authors have reported the prevalence of third molar impactions in different populations. (Table 1)

TABLE 1

Prevalence of impacted third molars in different populations

Study	*Population*	*Age group (yrs)*	*Number of subjects*	*% with one or more impacted third molar*
Schersten *et al.* (1989)	Sweden; Dental students	20-39	257	33
Morris and Jerman (1971)	U.S.; Males	17-24	5600	65
Brickley *et al.* (1996)	Wales; Non-random Males and Females	≥35	264	29
Olasoji and Odusanya (2000)	Nigeria; Urban	≥20	2400	23
Chu FCS, *et al.* (2003)	Hong Kong-Chinese pop.	≥17	7486	28.3

In a non-aged stratified study on 1,418 women in Sweden, 8% had impacted teeth and 85% of those teeth were third molars (Ahlqwist and Gröndahl, 1991). Chu, *et al.* (2003) studied 3,853 impacted third molar teeth, and found that mandibular third molars were the most commonly involved (~83%) followed by maxillary third molars (~18%).

Need for Removal of Third Molars

Removal of impacted third molars is the most common oral surgical procedure. In 2002 this procedure resulted in total expenditures in the range of $150-400 million in the U.S. alone. Many investigators have questioned the necessity of removal of third molars for patients who are asymptomatic or free of associated pathoses (Chu, *et al.* 2003; Tulloch and Antczak-Bouckoms, 1987).

In Western society, dental professionals emphasize preventive dentistry. Hugoson and Kugelberg showed a sharp increase in the numbers of third molars extracted between 20-30 years of age principally due to prophylactic removal (Garcia and Chauncey, 1989; Hugoson and Kugelberg, 1988). However, dental insurance plans are frequently not covering prophylactic third molar removals. It has been suggested that antibiotics be used to treat infections associated with impacted third molars instead of removing the tooth concerned. According to Tate (1994), those who are making these suggestions do not understand the cyclic nature of these infections with the resulting occurrence of resistant organisms often leading to very serious infections.

Reasons advanced to extract impacted mandibular third molar teeth have included:

In Sweden, Nordenram, *et al.* (1987) studied the indications for removal of 2,630 mandibular third molars. Reasons provided for extraction were pericoronitis (60%), prophylactic indicators such as prediction of complications if the tooth remained (20%), orthodontic indications (~11%), root resorption of adjacent molar (~5%), and cysts (~5%).

Other authors have also indicated additional indications for third molar extraction including 1) Pain due to partially erupted third molars and the possibility of infection that may accompany them (Nordenram, *et al.,* 1987); 2) Periodontal considerations related to the position of the third molar-periodontal defects on the distal aspect of the mandibular second molars (Baab, 1964); 3) Pathologic resorption of the adjacent teeth (Yamaoka, 1999); 4) Potential for cyst formation and the possible association with neoplastic transformations and pathologic fractures (Tevepaugh and Dodson 1995); 5) Orthodontic considerations (e.g. the *questionable* crowding of lower incisors) (Kaplan 1974) and 6) The presence of third molars under prosthetic appliances (Rosenthal, 1986)

Although pressure resorption of second molars has been associated with impacted and/or erupting third molars, the relationship between such resorption and age is unclear. To investigate this relationship, Yamaoka *et al.* (1999) studied 3,174 individuals of various ages. There were no age or sex differences for the incidence of second molar root resorption. In older individuals, root resorption associated with a completely impacted third molar was more frequent than with a partially impacted third molar, and root resorption at the apex was mainly seen in individuals over 50 years of age. Apical root resorption may be seen long after the formation of completely impacted third molars in both sexes.

Nerve Damage Following Third Molar Extraction

Damage to the inferior alveolar nerve (IAN) is an uncommon complication, but an important one. Temporary disturbances of nerve function typically arise from injuries related to the stretching or crushing of the IAN. Severe crushing injuries associated with nerve impingement may be sustained indirectly, when elevating a tooth or more directly, damaging the nerve with a surgical instrument. Trauma to the IAN can result in a deficiency ranging from total loss of sensation (anesthesia), to a mild decrease in feeling (mild hypoesthesia). These sensory deficits may be either temporary or permanent. Some patients may also experience dysesthesia, which is characterized by abnormally painful sensations. Such pain may be caused by a neuroma that formed some time after the surgery located at the site of the trauma, changes in the autonomic nervous system (sympathetically mediated pain), or alterations in the central nervous system (central neuropathic pain).

Other types of sensory deficits patients may experience include: 1) allodynia, which is a type of dysesthesia characterized by a painful response to normally nonpainful stimuli, such as light touching or shaving; 2) hyperalgesia, which is an exaggeration of the pain response to stimuli; or 3) hyperpathia, which is an exaggerated response to pain that persists even after the stimulus has been removed (LaBanc, 1992). The treatment of these nerve injuries through IAN microsurgery is often unsuccessful, usually not bringing back normal sensation.

There is a percentage of people that have disturbed sensations following third molar surgery and do have a sensation recovery after some time. Carmichael and McGowan (1992) report that the incidence of transient IAN damage ranges from 0.41% to 8.4% and permanent damage is reported to occur in 0.014% to 1.5% of cases. The presence of anesthesia, dysesthesia, or spontaneous pain also indicates a poor prospect for recovery. It has been reported that overall, 25% of patients with iatrogenic paresthesia suffer permanent effects (Zuniga and LaBanc, 1983). The risk of iatrogenic paresthesia of the third division of the trigeminal nerve depends on the procedure performed, the technique used, and the surgeon's experience. Iatrogenic paresthesia remains a complex clinical problem with major medico-legal implications.

Classification of Impacted Third Molars

Angulation

Tooth angulation provides an initial overview to the possible difficulty of the third molar extraction. This classification uses the angulation of the long axis of the impacted third molar in relation to the long axis of the second molar. There are four main groups based on angulation; namely: mesio-angular, horizontal, vertical, and disto-angular.

The mesio-angular impaction is usually the least difficult impacted mandibular third molar to remove. This third molar is tilted toward the second molar in a mesial direction. It is the most commonly presented third molar impaction and comprises about 43% of all impacted teeth (Peterson *et al.,* 1993).

When the third molar is lying horizontal or perpendicular to the second molar, it is termed a horizontal impaction. This type of impaction is more difficult to remove than the mesio-angular impaction. Horizontal impactions present themselves less frequently and are seen only in approximately 3% of all mandibular impactions (Peterson *et al.*, 1993).

In a vertical impaction, the third molar's long axis presents in the same direction as the second molar. This impaction occurs second in frequency, 38% of all impactions of mandibular third molar teeth, and is third in difficulty of removal (Peterson, *et al.*, 1993).

The last of the four angulation groups for mandibular third molar is the disto-angular impaction. This impaction presents itself with the long axis tilted distal to the second molar. This impaction is the most difficult to remove due to the path of removal involving the mandibular ramus. Disto-angular impactions are relatively uncommon as they account for only 6% of all impacted third molars (Peterson, *et al.*, 1993).

Depth

Pell and Gregory (1942) devised a classification for third molars that specifically allows the surgeon to carefully examine the relationship between the tooth and the anterior border of the ramus. Impacted mandibular third molars are divided into three groups: Class 1 - mesio-distal diameter of the crown is completely anterior to the anterior border of the mandibular ramus; Class 2 - mesio-distal diameter of the crown is one half covered by the ramus; Class 3 - the tooth is completely within the mandibular ramus. The order of difficulty is class 1 being the easiest and class 3 being the most difficult to remove surgically.

Pell and Gregory (1942) also classified the depth of the impacted third molar compared with the height of the adjacent second molar tooth. This system is called the "Pell and Gregory A, B, and C classification." In this classification, the degree of difficulty is measured by the thickness of the overlying bone. As the tooth lies deeper in bone, it becomes less accessible, and harder to remove. Class A impactions have the occlusal surface of the impacted tooth level or nearly level with the occlusal plane of the adjacent second molar. Class B impaction occurs when the impacted third molar's occlusal surface is between the occlusal plane and the cervical line of the adjacent second molar. Class C impactions are when the occlusal surface of the impacted third molar is below the cervical line of the adjacent second molar tooth.

The three classification systems are used in conjunction with one another to describe the difficulty of the third molar extraction. For example a mesio-angular impaction with a Class I ramus and a Class A depth is considered easy to remove while a disto-angular impaction with a Class 3 ramus and a Class C depth is considered the most difficult to remove.

Relationship to Important Structures

In the mandible imaging is important in determining in assessing the likelihood of eruption and if extraction is envisaged, how difficult treatment will be prior to extracting impacted third molars. One of the complications that may occur following the extraction of mandibular third molars is injury to the inferior alveolar nerve. Injury to the inferior alveolar nerve has been related to deeply impacted teeth (Van Gool *et al.,* 1977) and to roots in close approximation to the inferior dental canal (IDC) (Osborn *et al.,* 1985).

Thus, accurate assessment of the position of the inferior alveolar nerve in relation to the impacted third molar might reduce injuries to this nerve.

Anatomically, the nerve lies in the IDC which is enclosed within a tube of dense bone. The tube is seen on radiographs as two parallel radiopaque lines; one representing the roof of the canal and the other the canal floor. Oliver (1927) studied 50 dry specimens of mandibles and found in 60% of them a distinct IDC contained the whole of the inferior alveolar neurovascular bundle, while in the remaining 40% the vessels and branches of this bundle were spread out of the canal so a well-defined canal was not present. Carter and Keen (1971) radiographically examined 80 dried mandible specimens and found 61% of them showed a single bony canal with unbroken margins near the roots of molar teeth, while a bony canal with a broken upper wall was seen close to the molar roots in 14% of radiographs. The remaining 25% of the mandibles showed bony patterns lacking definite mandibular canals. Based on radiographic examination of a 100 edentulous human mandibles, Schroll (1975) concluded the position of the IDC was variable. This finding has been confirmed by Nortje et al. (1977a, b) who reviewed 3612 panoramic radiographs and found the position of the IDC was either touching or within 2 mm of the apices of molar teeth in 46.7% of the subjects. In 48.9% the IDC was touching or within 2 mm of the cortical plate of the lower border of the mandible and intermediately positioned between tooth apices and the lower border in 3.3% of the subjects.

Imaging Methods for Third Molar Localization

To extract mandibular third molars, a surgeon must be able to have adequate information about the tooth and all surrounding structures. Traditionally, periapical radiographs and rotational dental panoramic radiographs have been used to assess the relationship between the IAN and the adjacent third molar roots before surgery Koong *et al.,* (2006). There are numerous limitations in the use of periapical and panoramic radiographs, the most significant being an inability to determine three dimensional orientations due to absence of the bucco-lingual dimension. Due to such constraints, the uses of computed tomography (CT) (Ohman *et al.,* 2006), MRI (Kress *et al.,* 2004), and cone beam volumetric computed tomography (CBVCT) (Bouquet *et al.,* 2004) have been introduced to display, in three dimension, the location and morphology of the IAN to the roots of the third molar.

Value of Panoramic Imaging in Identification and Localization of the IAC

Rotational dental panoramic radiography is a process in which the image of the dentition within curved dental arches is projected onto an X-ray image detector. This technique has been modified over time, but the basic concepts are still pertinent. The source of radiation in panoramic radiography is a vertically slit-collimated X-ray beam that is used to scan the dentition. Due to the tomographic motion of the panoramic x-ray beam around the patient's head, an image of anatomy within a narrow zone of focus is produced. This "horseshoe" shaped zone of acceptably sharp anatomic structure is termed a focal trough or image layer. The focal trough of the panoramic X-ray unit is a three dimensional curved zone in which structures are reasonably well defined on the panoramic radiograph, and it is important for obtaining high quality images of the structures of interest (White and Pharoah, 2000). There is a single plane lingual to the center of the focal trough that produces optimal sharpness of the anatomic layer which is called the "focal plane" (sometimes misnamed the "central plane") in which the horizontal and vertical magnifications are distorted only by vertical projection geometry. This focal plane form is made by various points between the set focus and the plane of the image detector (e.g. indirect exposure X-ray film), various osseous structures will be projected on the detector at the exact same speed (or virtual movement) of the detector that is being used. (Figure 1) The points represent one half the path described by the plane of highest resolution in each machine.

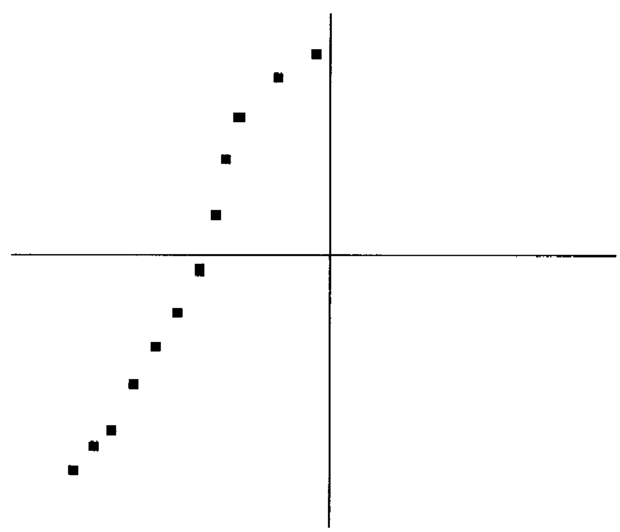


FIGURE 1 Focal plane form made by various points between set focus and the plane of the image detector

Anatomy to either side of the focal plane becomes progressively more blurred and distorted as it is displaced further from the plane of greatest spatial resolution due to detector changing velocities. This results in differences in projected image magnification. As structures progressively fall outside of the focal trough, the differences in magnification cause structures to appear too wide or too narrow depending on which side of the plane of highest resolution the structure is located.

The outside limits of this image layer are not completely clear. The amount of distortion or blurring that is acceptable is subjective. A value such as 0.5 mm for relative unsharpness can be used in calculations to determine the boundaries, or the subjective criteria as to what structures are in "sharp focus" may determine the boundaries in experimental studies (Glass, *et al.*, 1985). The focal troughs usually vary in size and shape, depending on such factors as effective projection radius, the size of the beam, and the relative speed of the detector.

Various manufacturers choose different shapes and sizes of the image layers for their panoramic radiograph machines. They often base their selection on the average dental arch having the focal trough bounded by acceptable resolution limits at 1.5 lp/mm. (Welander *et al.,* 1989). (Table 2)

TABLE 2

Panoramic manufacturer and reported focal trough width in the region of the mandibular third molar

Manufacturer / Model	***Planmeca Oy. Dimax 3***	***Gendex Orthoralix 9200***	***J. Morita Veraviewepocs SD***	***Instrumentarium OP 100***
Focal trough width	25mm	15mm	13mm	26mm

Due to the information that can be obtained from a panoramic radiograph, its use is often considered of value in the presurgical planning for the removal of impacted mandibular third molar teeth. The different shapes and sizes of the image layers have been determined, both mathematically and experimentally (Glass, *et al.* 1985). McDavid and colleagues (1981) concluded that the location of the focal plane of the image layer and the thickness of the image layer are very sensitive to even very small deviations in receptor speed and machine synchronization.

Standard form of the dentition in mandible relating to panoramic radiography

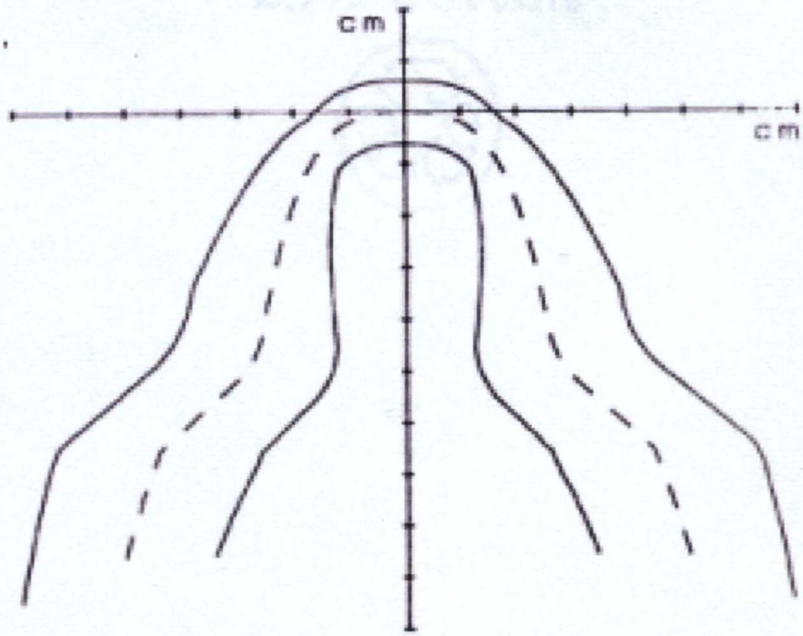
There are many panoramic radiographic machine models. Each has its own unique movement pattern with differences in image layer size, shape and width, all of which are all designed to capture and display the same structures.

Most panoramic units have only one pre-selected movement pattern. This movement produces an image layer that is designed to fit the "average" patient. However, not every patient has the same jaw size and shape. Deviations in size and form of an individual jaw from a pre-selected image layer will result in varying degrees of distortion and unsharpness (Welander, *et al.,* 1989). Several analyses have been made to study variations of the size and form of dental arches (Nummikoski, 1985; Lund and Manson-Hing, 1975; Manson-Hing, *et al.,* 1976) however, few studies have investigated the clinical effects of variations in focal trough dimensions on the diagnostic efficacy of panoramic radiography.

Information on the dimensions of the average dentition and mandible has been reported by Nummikoski *et al.* (1985). In their study, the forms of the dentition and the mandible were traced, taking into account not only the clinical crowns, but also the intrabony roots. The focal plane should be the average of both so that the dental arches fall within it. In a later study, Welander *et al.* (1989) studied average curves of the dentition in several different races and determined the average shape of the dentition and mandibular curves as polynomials. These were used to develop an average focal trough form. (Figure 2) These polynomials are used by various panoramic companies to produce a central plane for their panoramic systems which matches the average form of the dentition.

FIGURE 2

Average focal trough form from Welander *et al.* (1989)



Arch widths in relation to panoramic focal trough widths

Most rotational panoramic machines have been designed with the assumption that there is no significant variation in mandibular size between races and sexes. However, Nummikoski *et al.* (1988) determined that ethnic and sexual differences in the dental and mandibular arch widths were statistically significant. Male dental arch forms were, on average, 0.6 to 1.1 mm wider than female arch forms. Their investigation found differences of 8 to 10 mm in dental arch widths between the minimum and maximum values and reported differences of about 15 mm in the position of the mandibular condyles, respectively even within the same sex (Nummikoski *et al.*, 1988). Whether this deviation is sufficient to cause blurring of clinical significance in panoramic images depends on if the shape of the jaws coincident with the least distorted plane of the focal trough of a machine. If the jaw outline is coincident with the outer limits from the "least distorted plane", especially towards the lingual, a small deviation would make a difference. Points lingual and buccal to the sharpest plane lose sharpness as they progress farther from the plane, with lingually positioned points losing more sharpness than buccal points that are an equal distance from the sharpest plane.

Mandibular third molar impaction and panoramic radiographic signs of IAN association

When panoramic radiography is the only imaging modality used to assess the location of third molars. Proper assessment is essential to minimize morbidity. Unfortunately, interpretation of complex three dimensional anatomical relationships is often impossible due to inherent limitations associated with two dimensional conventional imaging systems (Danforth *et al.*, 2003)

Panoramic imaging has been, until recently, the standard radiologic examination used to evaluate the anatomic relationship of third molars and the IAN (Smith *et al.* 1997). When utilizing a panoramic radiograph, a number of radiographic signs have been reported as being associated with increased or "high risk" for proximity of the tooth to the IAN. Valmaseda-Castellon and Berini-Aytes (2001) studied the correlation between interpretation of panoramic radiographs and treatment outcomes of 1,117 mandibular third molar cases post extraction. They found that IAN damage increases with patient age, deflection of the molar roots when approaching the IAN, and the need to perform a distal ostectomy.

Blaeser and colleagues (2003) estimated the association between specific panoramic radiographic signs and IAN injury during mandibular third molar surgery. They used a case control study design and the sample consisted of patients who underwent removal of impacted mandibular third molars. Cases were defined as patients with confirmed IAN injury after third molar extraction, and controls were defined as patients without nerve injury. Five surgeons, who were blinded to injury status, independently assessed the preoperative panoramic radiographs for the presence of high risk radiographic signs including: diversion or bending of the canal, darkening of the tooth root, and interruption of the cortical white line of the canal. Bivariate analyses were completed to assess the relationship between radiographic findings and IAN injury. They found 8 cases with IAN injury and 17 controls. They indicated that panoramic findings of diversion of the inferior alveolar canal, darkening of the third molar root, and interruption of the cortical white lines are statistically associated with IAN injury. Based on the estimated predictive values in this study, the absence of positive radiographic signs was associated with a minimal risk of nerve injury, whereas, the presence of one or more of these signs was associated with an increased risk for IAN injury.

According to Bell (2004), the sensitivity and specificity in diagnosis of an intimate relation between the root of the mandibular third molar tooth and the IAN were 66% and 74%, respectively. When an intimate relationship is present, the relationship should be accurately diagnosed in 66% of the cases. With a specificity of 74%, an intimate relationship does not exist in 74% of the cases that present with no contact between the root of the tooth and the IAN. Given these percentages of sensitivity and specificity, panoramic radiographic imaging does not appear to be an accurate diagnostic tool for third molar surgery planning. They state that this sensitivity and specificity in diagnosing the presence or absence of an intimate relationship between root and nerve using a panoramic radiograph is unreliable. Given this low diagnostic accuracy, it has been questioned whether use of panoramic radiographic imaging to determine mandibular third molar relationship to the IAN influences surgical outcome. In their study they had a surgeon view 300 mandibular third molar teeth and recorded the radiological observations (seven of them) of the third molars and the IAN. Every tooth had a radiological sign present. The same surgeon removed the teeth and recorded their relationships to the IAN. Out of the 300 teeth removed, the neurovascular bundle was directly observed, the root was grooved, or the root's apices were deflected by the nerve bundle in 35 of the cases. Overall, they concluded that there was an intimate relationship between the mandibular third molar tooth and the IAN in 12 (51%) cases when darkening of the root was observed, and in only 11 (11%) cases when interruption of the radio-opaque outline of the inferior alveolar neurovascular bundle (along with superimposition) was observed. In this study, the most common radiographic appearance of a relationship between the mandibular third molar tooth and the IAN was superimposition in 110 (37%) out of the total 300 teeth. There were occasional combinations of radiographic signs, all with darkening of the root combined with deflection of root, narrowing of the root, and narrowing of the canal. All but one of these groups of combined radiographic signs was in the 35 (12%) cases where an intimate relationship between root and nerve was observed during surgery.

Sedaghatfar and colleagues (2005) studied 230 patients from whom 423 mandibular third molars were extracted. The primary predictor variable was the presence or absence of panoramic radiographic signs associated with an increased risk for IAN injury. The outcome variable of this study is defined as direct visualization of the IAN at the time of the third molar extraction. The frequency of the panoramic radiographic signs were: 1) darkening of the root, n = 72 third molars (17%), 2) interruption of the cortical white lines of the mandibular canal, n = 152 third molars (35.9%), 3) diversion of the inferior alveolar canal, n = 53 third molars (12.5%), 4) deflection of the roots, n = 59 third molars (13.9%), and 5) narrowing of the roots, n = 50 third molars (11.8%). Post extraction of the mandibular third molars, the IAN was visualized by the surgeon in 24 (5.7%) cases. Overall, 3 (0.7%) third molar extractions had evidence of IAN injury based on patient report and a neurosensory examination. All cases of IAN injury resolved within 1 year. It was determined that four of the radiographic signs were statistically associated with IAN exposure ($P < .001$). These were darkening of the root, interruption of the cortical white lines of the mandibular canal, diversion of the inferior alveolar canal, and narrowing of the roots. Deflection of the roots was not statistically associated with inferior alveolar nerve exposure. They found found that as the number of signs increases, the relative risk of IAN exposure also increases ($P = .004$). (Sedaghatfar, *et al.*, 2005).

Third molar analysis utilizing Computerized Tomography

In the past two decades computerized tomography has been utilized to assess third molars that could be associated with the mandibular canal. Several studies have compared panoramic radiographs to CT scans in determining the position of the third molar to the

IAN (Mahasantipiya *et al.,* 2005; Bell, 2004; Maegawa *et al*., 2003; Monaco *et al.*, 2004). These studies report high risk radiographic markers on a panoramic radiograph that may indicate a close tooth root relationship with the IAN; however, results have been inconsistent. As technology advances and prices of CT systems and procedures continue to drop, CT will likely become the standard for pre-surgical assessment of complicated third molar extraction cases that exhibit traditional high risk panoramic radiographic signs.

Monaco and colleagues (2004) conducted a study to evaluate the predictive value of five radiographic markers on panoramic radiographs to point out the relationship between the mandibular canal and the impacted third molar. They used 1. superimposition of the tooth on the canal, 2. increased radiolucency, 3. interruption of the radio-opaque border of the canal, 4. diversion of the canal, 5. narrowing of the canal, on panoramic radiographs as radiographic markers, comparing them with an axial CT scan. They identified a sample of 73 third molars that showed a close relationship between the third molar roots and the mandibular canal on the panoramic radiograph, and then classified them on the basis of the five radiograph markers. They also detected contact between the third molar and the mandibular canal on the CT scan. Out of the 73 teeth examined, 37 molars exhibited increased radiolucency, 13 had superimposition, 14 showed interruption of the radio-opaque border, 14 exhibited narrowing of the canal and 7 showed diversion of the canal. In 11 cases, two or more markers were recognizable. The predictive values of a positive test result were molars with increased radiolucency 73%, superimposition 38.5%, interruption of the radio-opaque border 71.4%, narrowing of the mandibular canal 78.6%, and diversion of the mandibular canal 100%. The authors also found that the third molar root apices had contact in all of the cases showing two or more radiographic markers. They concluded that increased radiolucency, narrowing and interruption of the radio-opaque border, as well as the presence of two or more radiographic markers were highly predictive of contact between the third molar and the mandibular canal. In these cases, a CT scan should be obtained. When compared with other studies, this study found a higher predictive value for diversion of the mandibular canal, however, because of the small sample size (seven cases of diversion of the canal), these results must be viewed with caution.

Mahasantipiya and colleagues (2005) determined the value of radiographic markers on rotational panoramic radiographs in assessing the true relationships of the IAN. They assessed the mandibular third molars using CT to determine the position and morphology of the IAN relative to the roots and the cortical plates. The radiographic markers on rotational panoramic radiographs were correlated with the CT findings to determine if there is an association with the IAN. There were 202 mandibular third molars in this study. Narrowing of the mandibular canal was found in relation to the mandibular third molars in 66.8% of the cases. The chance of narrowing of the mandibular canal as shown using CT increased when at least one of the radiograph markers, superimposition, narrowing, deviation or reduction in density was present on the rotational panoramic radiograph. Deviation of the mandibular canal on rotational panoramic radiographs was found to be the most significant predictor of narrowing of the canal to having a close relationship to the roots of the third molar and the mandibular canal.

Even though panoramic radiographs display high risk signs before third molar removal, they are not sufficient to determine the relationship between the molar and the mandibular canal in 3D. They do not show what kind of surgical approach, buccal or lingual, to take when removing bone to remove the impacted third molar while avoiding injury to the IAN. Superimposition of the mandibular canal to the roots of third molars is often seen in periapical and panoramic radiographs. The parallax method of taking periapicals has been useful in evaluating whether or not the root and the mandibular canal contact each other. However, it is usually difficult to estimate their precise proximity Nakagawa *et al.* (2002) used cone beam volumetric computerized tomography (CBVCT) in assessment of a mandibular third molar before surgery. They had a rotational panoramic radiograph with third molar roots superimposed over the mandibular canal. Through CBVCT, the mandibular canal was confirmed to lie between the mesial and distal third molar roots. With this knowledge, extreme care could be taken to avoid injuring the contents of the mandibular canal.

Three dimensional assessments of surrounding structures and the anatomic location of the third molar are not possible when utilizing a panoramic or periapical radiograph. Today, more accurate diagnostic aids are available to assess third molars that are in close proximity to the IAN. CT allows the surgeon to gain an understanding of what structures are close to the proximity of surgery, minimizing the risk of nerve injuries during third molar surgery. The use of multi-slice CT has greatly enhanced the capability of CT to demonstrate the location and morphology of the IAN. Multi-slice scanners are much faster than conventional CT scanners and the reformatted images are as sharp as the directly acquired images. Consequently, there has been a significant increase in the number of cases being referred for pre-surgical evaluation using multi-slice CT to evaluate the relationship between the IAN and the lower third molar roots. Mahasantipiya *et al.*, (2005) However, there are drawbacks to the use of this diagnostic aid. Multi-slice CT imaging is not readily accessible in all areas of the country and can be very costly to the patient (hundreds of dollars) if it is not covered by medical insurance. Also, the radiation dose that the patient receives can be high. Various publications have estimated the typical surface radiation doses to adults from multiple adjacent CT slices as 30-70 mGy per head scan series. (Nickoloff and Alderson, 2001) Although CT is better than the panoramic film, CT may still have imaging problems such as blurring, appropriate exposure techniques, imprecise site location, varying magnification, and image data is limited when provided a printout. This is adequate for routine cases but limiting for the complex cases where the potential for volume analysis and patient modeling could enhance the diagnostic process (Danforth *et al.,* 2003).

Cone Beam Volumetric Computed Tomography (CBVCT)

Recently, cone beam volumetric tomography (CBVCT) has been introduced and developed especially for the oral and maxillofacial region (Mozzo *et al.,* 1998; Hashimoto *et al.,* 2003; Sukovic 2003; Baba *et al.,* 2004). CBVCT uses rotational scanning by an x-ray source and reciprocation X-ray detector to facilitate acquisition of multiple single projection frame "basis" images. CBVCT allows two-dimensional (2D) multi-planar reformatting (MPR) and secondary reconstruction of the data within a personal computer, thereby allowing generation of images in orientations other than the conventional axial plane (Moshiri *et al.*, 2006). Developments in technology have made

CBVCT specifically for the craniofacial region feasible and affordable. A single CBVCT exposure provides three dimensional information which assists in viewing anatomical detail, diagnosis, and treatment planning. Some of the advantages for using CBVCT technology in clinical practice include: X-ray beam limitation, image accuracy, rapid scan time, radiation dose reduction, display modes unique to maxillofacial imaging, and reduced image artifact.

The gap that exists between traditional panoramic film radiography and medical CT associated with high cost, radiation, and lack of 3-dimensional view is being answered with CBVCT. CBVCT provides alternatives to film panoramic radiography and medical CT by providing the dentist with lower dose radiation than medical CT (50 μSv, Newtom 9000 full volume scan), lower cost to patient ($150-$250), and volumetric three dimensional imaging of the surrounding surgical third molar site (Danforth *et al.*, 2003). However, CBVCT produces a higher radiation dose when compared to panoramic radiography. Ludlow *et al.,* (2003, 2006) examined the radiation doses for the NewTom 9000 CBVCT machine and the Orthophos Plus DS panoramic unit. CBVCT examinations compared to panoramic radiography resulted in doses that were 3-7 times higher (E_{ICRP60}) and 2-4 times higher (E_{SAL}) (Ludlow, *et al.,* 2003).

CBVCT accuracy

A number of authors have recently reported on the accuracy of CBVCT in maxillofacial imaging. Hilgers *et al.* (2005) showed that condylar dimensions and various cephalometric landmarks are accurate when measured on CBVCT compared to the "truth" measured on dry skulls. In another study using dry skulls, Moshiri *et al.* (2006)

compared measurements to those taken from both CBVCT images and traditional lateral cephalometric images. They showed that CBVCT images more accurately demonstrate actual measurements made directly on a skull than traditional lateral cephalometric radiographs Lascala *et al.* (2004) utilized the NewTom 9000 CBVCT machine and examined 13 measurements on the skull and scans. They showed that skull measurements were always larger than those on the CBVCT scan, but only significantly for internal structures of the skull base. Since these were the only structures that showed a significant difference, it was concluded that CBVCT scans are reliable for linear measurements of other structures that are more closely associated with dentomaxillofacial imaging.

Third molar analysis utilizing CBVCT

Pawelzik and colleagues (2002) evaluated the geometric, topographic, and anatomic reliability of volumetric computed tomography images by comparing conventional panoramic radiographs with reconstructed volumetric computed tomography panoramic and paraxial images before performing third molar surgery. A total of six anatomic sites on 10 patients who showed a topographic relationship between the apices of the third molar root and the mandibular canal were preoperatively assessed by five oral surgeons using conventional panoramic radiographs. These were complemented and compared with secondary reconstructed paraxial and panoramic volumetric computed tomography images. The position of the apices in relation to the mandibular canal could be revealed on 94% of volumetric computed tomography reconstructed paraxial images. In 90% of the para-axial images, it was possible to assess the relationship of the mandibular canal and its adjacent anatomy. However, the visual grading score for conventional panoramic images was significantly better on all seven assessed anatomic sites compared with the reconstructed volumetric computed tomography panoramic images.

These results suggest that the volumetric computed tomographic para-axial images may provide a significantly clearer perception of the mandibular nerve than conventional panoramic radiographs. However, CBVCT has a radiation dose of up to 10 times higher than the conventional panoramic radiograph. In this study it was concluded that the conventional panoramic radiographs were shown to be better than the volumetric computed tomography reconstructed panoramic images and were an invaluable tool in the "expert-derived" assessment and posed the potential for identifying the need for further volumetric computed tomography diagnostic procedures.

Enciso *et al.* (2006) examined the spatial relationship of six impacted third molars using imaging data obtained from various 3-D volumetric imaging systems (NewTom 9000, J. Morita 3D Accu-i-tomo and Hitachi MercuRay). An interactive virtual model of a proposed third molar surgical site, including the third molar and the inferior dental canal, was developed. They concluded that anatomical accuracy, benefit for risk assessment, and cost effectiveness of developing the model requires further investigation.

Significant radiographic signs

From the results of the previous authors mentioned above, a number of significant radiographic signs have been identified that act as markers for the relationship between the IAN and the third molar tooth root. (Table 3)

TABLE 3

Significant panoramic radiological signs found in previous studies

Parameter	*Study**					
	1	*2*	*3*	*4*	*5*	*6*
Third molars examined	1117	25	300	73	202	423
Radiographic sign(s)	**1.**deflection of molar roots	**1.** diversion of canal **2.** darkening of root **3.** interruption of cortical white lines of canal	**1.** darkening of root **2.**interruption of cortical white lines of canal **3.**superimposition of tooth over canal **4.** combinations all with darkening of root combined with deflection of root, narrowing of root, narrowing of canal.	**1.** ↑ radiolucency at apex of root **2.** narrowing of canal **3.** interruption of cortical white lines of canal. **4.** diversion of canal **5.** presence of two or more markers	**1.** Deviation of canal	**1.** darkening of root **2.**interruption of the cortical white lines of canal **3.** diversion of canal **4.** narrowing of roots **5.** presence of two or more markers

* Study: (1) Valmaseda-Castellon E, Berini-Aytes L. (2001); (2) Blaeser B, *et al.*, (2003); (3) Bell GW. (2004); (4) Monaco G, *et al.*, (2004); (5) Mahasantipiya PM, *et al.*, (2005); (6) Sedaghatfar M, *et al.*, (2005)

Based on the results of these authors, our study will focus on the following six (6) radiographic signs that have been found to be statistically significant and clinically important in determining the relationship of the IAC with impacted molar teeth.in previous studies:

(1) *Darkening of the root.* This results from loss of root density in a tooth that is impinged upon by the canal. Normally the radiographic density of the root is uniform throughout its length and does not change when the tooth and the canal overlap (Figure 3).

FIGURE 3

Darkening of the root of the mandibular third molar

(2) *Interruption of the cortical white lines of the mandibular canal.* This is found when the radio-opaque lines that constitute the inferior alveolar canal are discontinuous because a tooth root lies within the canal. Disruptions to the continuity of the mandibular canal can be indicative of root proximity to the mandibular canal. Disruption may be defined as an interruption to the white, cortical boundaries of the canal, represented by the two radio-opaque lines that make up the roof and floor of the inferior alveolar canal. One or both lines may be involved and is considered to be interrupted if it disappears immediately before it reaches the tooth structure (Figure 4).

FIGURE 4

Interruption of the cortical white lines of the mandibular canal

(3) *diversion or displacement of the inferior alveolar canal.* This occurs when there is a change in direction as the canal crosses the mandibular third molar. This sign presents as mandibular canal remodeling literally around the tooth (Figure 5).

FIGURE 5

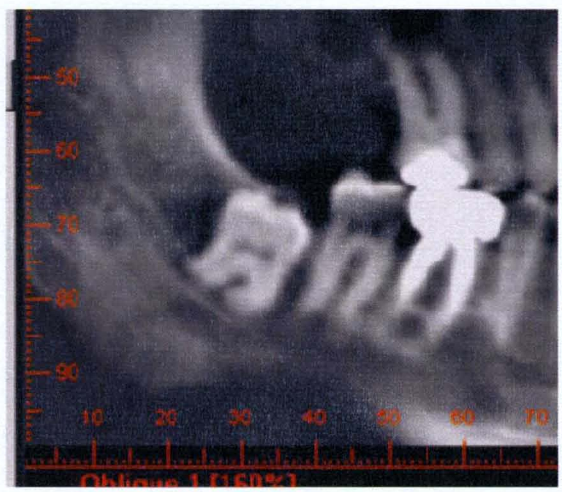
Diversion or displacement of the inferior alveolar canal

(4) *Deflected roots.* This refers to visible deflection of roots in the proximity of the mandibular canal. A close, proximal relationship of root to the mandibular

canal may be seen as an abrupt deviation of the root as it encounters the inferior alveolar canal. The root itself may be deflected to the buccal or lingual, or the root may completely engulf the canal. When the apex of the roots are pointed mesially or distally the radiograph will display the apex of the root tips diverted in a mesial or distal direction such as the one shown. Roots deflected buccally or lingually may not be visualized radiographically due to the inability of the radiograph to image structures lying parallel to the imaging beam. (Figure 6)

<u>FIGURE 6</u>

Deflected roots of the mandibular third molar



(5) *Superimposition of the canal.* This occurs when the superior and inferior cortical bone borders of the mandibular canal are superimposed on the root of the third molar. Even though superimposition of the canal to the roots of the third molar could be that one is buccal or lingual to one another, prior research has shown that this sign is viable to look for (Figure 7).

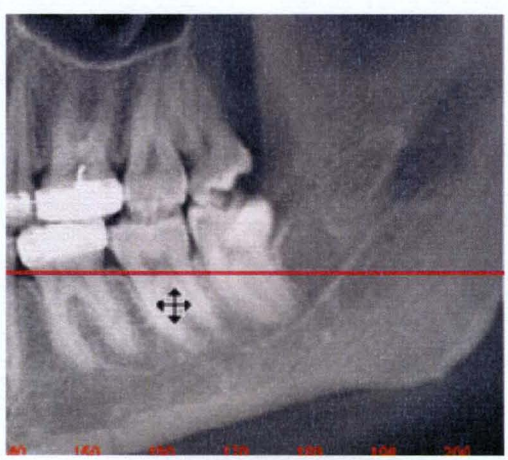
FIGURE 7

Superimposition of the canal with the mandibular third molar

(6) *Narrowing of the inferior alveolar canal.* This refers to the constriction of the inferior alveolar canal and can be indicative of a close proximity of the nerve to the tooth. Narrowing of the canal is often associated with the downward displacement of the upper and lower borders of the mandibular canal, creating an hourglass appearance. The hourglass appearance may indicate a partial or complete encirclement of the canal by the root (Figure 8).

FIGURE 8

Narrowing of the inferior alveolar canal



Previous investigations investigating the radiological signs associated with the relationship of the IAC to mandibular third molars have all been performed using conventional panoramic images with a set focal trough width and arch form. To date there is a dearth of information in the literature comparing the prevalence of these signs with panoramic images generated with different machines, each with a different focal trough width and arch form shape. Utilizing CBVCT, it is possible to compare these variables to determine if focal trough width and arch form shape play a factor in the visualization of high risk radiological signs for mandibular third molar and IAN involvement.

The panoramic radiograph was, until very recently the standard radiographic image made to analyze third molars prior to extraction (Smith *et al.,* 1997). Such panoramic radiographs are used to determine the type of impaction. Also, they are used to observe if there is any presence or sign that the third molar has an association with the mandibular canal that would increase the likelihood of IAN injury if the third molar were removed. Panoramic radiographs are known to have a number of limitations, including but not limited to: magnification, distortion, and superimposition of structures (Tronje *et al.*, 1981a; Tronje *et al.*, 1981b; Tronje *et al.*, 1981c). Conventional panoramic X-ray systems have a fixed movement pattern giving only one pre-selected layer that is designed to coincide with an 'average patient'. Deviation in size and form of an individual jaw from the pre-selected image layer will result in varying degrees of distortion and unsharpness inclusive of the third molar region (Welander *et al.*, 1989). These radiographs may or may not produce radiographic signs a surgeon would look for when attempting to determine if an impacted mandibular third molar is intimately positioned to the IAN.

The purpose of this investigation is to determine if simulated panoramic radiographs viewed in two different focal trough shapes, and three different focal trough widths alter the ability of observers to identify high risk radiological signs associated with an intimate anatomic relationship between impacted third molar teeth and the mandibular canal.

CHAPTER II

PURPOSE AND HYPOTHESIS

Study Objectives

The aim of this research was to simulate panoramic images of different focal trough specifications (trough size and arch shape) and relate previously reported high risk panoramic third molar radiographic signs associated with the mandibular canal to actual 3D distances determined by Cone Beam Volumetric Computerized Tomography (CBVCT). Reconstructed panoramic radiographs generated from cone beam volumetric computed tomography (CBVCT) datasets have been used in this study. All images were generated using an i-CAT® (Imaging Sciences International, Hatfield, PA). This study postulates that the wider the focal trough width and the more customized the focal trough shape to the patient's arch form, the more accurate will be the detection of high risk radiologic signs present in the reconstructed panoramic radiographs.

The specific aims were to:

1) Determine whether a generated customized focal trough shape compared to an average form of dentition focal trough shape more accurately indicates panoramic dental and osseous radiological signs indicative of high risk nerve association and features (e.g. darkening of

the root, disruption of the cortical white lines of the IAN canal, deviation of the IAN canal, deflection of roots, superimposition of the roots on the IAN canal, narrowing of the IAN canal (Sedaghatfar *et al.* 2005; Bell *et al.* 2004; Mahasantipiya *et al.* 2005; Smith et al. 1997) for determining a relationship between impacted third molar teeth and the IAN canal.

2) Determine whether a relationship between panoramic radiography focal trough widths and panoramic dental and osseous high risk nerve association radiological signs and features (darkening of the root, disruption of the cortical white lines of the IAN canal, deviation of the IAN canal, deflection of roots, superimposition of the roots on the IAN canal, narrowing of the IAN canal), for determining a relationship between impacted third molar teeth and the IAN canal.

Study Hypotheses

Null Hypotheses (H_o)

1) There is no difference between focal customized and standardized trough shapes and high risk radiological signs associated with the IAN.
2) There is no difference between focal trough widths and high risk radiological signs associated with the IAN.

Alternate Hypotheses (H_1)

1) There is a difference between customized and standardized focal trough shapes and high risk radiological signs associated with the IAN.
2) There is a difference between focal trough widths and high risk radiological signs associated with the IAN.

CHAPTER III

METHODS AND MATERIALS

Sample and Study Approval

The Human Studies Committee of the University of Louisville approved the study protocol (HSC reference # 585.05) through Expedited Review Procedure in November 2005.

Sample

The sample was derived from the database of cone beam CT image datasets, obtained using an FDA/CDRH approved cone beam volumetric computerized tomography scanner (i-CAT, Imaging Sciences International, Hatfield, PA, USA) located in Radiology and Imaging Sciences, Dept. of Surgical/Hospital Dentistry at the University of Louisville School of Dentistry. This instrument is partially owned and operated by Drs. Allan G. Farman and William C. Scarfe within the ULSD faculty private practice. A retrospective radiographic chart audit was performed by the PI between January and February 2005 on all available CBVCT scans (approximately 330 available at that time). The sample was not identified by age, gender, or ethnicity.

Only CBVCT datasets that were made using a full field of view CBVCT were considered for inclusion in the study. Patients are referred for imaging related principally to the assessment of pathology, temporomandibular joint evaluation and implant site assessment. At the time of the study, few patients had been specifically referred for third molar assessment related to IAN involvement. Therefore numerous imaging studies had been performed using various imaging protocols including field limitation and high and low resolution voxels.

The i-CAT unit was operated at 3-8 mA (pulse-mode) and 120 kV using a high frequency generator with fixed anode and 0.5 mm nominal focal spot size. The anterior symphyseal region of the mandible of each patient was inserted into the chin holder and vertical and horizontal lasers were used to position the patient's head. The patient's head was also oriented by adjustment of the chin support until the mid-sagittal plane was perpendicular to the floor and the horizontal laser reference coincided with the intersection of the posterior maxillary teeth and alveolar ridge. Lateral scout radiographs were taken and small adjustments to head position were made so that discrepancies between bilateral structures (e.g. posterior and inferior borders of the mandibular rami and zygomatic arches) were less than 5 mm. A single 360 degree rotation, 20 s. scan, comprising 306 basis projections was then made for each skull with a 17.0 cm (diameter) x 13.2 cm (height) field of view using i-CAT acquisition software (version 1.7.7). Exposure parameters were unable to be altered as acquisition was controlled by automatic exposure control. Primary reconstruction of the data was automatically performed immediately after acquisition and took approximately 60 seconds. Secondary reconstruction occurred in "real time" and provided contiguous color correlated perpendicular axial, sagittal, and coronal 2D MPR slices, with isotropic 0.4mm voxels in each orthogonal plane.

Previous studies have shown that there is no magnification or distortion in resultant secondary reconstruction images from this machine and all measurements can be assumed to have a 1:1 relationship with the actual object. Images were made according to the manufacturer's recommendations using the chin rest and vertical side guides, aligning the vertical light beam at the midline and the horizontal light beam intersecting the top of the right and left external auditory meatus. CBVCT images were acquired using a flat panel hydrogenated amorphous silicon detector.

The following inclusional criteria were applied to the available full FOV scans:

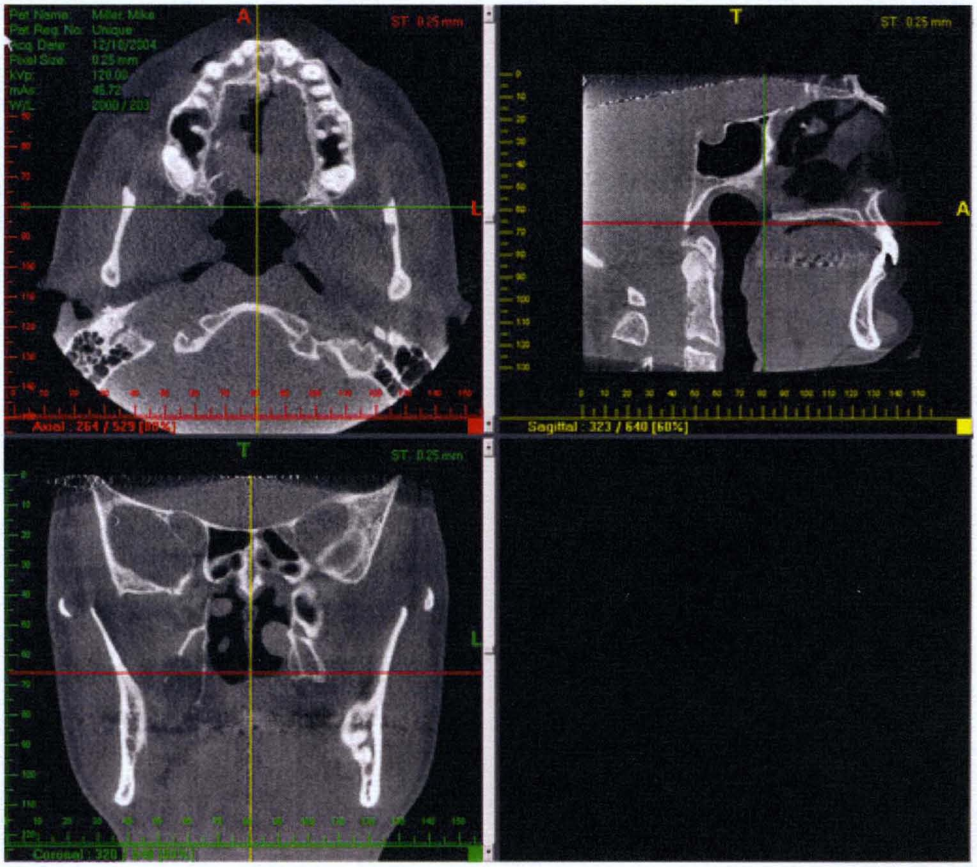
1) Mandibular third molar teeth had to be present in at least one side
2) Mandibular third molar teeth were within 3mm from the inferior alveolar nerve canal (IAC).

After examining the scans, 50 mandibular third molars met the inclusion criteria. Most scans were excluded due to the absence of third molar teeth, third molars were not near the IAC, or the scan was a limited volume scan not including the desired anatomical details.

The datasets from the included scans were accessed by the PI and the dataset was viewed in all three planes: sagittal, coronal, and axial. (Figure 9)

FIGURE 9

Conventional i-CAT three planes of view: axial, sagittal, and coronal



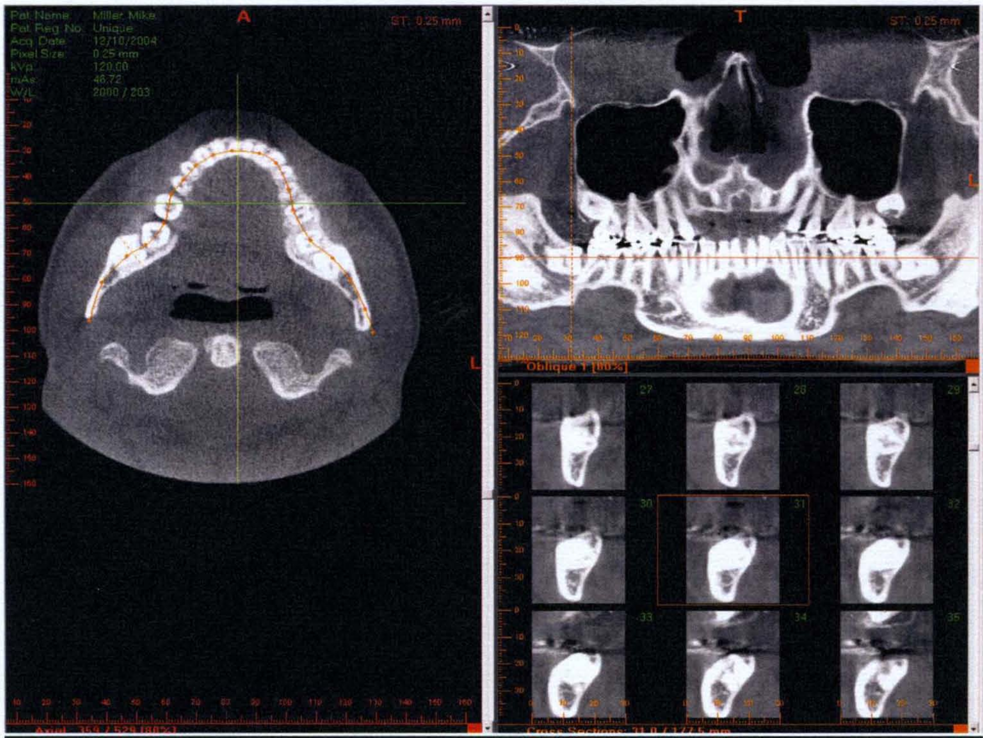
Panoramic reconstruction

Customized focal trough

Panoramic reconstruction utilizing CBVCT images was accomplished by first viewing the mandible in the axial view at the occlusal level of the third molars. No manipulation of the sagittal view was done before the axial view was examined to locate the focal plane of the focal trough. The CB devices default patient sagittal position was used. This accounts for the variability in head positioning that is possible when conventional panoramic radiographs are taken. The focal plane of the focal trough was then constructed by placing points throughout the occlusal surfaces of the teeth present in the axial view. These points were adjusted accordingly so that when the reconstructed panoramic focal trough was viewed at .25 mm width, the mandibular canal was visible. This was done to verify the mandibular canal position was as close as possible to the focal plane for the clearest visibility of the IAN when the focal trough widths of 10, 20, and 40 were constructed. (Figure 10) Panoramic reconstruction was accomplished on the i-CAT to a scale of 1 cm = 12mm. This was done to account for distortion and magnification that is typically encountered on a traditional panoramic radiograph.

FIGURE 10

CBVCT display showing axial view with panoramic reconstruction and cross section view of mandible

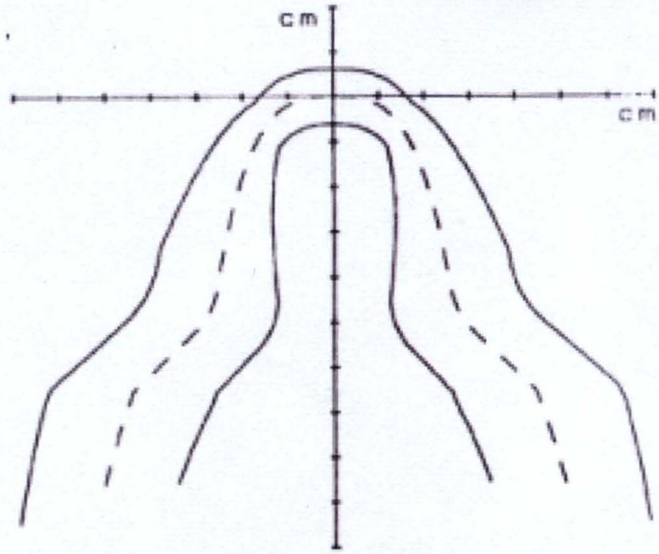


Standardized Focal Trough

The average form of dentition focal trough (Welander *et al.* 1989) was used to construct the average form dentition focal trough shape used in this study. No manipulation of the sagittal view was done before the axial view was examined to construct the focal plane of the focal trough. An acetate copy was made to scale of 1:1 from the standard form of the dentition and the mandible (Welander *et al.*, 1989). (Figure 11)

FIGURE 11

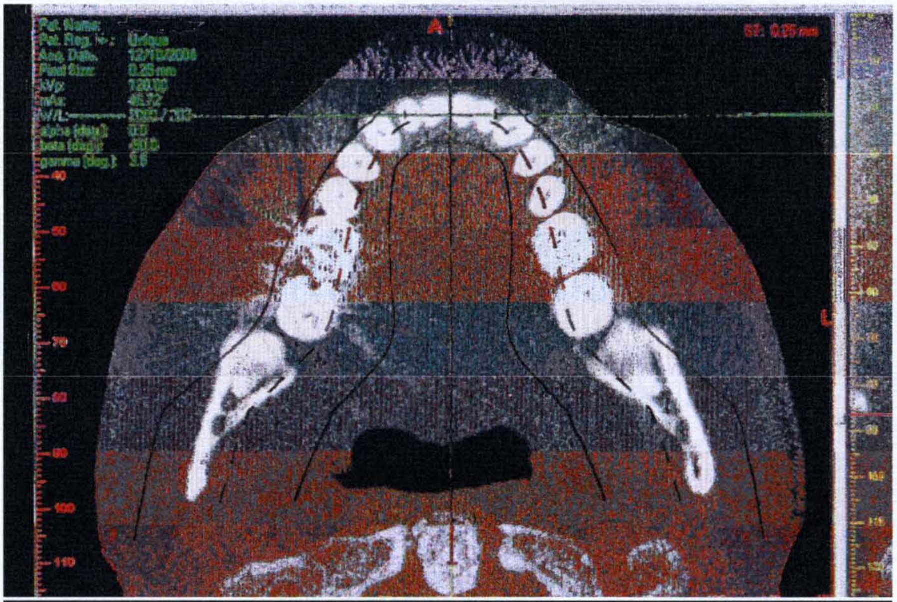
Average focal trough form Welander *et al.,* 1989



In the dataset axial view of the mandible, the acetate was taped on the computer screen so that the intersection of the horizontal and vertical reference lines was positioned between the mandibular central incisors (vertical line) and on the cingulum of the mandibular central incisors (horizontal line). (Figure 12)

FIGURE 12

Acetate of average focal trough form (Welander *et al.,* 1989) placed over mandible.



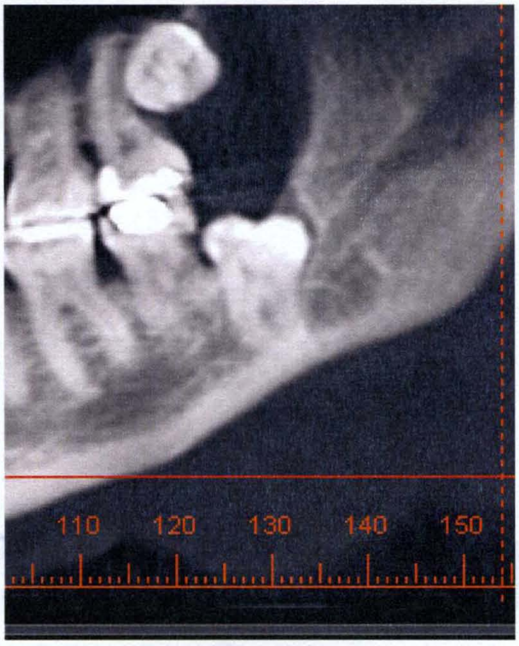
The focal plane of the focal trough was then constructed by placing points along the dashed line on the acetate. Panoramic reconstruction was accomplished on the i-CAT to a scale of 1 cm (acetate): .96 cm on the iCAT. This was the closest to a true 1:1 relationship that could be accomplished.

Third Molar Image Display

Panoramic reconstructions were generated for both the customized focal plane and focal trough, and standardized arch form based on the average form of dentition of mandible in focal trough widths of 10, 20, and 40mm. This provided a total of three hundred third molars, fifty in each focal trough width group. The image of each third molar in each focal trough width was cropped approximately 3cm in all directions. This was done so the raters could see nothing but the third molar and all close approximations present. Each cropped third molar was exported as a lossless TIF format without image enhancement. (Figure 13) For display and analysis, the cropped third molar images were imported to commercial photographic imaging software (Adobe Photoshop 7.0; 2002; Adobe, 2002; San Jose, CA) and images equalized prior to analysis. Equalization redistributes the brightness values of pixels so that they are more evenly represented over the entire range of brightness levels. After detecting the brightest and darkest values in the image, they are remapped so the brightest value represents white and the darkest represents black. Brightness is then equalized by distributing the intermediate pixel values evenly through the gray scale. This was done to better view the anatomical detail of the IAN and the mandibular third molar.

FIGURE 13

Representative example of cropped third molar image



The 300 images were coded and all images were viewed on a 19 inch flat panel color active matrix TFT (Dell E171FPb Flat Panel Color Monitor, Dell inc., Round Rock, TX, USA) screen with a resolution of 1024 x 768 at 60 Hz and a 0.264 dot pitch, operated at 32 bit. The 300 images were imported into a slide show using commercial software IrfanView©.

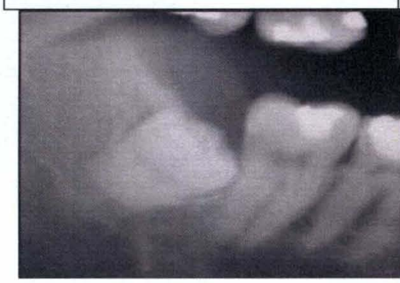
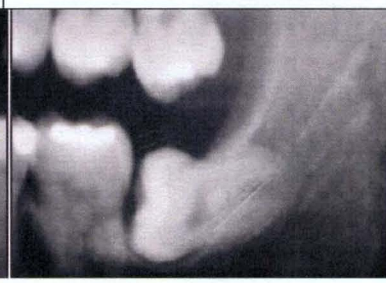
Determination of Third Molar Relationship

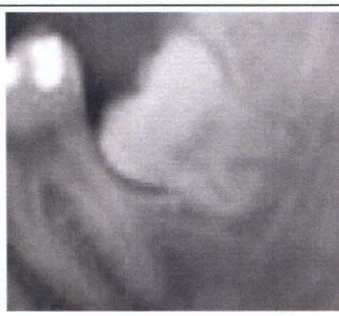
Subjective Evaluation

Two independent observers viewed images of the 300 molars. The PI randomized all images in regards to focal trough width and focal trough shape using Research Randomizer© software. Guided by the published radiographic signs associated with IAC involvement with the roots of third molars (Valmaseda-Castellon and Berini-Aytes, 2001; Blaeser *et al.,* 2003; Bell, 2004; Monaco *et al.*, 2004; Mahasantipiya *et al.*, 2005), each image was viewed and observers asked to indicate 1) Whether the image was of acceptable image quality and 2) which sign(s) of IAC involvement are present. Observers were provided with an instructional sheet providing examples of IAC associations to assist them in their decision (Table 4).

TABLE 4

Radiographic signs observed

Darkening of the root	Disruption of the cortical white lines of the canal	Deviation of canal
		

Deflection of roots	Superimposition of canal	Narrowing of canal
		

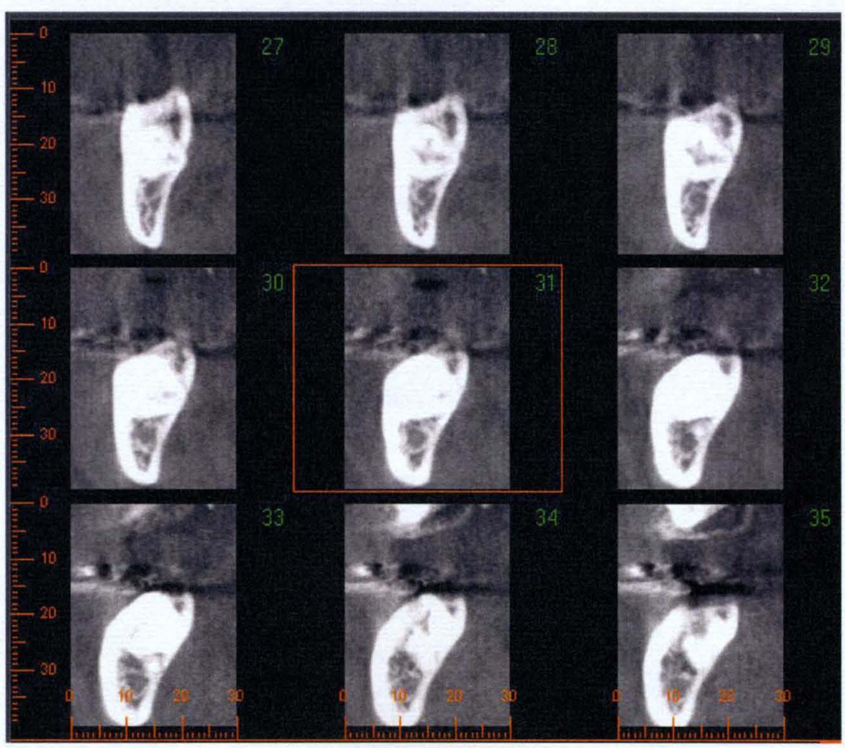
To minimize intra- and inter-observer variability, each observer viewed an additional 20 images selected at random (Research Randomizer© software: http://www.randomizer.org/) for each focal trough width (10, 20, and 40mm) and each focal trough shape (standard and customized) for a total of 120 repeated images.

Objective Evaluation

Utilizing the serial transplanar cross sectional image display mode (Figure 14), direct measurements from the end of the root of the molar to the IAC were performed by each observer. The dataset also was used to detect the canal position, and whether the root was notched or the canal transverses through the root. Repeated measurements of 20 of the total 50 were made to determine intra- and inter-observer variability. These 20 repeated tooth measurements were randomized using Research Randomizer© software.

FIGURE 14

Screen image display demonstrating representative cross–sectional images of mandible to measure distance from root to IAN



Data Analysis

All data was input into a spreadsheet (Microsoft Excel XP, Microsoft Corp., Redmond, WA, USA) and then exported to a statistical analysis program SAS (Statistical Analysis System Version 8; SAS Institute Inc., Cary, NC, 1999). Ordinal logistic regression analysis was used to measure the outcome of radiographic signs present with three categories (Category 1, 0 to 1mm; Category 2, >1 to < 2mm, Category 3, >2mm) and focal trough width. The Intraclass correlation coefficient (ICC) was used as a measure of agreement to measure both inter -and intra-rater variability.

CHAPTER IV

RESULTS

Fifty images of mandibular third molar teeth were examined by each observer to provide a total of 100 observations. Images were presented representing three different focal trough widths (10, 20, and 40mm) and two focal trough shapes (customized and average form). In addition, the observers measured the distance between the third molar root and the IAC, recorded the bucco-lingual relationship to the mandibular canal, and also the association of the IAC to root of the third molar.

Distances from the third molar root varied and could be classified into three groups. (Table 5)

TABLE 5

Distance from third molar root to IAC as measured on the transplanar cross-sectional images.

Category	*Frequency*	*Percent*
0-1 mm	78	78
1-2 mm	10	10
2+ mm	12	12
Total	100	100

The bucco-lingual relationship of the 100 mandibular third molar teeth to the mandibular canal based on imaging findings are shown in Table 6. There was variability in the relationships of the IAC to the root with most (46%) being buccal to the root. Statistical analysis showed no significance in relative position of the IAC to the root of the tooth.

TABLE 6

Buccolingual position of the mandibular canal in relation to the third molar root.

Location of IAC relative to mandibular third molar tooth	***Frequency***	***Percent***
Buccal	46	46
Lingual	23	23
Central	31	31
Total	100	100

The incidence of radiographic signs observed related to the association of the IAC to the root of the third molar is shown in Table 7. Several teeth showed notching of the root with the nerve, while a majority showed nothing present. No canals were observed to travel through the middle of the roots.

TABLE 7

Incidence of radiographic signs of IAC involvement in relation to the root of the third molar

Radiographic Sign	*Frequency*	*Percent*
Root is notched	21	21
Nothing	79	79
Nerve runs through root	0	0
Total	100	100

Frequencies of the six panoramic radiographic signs associated with IAC involvement with the root of the mandibular third molar features with respect to focal trough width and focal trough shape are shown in Table 8 and 9 respectively/

TABLE 8

Customized arch form- signs present

	Focal Trough Width (mm)		
Radiographic Sign	***10mm***	***20mm***	***40mm***
Darkening of root	62	54	42
Disruption of cortical lines	49	45	38
Deviation of canal	12	7	10
Deflection of roots	26	17	14
Superimposition of canal	54	48	45
Narrowing of canal	24	16	17
Undiagnostic	2	2	7

TABLE 9

Average form arch form- signs present

	Focal Trough Width (mm)		
Radiographic Sign	***10mm***	***20mm***	***40mm***
Darkening of root	19	32	26
Disruption of cortical lines	16	34	34
Deviation of canal	6	13	7
Deflection of roots	4	13	14
Superimposition of canal	15	38	28
Narrowing of canal	8	14	7
Undiagnostic	60	28	29

Multivariate analysis using these 6 radiographic signs as predictor variables relative to the focal trough width and focal trough shape showed that two features, 1) darkening of the root and 2) narrowing of the canal in focal trough width 20mm and the customized arch form was a significant predictor of close involvement of the root of the tooth to the mandibular nerve (Table 10).

TABLE 10

Type III Analysis of Effects - Trough width 20mm, customized arch form

Effect	*DF*	*Wald chi-square*	*P value*
Darkening of root	2	6.8825	**.0320**
Disruption of cortical lines	1	1.0038	.3164
Deviation of canal	1	0.0000	.9978
Deflection of roots	1	2.2848	.1306
Superimposition of canal	1	1.2240	.2686
Narrowing of canal	1	3.9473	**.0469**

Tables 11-16 show the inter-rater agreement as determined by the average measures ICC varied for each of the six panoramic signs present.

For darkening of the root, there was only significance in two focal trough widths (10 and 20mm) with the average focal trough form (Table 11).

TABLE 11

ICC and ANOVA results comparing inter-rater agreement for each arch form and width

Focal Trough Variable			*F Test*	
Arch Form	***Trough Width***	***ICC***	***Value***	***Significance***
Customized	10	.457	1.840	.096
Customized	20	.378	1.608	.155
Customized	40	.061	1.065	.446
Average	10	.858	7.043	.000
Average	20	.608	2.550	.024
Average	40	.482	1.929	.081

For disruption of the cortical white lines of the canal, significance was found with observation in everything. (Table 12)

TABLE 12

Focal Trough Variable			*F Test*	
Arch Form	***Trough Width***	***ICC***	***Value***	***Significance***
Customized	10	.640	2.778	.016
Customized	20	.711	3.462	.005
Customized	40	.588	2.425	.030
Average	10	.965	28.500	.000
Average	20	.785	4.649	.001
Average	40	.602	2.513	.026

For deviation of the canal, there was only significance in three focal trough widths (10, 20, and 40mm) all in the average focal trough form (Table 13).

TABLE 13

Focal Trough Variable			*F Test*	
Arch Form	***Trough Width***	***ICC***	***Value***	***Significance***
Customized	10	.387	1.632	.147
Customized	20	-.115	.897	.593
Customized	40	.443	1.797	.105
Average	10	.847	6.542	.000
Average	20	.717	3.533	.004
Average	40	.576	2.358	.034

For deflection of roots, there were only two significant measures and they were in the focal trough width of 10 and 20 mm in the average form (Table 14).

TABLE 14

Focal Trough Variable			*F Test*	
Arch Form	***Trough Width***	***ICC***	***Value***	***Significance***
Customized	10	.000	1.00	.500
Customized	20	-.353	.739	.742
Customized	40	.497	1.98	.072
Average	10	.894	9.460	.000
Average	20	.648	2.842	.014
Average	40	.276	1.381	.244

For superimposition of canal, significance was found with observation in everything. (Table 15)

TABLE 15

Focal Trough Variable			*F Test*	
Arch Form	*Trough Width*	*ICC*	*Value*	*Significance*
Customized	10	.700	3.333	.006
Customized	20	.580	2.381	.033
Customized	40	.550	2.220	.045
Average	10	.968	31.667	.000
Average	20	.587	2.421	.031
Average	40	.560	2.274	.041

For narrowing of the canal, significance was only found in two of the measurements. The customized arch form 40mm focal trough width, and the average arch form in the 10mm focal trough width. (Table 16)

TABLE 16

Focal Trough Variable			*F Test*	
Arch Form	*Trough Width*	*ICC*	*Value*	*Significance*
Customized	10	-.667	.600	.863
Customized	20	-.600	.625	.843
Customized	40	.581	2.389	.033
Average	10	.913	11.435	.000
Average	20	.510	2.042	.064
Average	40	.485	1.943	.078

Inter-observer agreement in the measurement of root to nerve and nerve position was found to be statistically significant ($P<.05$). (Table 17)

TABLE 17

ICC and ANOVA results comparing measurements of root to nerve, nerve position, and nerve to root association.

Measurement variable		***F Test***	
	ICC	***Value***	***Significance***
distance measurement	.635	2.737	.015
nerve position	.640	2.776	.014
nerve to root assoc.	.504	2.018	.064

Tables 18-29 show the intra-rater agreement as determined by the average measures ICC varied for each of the six panoramic signs present.

For darkening of the root, Observer #1 showed significance for every sign measurement (Table 17), whereas Observer #2 showed significance in focal trough width 10mm-customized focal trough arch form and 10mm-average focal trough arch form (Table 18).

TABLE 18

Intra-rater ANOVA Comparison of ICC for Observer #1 for Observations concerning darkening of the root.

Focal Trough Variable		*ICC*	*F Test*	
Arch Form	*Trough Width*		*Value*	*Significance*
Customized	10	.883	8.526	.000
Customized	20	.608	2.549	.022
Customized	40	.534	2.144	.049
Average	10	.879	8.263	.000
Average	20	.835	6.079	.000
Average	40	.653	2.882	.012

TABLE 19

Observer #2- darkening of the root

Focal Trough Variable		*ICC*	*F Test*	
Arch Form	*Trough Width*		*Value*	*Significance*
Customized	10	.635	2.737	.015
Customized	20	-.462	.684	.794
Customized	40	.406	1.684	.128
Average	10	.859	7.105	.000
Average	20	.293	1.415	.224
Average	40	-.153	.867	.620

For disruption of the cortical while lines of the canal, Observer #1 showed significance of great consistency in all measurements (Table 19) while Observer #2 showed significant results with all but the 40mm focal trough width in the average focal trough arch form. (Table 20)

TABLE 20

Intra-rater ANOVA Comparison of ICC for Observer #1 for Observations concerning disruption of the cortical white lines of the canal.

Focal Trough Variable			***F Test***	
Arch Form	***Trough Width***	***ICC***	***Value***	***Significance***
Customized	10	.533	2.140	.050
Customized	20	.744	3.905	.002
Customized	40	.727	3.663	.003
Average	10	.903	10.316	.000
Average	20	.732	3.727	.003
Average	40	.662	2.957	.010

TABLE 21

Observer #2- disruption of the cortical white lines of the canal

Focal Trough Variable			***F Test***	
Arch Form	***Trough Width***	***ICC***	***Value***	***Significance***
Customized	10	.566	2.305	.036
Customized	20	.533	2.140	.050
Customized	40	.543	2.188	.045
Average	10	.964	27.895	.000
Average	20	.705	3.389	.005
Average	40	.513	2.053	.059

For deviation of the canal, Observer #1 showed significance in all measures except 10 and 20mm focal trough width in the customized arch form (Table 21). However Observer #2 showed only significant results in the 10 and 20mm focal trough width in the average focal trough form. (Table 22)

TABLE 22

Intra-rater ANOVA Comparison of ICC for Observer #1 for Observations concerning deviation of the canal.

Focal Trough Variable			*F Test*	
Arch Form	*Trough Width*	*ICC*	*Value*	*Significance*
Customized	10	-.188	.842	.644
Customized	20	.472	1.895	.082
Customized	40	.717	3.536	.004
Average	10	.930	14.263	.000
Average	20	.695	3.283	.006
Average	40	.875	8.000	.000

TABLE 23

Observer #2- deviation of the canal

Focal Trough Variable			*F Test*	
Arch Form	*Trough Width*	*ICC*	*Value*	*Significance*
Customized	10	.469	1.884	.084
Customized	20	-.056	.947	.545
Customized	40	-.157	.865	.623
Average	10	.986	71.316	.000
Average	20	.773	4.400	.001
Average	40	.320	1.472	.199

For deflection of roots, Observer #1 had significance in all measurements. (Table 23) whereas Observer #2 had significance in only two measurements, 10 and 20mm in the average focal trough form. (Table 24)

TABLE 24

Intra-rater ANOVA Comparison of ICC for Observer #1 for Observations concerning deflection of roots.

Focal Trough Variable			***F Test***	
Arch Form	***Trough Width***	***ICC***	***Value***	***Significance***
Customized	10	.000	1.000	.050
Customized	20	.000	1.000	.050
Customized	40	.667	3.000	.009
Average	10	.950	19.947	.000
Average	20	.712	3.478	.004
Average	40	.732	3.737	.003

TABLE 25

Observer #2- deflection of roots

Focal Trough Variable			***F Test***	
Arch Form	***Trough Width***	***ICC***	***Value***	***Significance***
Customized	10	.470	1.887	.084
Customized	20	.367	1.579	.159
Customized	40	.034	1.035	.468
Average	10	.985	65.842	.000
Average	20	.795	4.883	.000
Average	40	.259	1.349	.256

For superimposition of the canal Observer #1 had significance in all measurements except the 20 and 40mm focal trough width in the customized arch form (Table 25). Observer #2 had significance in only two measurements, 10 and 20 mm in the average focal trough form. (Table 26)

TABLE 26

Intra-rater ANOVA Comparison of ICC for Observer #1 for Observations concerning superimposition of the canal.

Focal Trough Variable			***F Test***	
Arch Form	***Trough Width***	***ICC***	***Value***	***Significance***
Customized	10	.682	3.147	.007
Customized	20	.412	1.702	.123
Customized	40	.401	1.669	.132
Average	10	.931	14.474	.000
Average	20	.835	6.079	.000
Average	40	.606	2.536	.023

TABLE 27

Observer #2- superimposition of the canal

Focal Trough Variable			***F Test***	
Arch Form	***Trough Width***	***ICC***	***Value***	***Significance***
Customized	10	.162	1.193	.349
Customized	20	-.583	.632	.839
Customized	40	.120	1.137	.388
Average	10	.883	8.537	.000
Average	20	.701	3.339	.005
Average	40	.223	1.287	.290

For narrowing of the canal, Observer #1 had significance in all of the measurements (Table 27). Observer #2 had significance in only two measurements, 10 and 20mm in the average focal trough form. (Table 28)

TABLE 28

Intra-rater ANOVA Comparison of ICC for Observer #1 for Observations concerning narrowing of the canal.

Focal Trough Variable			***F Test***	
Arch Form	***Trough Width***	***ICC***	***Value***	***Significance***
Customized	10	.568	2.316	.035
Customized	20	.615	2.596	.020
Customized	40	.676	3.088	.008
Average	10	.911	11.263	.000
Average	20	.778	4.505	.001
Average	40	.645	2.819	.013

TABLE 29

Observer #2- narrowing of the canal

Focal Trough Variable			***F Test***	
Arch Form	***Trough Width***	***ICC***	***Value***	***Significance***
Customized	10	.469	1.884	.084
Customized	20	-.267	.789	.695
Customized	40	.222	1.286	.291
Average	10	.950	19.947	.000
Average	20	.799	4.977	.000
Average	40	.367	1.579	.159

Intra-observer agreement between root to nerve measurement, nerve position, and nerve to root association showed significance (P<.05) in all of them in both observer #1 and observer #2. (Tables 30 & 31)

TABLE 30

Intra-rater ANOVA Comparison of ICC for Observer #1 for measurements concerning root to nerve measurement, nerve position, and nerve to root association.

Measurement variable		***F Test***	
	ICC	***Value***	***Significance***
distance measurement	.614	2.593	.020
nerve position	.779	4.526	.001
nerve to root assoc.	.791	4.789	.001

TABLE 31

Observer #2- root to nerve measurement, nerve position, and nerve to root association.

Measurement variable		***F Test***	
	ICC	***Value***	***Significance***
distance measurement	.927	13.632	.000
nerve position	.972	35.526	.000
nerve to root assoc.	1.00		.000

CHAPTER V

DISCUSSION

Radiological evaluation is essential in evaluating the topographic relationship between the mandibular canal and the mandibular third molar, and panoramic images are commonly used for this. Panoramic images lack the ability to provide spatial information, and numerous clinical studies have been performed to evaluate panoramic radiographic signs suggestive of communication with the inferior alveolar nerve. (Valmaseda-Castellon and Berini-Aytes, 2001; Blaeser *et al.,* 2000; Bell 2004; Monaco *et al.*, 2004; Mahasantipiya *et al.*, 2005; Sedaghatfar *et al.*, 2005). The results of these authors indicate that each of the following either individually or in combination may act as a radiographic marker indicate a close relationship between the mandibular canal and the third molar: deflection of roots, diversion of canal, interruption of canal wall, darkening of root, superimposition of canal, narrowing of canal, narrowing of roots.

Bell (2004) examined panoramic images of 300 mandibular third molar teeth and reported that darkening of the root, interruption of cortical white lines of canal, and superimposition of tooth over canal significantly correlated third molar root and nerve communication. He also concluded that sensitivity and specificity of panoramic images in determining communication between the mandibular canal and the root of the third molar being 66% and 74% respectively is disappointing. He found that sensitivity and specificity vary widely among different observers. No previous studies have investigated the effect of varying focal trough shape and width on panoramic radiologic signs associated with proximity of the IAC to the third molar root. This study showed that two panoramic features, darkening of the root, and narrowing of the canal in the customized 20mm focal trough shape and width all significantly correlated with very close proximity of mandibular third molar root to IAN. Two representative cases are shown in Figs. 15 and 16. These two features are consistent with those reported by Monaco *et al.*, (2004). Darkening of the roots, found to be of significance in this study, has also been reported by other authors. (Blaeser *et al.,* 2003; Bell, 2004; Monaco *et al.*, 2004; Sedaghatfar *et al.*, 2005).

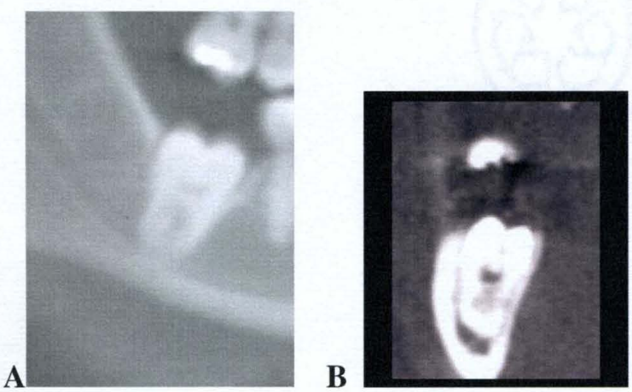
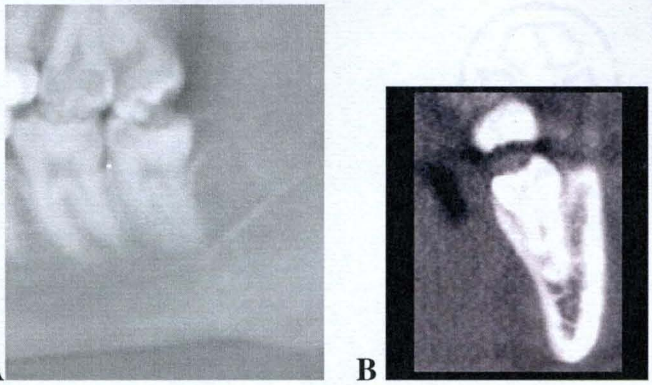


FIGURE 15

(A) Darkening of the root viewed on customized focal trough shape in 20mm focal trough width. (B) Root of third molar communicating with IAN.

FIGURE 16

(A) Narrowing of the canal viewed on customized focal trough shape in 20mm focal trough width. (B) Root of third molar communicating with IAN.



A B

Because of the ability of CBVCT imaging to adjust the features of curved planar MPR, we were able to adjust both the focal tough shape and width of the constructed "panoramic" image. We found that that the customized focal trough shape and 20mm focal trough width showed statistical significance for two signs. The resolution of a normal panoramic throughout the focal trough is not uniform, being 1.5 lp/mm at the periphery of the focal trough and increasing up to 5 lp/mm at the center of the focal trough. (Scarfe *et al.*, 1998). In a majority of cases, for the average focal trough arch form and 10mm and 20mm focal trough widths, a large number of undiagnosable cases were found. This was most probably because the third molar and the IAN are not within the clearest plane of resolution (Figure 17). This is because not every person has the same mandibular arch form size and width. A number of panoramic radiographic machines have arch size selections that will change the parameters of the focal trough dimensions. However, the only available selections are usually adult and child. The adult selection invariably does not conform to the individual arch form but the "average" arch form. Therefore it is not surprising that there may be variable image quality due to variations in the position and relationship of the third molars in the posterior mandible.

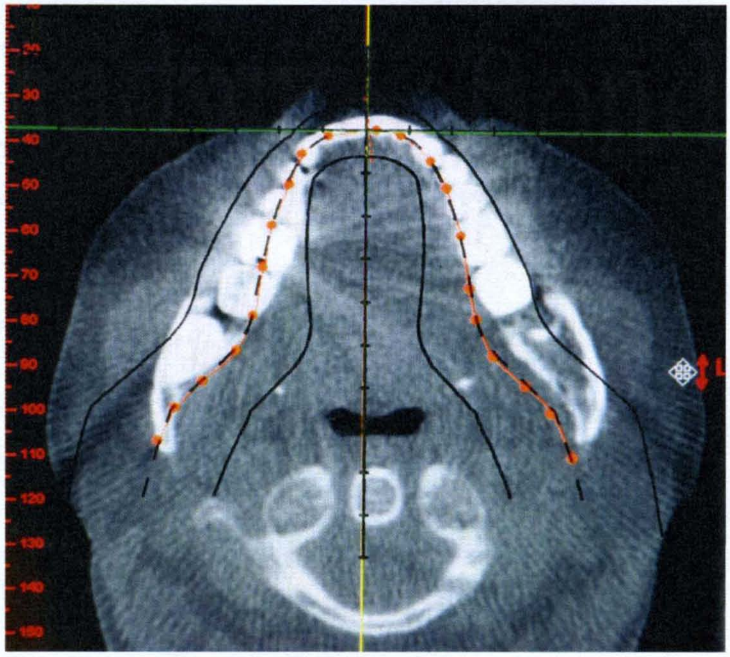
This discrepancy between the location of the third molar due to anatomic variability and focal trough shape invariably results in reduced clarity of the outline of the IAC. What is the optimal focal trough width if a standard focal trough arch form is used?

Due to the variability of mandibular arch forms, no signs were found significant in the standard arch form for the average adult of the panoramic radiograph machines that are used today. In the customized focal trough arch form, 20mm focal trough width, two signs which were darkening of the root and narrowing of the canal, were found to be statistically significant to close proximity of the IAC. This focal trough width does correlate to some of the focal trough widths used in panoramic radiograph machines today that incorporate one focal trough arch form. (See Table 2)

All of the other focal trough widths (10 and 40mm- customized shape and 10, 20, and 40mm- average shape) showed no significance in predicting an outcome measure. These findings suggested that the other four panoramic features may not significantly contribute to the prediction of close nerve involvement in any of the focal trough widths and focal trough shapes. Thus, in the present study, darkening of the root and narrowing of the canal in the focal trough width of 20mm-customized focal trough shape was defined as the diagnostic criterion of panoramic images to predict close neurovascular involvement of the third molar and the mandibular nerve.

FIGURE 17

Average arch form focal trough. Note the third molars lying buccal to the focal plane



There were several potential weaknesses in this study. When using the acetate overlay in the axial view on the i-CAT for the average form focal trough, a 1cm (acetate): 0.96 (i-CAT) ratio was used to fabricate the central plane of the reconstructed panoramic. This ratio was the closest to a 1:1 ratio for acetate to i-CAT in this fabrication. This may have introduced some discrepancy in the placement of the central plane in relation to the third molar, however it may be clinically insignificant. The number of teeth used in the study (50) was relatively small. It may be beneficial to increase the sample size and the number of observers to reduce inter-rater variability. A high number of cases in the average form focal trough, 10mm and 20mm were undiagnosable. This was most likely because the third molars were located outside of the central plane and had less clarity resolution. Many images were excluded because of this. Thus, it increased the inter-rater and intra-rater reliability in this study. Some of the images in each of the categories had unsharpness in the reconstructed panoramics that caused the observers difficulty in interpreting signs present or absent.

Inter-rater reliability varied somewhat in each focal trough form, focal trough width, and panoramic radiographic sign present. This indicated that there is variability between observers for panoramic radiographic signs present and seeing these signs on a panoramic can be subjective to the observer. Intra-rater reliability varied somewhat from fair to excellent in each focal trough form, focal trough width, and panoramic radiographic sign present. Observer #1 had excellent consistency in all radiographic focal trough forms, focal trough widths, and panoramic radiographic signs present while observer #2 had fair to poor results with a majority of her consistency being found in average focal trough form, 10mm and 20mm. This was possibly due to the number of undiagnosable images present in those categories. Though there was quite a range in the agreement of the two observers, all observations were used in the statistical analysis. Prior tests of observer quality and panoramic radiographic sign level calibration may have reduced of the variability the data.

CHAPTER VI

SUMMARY AND CONCLUSIONS

This study was conducted to determine if multiplanar curved transaxial images representing simulated panoramic images reconstructed from cone beam CT volumetric datasets, viewed with two different focal trough shapes and three different focal trough widths, influenced the ability of observers to identify high risk panoramic radiological signs associated with an intimate anatomic relationship between third molars and the IAC.

A series of 50 mandibular third molar teeth being less than 3mm from the IAC were picked from the files of the i-CAT CBVCT at the University of Louisville Radiology Department. The 50 teeth were reconstructed into panoramic images with two different arch shapes (customized and average form), and three different focal trough widths at the third molar region (10, 20, and 40mm). A slide show consisting of 300 slides (two arch forms and three different focal trough widths) was viewed by each observer. Six high risk radiological panoramic signs of the third molar related to the IAN were evaluated at each tooth (slide) and determined to be present or absent. Each observer utilized the CBVCT cross sectional analysis of the mandible to measure the distance, in millimeters, of the mandibular canal to the closest part of the mandibular third molar tooth. The observers also noted the position of the IAN in relation to the roots (buccal, lingual, or central) and the nerve to root association (notched, nothing, or nerve runs through root) in the mandibular cross section. Through these observations, statistical analysis was performed to determine if the teeth that have high risk radiological signs are in close proximity to the IAN, relative to the focal trough arch forms and the focal trough widths.

The results of the statistical analysis found observers were able to identify two panoramic radiological signs indicative of close proximity to the IAN using the customized focal trough arch form and the 20mm focal trough width. These signs were darkening of the root and narrowing of the canal. These predictors have also been found to be of significance by other authors. (Blaeser *et al.,* 2003; Bell 2004; Monaco *et al.*, 2004; Sedaghatfar *et al.*, 2005). It was also determined that no correlation was present between the location of the IAC (buccal, lingual, or central) and proximity of tooth root.

There was significant inter-rater agreement between the observers for a number of radiographic features. This indicates that there is some variability in signs that were present in the parameters not mentioned above by each observer. This also implies that there is subjective variability between observers when asked to indicate specific radiologic signs associated with third molar involvement with the IAC. Reliability for measurements, nerve position, and nerve root association all demonstrated high inter-rater agreement. Intra-rater reliability was inconsistent between observers.

Therefore, the null hypothesis must be rejected based on the data gathered for this project. There was a statistically significant difference in the customized focal trough arch form, and a statistically significant difference in the focal trough width with two panoramic high risk third molar radiological signs that predict close proximity of the third molar to the IAN for one of six conditions.

As CBVCT develops providing smaller voxel dimensions, this study could be conducted again using a customized focal trough form and a focal trough width of 17-23mm to determine the ideal focal trough size and which panoramic radiological third molar high risk signs are present. With the higher resolution in future CBVCT, mandibular canal and third molar root high risk signs may be more visible when viewing reconstructed panoramics. In future panoramic radiographic machines, an initial scan of the patients' dentition would be made. From this initial scan, the boundaries of the focal trough and central plane would be made. A second true panoramic scan would be done using the patients arch form (customized from the initial scan) to fabricate the panoramic radiograph. This would produce the optimal image necessary to look for third molar high risk panoramic signs associated with close proximity to the mandibular canal.

REFERENCES

Ahlqwist M., Gröndahl H-G. Prevalence of impacted teeth and associated pathology in middle-aged and older Swedish women. *Community Dent Oral Epidemiol* 1991;**19**:116-119.

Baab, D. Caries and periodontitis associated with unerupted third molars. *Oral Surg Oral Med Oral Path* 1964;**58**(4):428-430.

Baba R, Ueda K, Okabe M. Using a flat-panel detector in high resolution cone beam CT for dental imaging. *Dentomaxillofac Radiol* 2004;**33**:285-290.

Bell GW. Use of dental panoramic tomographs to predict the relation between mandibular third molar teeth and the inferior alveolar nerve. Radiological and surgical findings, and clinical outcome. *Br J Oral Macillofac Surg* 2004; **42**:21-27.

Blaeser B, August M, Donoff RB, Kaban L, and Dodson T. Panoramic radiography risk factors for inferior alveolar nerve injury after third molar extraction. *J Oral Maxillofac Surg* 2003;**61**:417-421.

Bouquet A, Coudert JL, Bourgeois D, Mazoyer JF, Bossard D. Contributions of reformatted computed tomography and panoramic radiography in the localization of third molars relative to the maxillary sinus. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod.* 2004 Sep;**98**(3):342-7.

Brickley MR, Tanner M, Evans DJ, Edwards MJ, Armstrong RA, and Shepherd JP. Prevalence of third molars in dental practice attenders aged over 35. *Comm Dent Health* 1996;**13**:223-227.

Carmichael FA, McGowan DA. Incidence of nerve damage following third molar removal: a west Scotland oral surgery research group study. *Br J Oral Surg* 1992;**30**:78-82.

Carter RB, Keen EN. Intramandibular course of the inferior alveolar nerve. *J Anat* 1971;**108**: 433-440.

Chu FCS, Li TKL, Lui VKB, Newsome PRH, Chow RLK, and Cheund LK. Prevalence of impacted teeth and associated pathologies-a radiographic study of the Hong Kong Chinese population. *Hong Kong Med J* 2003;**9**:158-162.

Danforth R, Peck J, Hall P. Cone Beam Volume tomography: An Imaging Option for Diagnosis of Complex Mandibular Third Molar Anatomical Relationships. *J Calif Dent Assoc* 2003;**31**:847-852.

Danforth, R, Peck, J, and Hall P. Cone beam volume tomography: an imaging option for diagnosis of complex mandibular third molar anatomical relationships. *CDA Journal* 2003;**31**:847-852.

Enciso R, Danforth RA, Alexandroni ES, Memon A, and Mah J. Third molar evaluation with cone-beam computerized tomography. *Int J CARS.* 2006;**1**:113-116

Garcia RI, Chauncey HH. The eruption of third molars in adults: a 10 year longitudinal study. *Oral Surg* 1989;**68**(1):9-13.

Glass BJ, McDavid WD, Welander U, Morris CR. The central plane of the image layer determined experimentally in various rotational panoramic x-ray machines. *Oral Surg Oral Med Oral Pathol* 1985;**60**: 104-112.

Harris CR, Jerman AC. Panoramic radiograph survey of embedded third molars. *J Oral Surg* 1971;**29**:122-125.

Hashimoto K, Arai Y, Iwai K, Araki M, Kawashima S, Terakado M. A comparison of anew limited cone beam computed tomography machine for dental use with amultidetector row helical CT machine. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2003;**95**:371–377.

Hilgers ML, Scarfe WC, Scheetz JP, Farman AG. Accuracy of linear temporomandibular joint measurements with cone beam computed tomography and digital cephalometric radiography. *Am J Orthod Dentofacial Orthop* 2005;**128**:803-811

Hugoson A, Kugelberg CF. The prevalence of third molars in a Swedish population. An epidemiological study. *Comm Dent Health* 1988: **5**(2): 121-138.

Kaplan, RG. Mandibular third molars and post retention crowding. *Am. J. Orthod* 1974;**66**: 411-429.

Koong B, Pharoah MJ, Bulsara M, Tennant M. Methods of determining the relationship of the mandibular canal and third molars: a survey of Australian oral and maxillofacial surgeons. *Aust Dent J.* 2006 Mar;**51**(1):64-8.

Kress B, Gottschalk A, Anders L, Stippich C, Palm F, Bahren W, Sartor K. High-resolution dental magnetic resonance imaging of inferior alveolar nerve responses to the extraction of third molars. *Eur Radiol.* 2004 Aug;**14**(8):1416-20. Epub 2004 Mar 9.

LaBanc JP. Classification of nerve injuries. *Oral Maxillofac Clin North Am* 1992; **4**(2):285–296.

Lascala CA, Panella J, Marques MM. Analysis of the accuracy of linear measurements obtained by cone beam computed tomography (CBCT-NewTom). *Dentomaxillofac Radiol* 2004;**33**:291-294.

Ludlow JB, Davies-Ludlow LE, Brooks SL, Howerton B. Dosimetry of 3 CBCT devices for oral and maxillofacial radiology: CB Mercuray, NewTom 3G and i-CAT. *Dentomaxillofac Radiol.* 2006;**35**(4):219-226.

Ludlow JB, Davies-Ludlow LE, Brooks SL. Dosimetry of two extraoral direct digital imaging devices: NewTom cone beam CT and Orthophos Plus DS panoramic unit. *Dentomaxillofac Radiol. 2003*;**32**(4):229-234.

Lund TM, Manson-Hing LR. Relations between tooth positions and focal troughs of panoramic machines. *Oral Surg Oral Med Oral Pathol* 1975;**40**:285-293.

Maegawa H, Sano K, Kitagawa Y, Ogasawara T, Miyauchi K, Sekine J. Preoperative assessment of the relationship between the mandibular third molar and the mandibular canal by axial computed tomography with coronal and sagittal reconstruction. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2003;**96**:639-646.

Mahasantipiya PM, Savage NW, Monsour PAJ, and Wilson RJ. Narrowing of the inferior dental canal in relation to the lower third molars. *Dentomaxillofac Radiol* 2005;**34**:154-163.

Manson-Hing LR, Lund TM, Ohba T. Japanese tooth positions and focal troughs of panoramic machines. *Oral Surg Oral Med Oral Pathol* 1976;**41**:797-802.

McDavid WD, Tronje G, Welander, U, Morris CR: Effects of errors in film speed and beam alignment of the image layer in rotational panoramic radiography. *Oral Surg Oral Med Oral Pathol* 1981;**52**:561-564.

Monaco G, Montevecchi M, Bonetti GA, Gatto MRA, and Checchi L. Reliability of panoramic radiography in evaluating the topographic relationship between the mandibular canal and impacted third molars. *J Am Dent Assoc* 2004;**3**:312-318.

Moshiri M, Scarfe WC, Hilgers ML, Scheetz JP, Silveira AM, and Farman AG. Accuracy of imaging methods from imaging plate and CBCT-derived lateral cephalometric images. *Am J Orthod Dentofac Orthop* accepted 2006.

Mozzo P, Procacci C, Tacconi A, Martini PT, Andreis IA. A new volumetric CT machinefor dental imaging based on the cone-beam technique: preliminary results. *Eur Radiol* 1998;**8**:1558–1564.

Mozzo P, Procacci C, Tacconi A. A new volumetric CT machine for dental imaging based on the cone-beam technique: Preliminary results. *Eur Radiol* 1998;**8**:1558-1564.

Nakagawa Y, Kobayashi K, Ishii H, Mishima A, Ishii H, Asada K, and Ishibashi K. Preoperative application of limited cone beam computerized tomography as an assessment tool before minor oral surgery. *Int J Oral Maxillofac Surg* 2002;**31**:322-327.

Nickoloff El, and Alderson PO. Radiation Exposures to Patients from CT: Reality, Public Perception, and Policy. *AJR* 201;**177**:285-287.

Nordenram A, Aas E, Hjorting-Hansen, E. Retinerade tander. *Oral kirurgi* 1986;98-120.

Nordenram A, Hultin M, Kjellman O, Ramstrom G. Indication for surgical removal of third molars: Study of 2630 cases. *Swed Dent J* 1987;**11**:23-29.

Nortje CJ, Farman AG, Joubert JJ. The radiographic appearance of the inferior dental canal: an additional variation. *Br J Oral Surg* 1977a; **15**: 171-172.

Nortje CJ, Farman AG, Grotepass FW. Variation in the normal anatomy of the inferior dental (mandibular) canal: a retrospective study of panoramic radiographs from 3612 routine dental patients. *Br J Oral Surg* 1977b; **15**: 55-63.

Nummikoski P, Prihoda T, Langlais R, McDavid W, Welander U, Tronje G. Dental and mandibular arch widths in three ethnic groups in Texas: A radiographic study. *Oral Surg Oral Med Oral Pathol* 1988;**65**:609-617.

Nummikoski P. The size and shape of the dental arch in different sex and ethnic groups. Masters Thesis, The University of Texas graduate School of Biomedical Science at San Antonio, San Antonio, Texas, USA 1985.

Ohman A, Kivijarvi K, Blomback U, Flygare L. Pre-operative radiographic evaluation of lower third molars with computed tomography. *Dentomaxillofac Radiol.* 2006 Jan;**35**(1):30-5.

Olasoji HO, Odusanya SA. Comparative study of third molar impaction in rural and urban areas of south western Nigeria. *Odonto-Stomatologie Tropicale* 2000-N°90:25-28.

Oliver E. Le canal dentaire et son nerf chez l'adult. *Ann Anat Pathol* 1927; **4**: 975-987.

Osborn TP, Frederickson G Jr, Small IA, Torgerson TS. A prospective study of complications related to mandibular third molar surgery. *J Oral Maxillofac Surg* 1985;**43**:767-769.)

Pawelzik J, Cohnen M, Willers R, and Becker J. A comparison of conventional panoramic radiographs with volumetric computed tomography images in the preoperative assessment of impacted mandibular third molars. *J Oral Maxillofac Surg* 2002;**60**:979-984.

Pell GJ, Gregory G. Report on a ten year study of a tooth division technique for the removal of impacted teeth. *Am J Orthod* 1942;**28**:660-669.

Peterson LJ, Ellis E, Hupp J, and Tucker M. *Contemporary Oral and Maxillofacial Sirgery*, 2nd ed., C.V. Mosby Co., St. Louis, 1993;237-242.

Rood JP, Shehab AA. The radiological predilection of inferior alveolar nerve injury during third molar surgery. Br *J Oral Maxillofac Surg* 1990;**28**:20-25.

Rosenthal, RL. Extrusion of an impacted third molar for use as a fixed partial denture abutment. *Gen Dent* 1986;**34**(4): 2980-2991.

Scarfe WC, Farman AG, Sukovic P. Clinical applications of Cone-Beam Computed Tomography in Dental Practice. *J Can Dent Assoc.* 2006;**72**(1):75-80

Scarfe WC, Farman AG. Characteristics of the orthopantomograph OP 100. *Dentomaxillofac Radiol* 1998;**27**:51-7.

Schersten E, Lysell L, and Rohlin M. Prevalence of impacted third molars in dental students. *Swed Dent J* 1989;**13**(1-2):7-13.

Schroll K. Anatomische und roentgenologische untersuchungen veber den verlang des nervus alveolaris inferior um unbezahten kieger. *Acta Stomatol Belg* 1975; **72**: 771-776.

Sedaghatfar M, August MA, Dodson TB. Panoramic radiographic findings as predictors of inferior alveolar nerve exposure following third molar extraction. *J Oral Maxillofac Surg* 2005;**63**: 3-7.

Smith AC, Barry SE, Chiong AY, Hadzakis D, Kha SL, Mok SC. Inferior alveolar nerve damage following removal of mandibular third molar tooth. A prospective study using panoramic radiography. *Aust Dent J* 1997;**42**:149-152.

Stedman's medical dictionary. 25th ed. Baltimore: Williams & Wilkins; 1990. Impaction; p. 956.

Sukovic P. Cone beam computed tomography in craniofacial imaging. *Orthod CraniofacRes* 2003;**6**(Suppl 1):31–36.

Tate, TE. Impactions:Observe or Treat?. *J Calif Dent Assoc* 1994;**22**(6): 59-64.

Tevepaugh, DB, Dodson, TB. Are Mandibular Third Molars a Risk Factor for Angle Fractures? A retrospective Cohort Study. *J Oral Maxillofac Surg* 1995;**53**:646-649.

Tronje G, Eliasson S, Julin P, Welander U. Image distortion in rotational panoramic radiography. II. Vertical distances. *Acta Radiol Diagn Stockh* 1981a;**22**:449-455.

Tronje G, Welander U, McDavid WD, and Morris CR. Image distortion in rotational panoramic radiography. I. General considerations. *Acta Radiol Diagn Stockh* 1981b;**22**:295-299.

Tronje G, Welander U, McDavid WD, Morris CR. Image distortion in rotational panoramic radiography. III. Inclined objects. *Acta Radiol Diagn Stockh* 1981c;**22**:585-592.

Tulloch JFC, and Antczak-Bouckoms AA. Decision analysis in the evaluation of clinical strategies for the management of mandibular third molars. *J Dent Educ* 1987;**51**:652-658.

Van Gool AV, Ten Bosch JJ, Boering G. Clinical consequences of complaints and complications after removal of the mandibular third molar. *Int J Oral Surg* 1977; **6**: 29-37.

Valmaseda-Castellon E, Berini-Aytes L. Inferior alveolar nerve damage after lower third molar surgical extraction: A prospective study of 1,117 surgical extractions. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2001;**92**:377-383.

Welander U, Nummikoski P, Tronje G, McDavid WD, Legrell PE, and Langlais RP. Standard forms of dentition and mandible for applications in rotational panoramic radiography. *Dentomaxillofac Radiol* 1989;**18**:60-67.

White SC and Pharoah M J. Panoramic radiography. *Oral radiology: principles and interpretation* St. Louis: C V. Mosby Inc.; 2000: 205-216.

Yamaoka M, Furusawa K, Ikeda M, Hasegawa T. Root resorption of mandibular second molar teeth associated with the presence of the third molars. *Australian Dental Journal* 1999;**44**:112-116.

Zuniga JR, LaBanc JP. Advances in microsurgical nerve repair. *J Oral Maxillofac Surg* 1993; **51**(suppl 1):62–68.

Appendix A- SAS raw data

```
                                  1          0       1
                             The SAS System        15:32 Friday, April 20,
2007   1

---------------------------------- tro_width=10 arch_form=1 ----------------------------
------

                              The LOGISTIC Procedure

                                Model Information

              Data Set                       WORK.JIM
              Response Variable              meas                    meas
              Number of Response Levels      3
              Model                          cumulative logit
              Optimization Technique         Fisher's scoring


                      Number of Observations Read         100
                      Number of Observations Used         100


                                Response Profile

                        Ordered                       Total
                          Value          meas     Frequency

                              1             3            12
                              2             2            10
                              3             1            78

         Probabilities modeled are cumulated over the lower Ordered Values.


                             Class Level Information

                                                Design
                         Class       Value     Variables

                         sign_1      0           1      0
                                     1           0      1
                                     2           0      0

                         sign_2      0           1      0
                                     1           0      1
                                     2           0      0

                         sign_3      0           1      0
                                     2           0      0

                         sign_5      0           1      0
                                     1           0      1
                             The SAS System        15:32 Friday, April 20,
2007   2

---------------------------------- tro_width=10 arch_form=1 ----------------------------
------

                              The LOGISTIC Procedure

                             Class Level Information

                                                Design
                         Class       Value     Variables

                                     2           0      0
```

sign_6	0	1	0
	1	0	1
	2	0	0
ner_pos	1	1	0
	2	0	1
	3	0	0
n_r_inv	1	1	
	2	0	

Model Convergence Status

Quasi-complete separation of data points detected.

WARNING: The maximum likelihood estimate may not exist.
WARNING: The LOGISTIC procedure continues in spite of the above warning. Results shown are
based on the last maximum likelihood iteration. Validity of the model fit is questionable.

Score Test for the Proportional Odds Assumption

Chi-Square	DF	Pr > ChiSq
29.3608	10	0.0011

Model Fit Statistics

Criterion	Intercept Only	Intercept and Covariates
AIC	139.698	145.243
SC	144.908	176.505
-2 Log L	135.698	121.243

------------------------------- tro_width=10 arch_form=1 ----------------------------------

The LOGISTIC Procedure
WARNING: The validity of the model fit is questionable.

R-Square 0.1346 Max-rescaled R-Square 0.1812

Testing Global Null Hypothesis: BETA=0

Test	Chi-Square	DF	Pr > ChiSq
Likelihood Ratio	14.4546	10	0.1532
Score	11.8755	10	0.2935
Wald	9.6635	10	0.4705

Type 3 Analysis of Effects

Effect	DF	Wald Chi-Square	Pr > ChiSq
sign_1	2	0.7006	0.7045
sign_2	1	1.0352	0.3089
sign_3	1	0.0012	0.9727
sign_4	1	0.7689	0.3806
sign_5	1	0.9812	0.3219
sign_6	1	1.1859	0.2761
ner_pos	2	1.9888	0.3699

n_r_inv	1	2.5005	0.1138

NOTE: The following parameters have been set to 0, since the variables are a linear combination of other variables as shown.

```
sign_21 =  sign_10 + sign_11 - sign_20
sign_31 =  sign_10 + sign_11 - sign_30
sign_41 =  sign_10 + sign_11 - sign_40
sign_51 =  sign_10 + sign_11 - sign_50
sign_61 =  sign_10 + sign_11 - sign_60
```


---------------------------------- tro_width=10 arch_form=1 ----------------------------------

The LOGISTIC Procedure

WARNING: The validity of the model fit is questionable.

Analysis of Maximum Likelihood Estimates

Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept	3	1	-12.1122	145.0	0.0070	0.9334
Intercept	2	1	-11.3060	145.0	0.0061	0.9378
sign_1	0	1	8.8275	145.0	0.0037	0.9514
sign_1	1	1	8.2769	145.0	0.0033	0.9545
sign_2	0	1	0.5712	0.5614	1.0352	0.3089
sign_2	1	0	0	.	.	.
sign_3	0	1	0.0322	0.9411	0.0012	0.9727
sign_3	1	0	0	.	.	.
sign_4	0	1	0.6136	0.6998	0.7689	0.3806
sign_4	1	0	0	.	.	.
sign_5	0	1	0.6472	0.6534	0.9812	0.3219
sign_5	1	0	0	.	.	.
sign_6	0	1	0.8073	0.7413	1.1859	0.2761
sign_6	1	0	0	.	.	.
ner_pos	1	1	-0.3107	0.6255	0.2468	0.6193
ner_pos	2	1	0.6599	0.7544	0.7651	0.3817
n_r_inv	1	1	-1.7347	1.0970	2.5005	0.1138

Odds Ratio Estimates

Effect	Point Estimate	95% Wald Confidence Limits	
sign_1 0 vs 2	>999.999	<0.001	>999.999
sign_1 1 vs 2	>999.999	<0.001	>999.999
sign_2 0 vs 2	1.770	0.589	5.320
sign_3 0 vs 2	1.033	0.163	6.532
sign_4 0 vs 2	1.847	0.469	7.280
sign_5 0 vs 2	1.910	0.531	6.875
sign_6 0 vs 2	2.242	0.524	9.586
ner_pos 1 vs 3	0.733	0.215	2.497
ner_pos 2 vs 3	1.935	0.441	8.486
n_r_inv 1 vs 2	0.176	0.021	1.515

---------------------------------- tro_width=10 arch_form=1 ----------------------------------

The LOGISTIC Procedure

WARNING: The validity of the model fit is questionable.

Association of Predicted Probabilities and Observed Responses

Percent Concordant	71.5	Somers' D	0.454
Percent Discordant	26.1	Gamma	0.465
Percent Tied	2.5	Tau-a	0.168
Pairs	1836	c	0.727

---------------------------------- tro_width=10 arch_form=2 ----------------------------------

The LOGISTIC Procedure

Model Information

Data Set	WORK.JIM	
Response Variable	meas	meas
Number of Response Levels	3	
Model	cumulative logit	
Optimization Technique	Fisher's scoring	

Number of Observations Read	100
Number of Observations Used	100

Response Profile

Ordered Value	meas	Total Frequency
1	3	12
2	2	10
3	1	78

Probabilities modeled are cumulated over the lower Ordered Values.

Class Level Information

Class	Value	Design Variables	
sign_1	0	1	0
	1	0	1
	2	0	0
sign_2	0	1	0
	1	0	1
	2	0	0
sign_3	0	1	0
	1	0	1
	2	0	0
sign_4	0	1	0
	1	0	1
	2	0	0
sign_5	0	1	0
	1	0	1

---------------------------------- tro_width=10 arch_form=2 ----------------------------------

The LOGISTIC Procedure

Class Level Information

Class	Value	Design Variables	
	2	0	0
sign_6	0	1	0
	1	0	1
	2	0	0
ner_pos	1	1	0
	2	0	1
	3	0	0
n_r_inv	1	1	
	2	0	

Model Convergence Status

Quasi-complete separation of data points detected.

WARNING: The maximum likelihood estimate may not exist.
WARNING: The LOGISTIC procedure continues in spite of the above warning. Results shown are
based on the last maximum likelihood iteration. Validity of the model fit is questionable.

Score Test for the Proportional Odds Assumption

Chi-Square	DF	Pr > ChiSq
43.2539	10	<.0001

Model Fit Statistics

Criterion	Intercept Only	Intercept and Covariates
AIC	139.698	142.186
SC	144.908	173.448
-2 Log L	135.698	118.186

The LOGISTIC Procedure

WARNING: The validity of the model fit is questionable.

R-Square 0.1606 Max-rescaled R-Square 0.2163

Testing Global Null Hypothesis: BETA=0

Test	Chi-Square	DF	Pr > ChiSq
Likelihood Ratio	17.5118	10	0.0638
Score	14.1480	10	0.1663
Wald	11.4684	10	0.3222

Type 3 Analysis of Effects

Effect	DF	Wald Chi-Square	Pr > ChiSq
sign_1	2	1.3862	0.5000

sign_2	1	0.5179	0.4717
sign_3	1	0.1257	0.7229
sign_4	1	0.0026	0.9593
sign_5	1	1.1156	0.2909
sign_6	1	2.0780	0.1494
ner_pos	2	3.4134	0.1815
n_r_inv	1	2.9514	0.0858

NOTE: The following parameters have been set to 0, since the variables are a linear combination of other variables as shown.

```
sign_21 =  sign_10 + sign_11 - sign_20
sign_31 =  sign_10 + sign_11 - sign_30
sign_41 =  sign_10 + sign_11 - sign_40
sign_51 =  sign_10 + sign_11 - sign_50
sign_61 =  sign_10 + sign_11 - sign_60
```


---------------------------------- tro_width=10 arch_form=2 ----------------------------------

The LOGISTIC Procedure

WARNING: The validity of the model fit is questionable.

Analysis of Maximum Likelihood Estimates

Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept	3	1	-1.4657	0.5088	8.2977	0.0040
Intercept	2	1	-0.6179	0.4732	1.7053	0.1916
sign_1	0	1	-13.1590	223.8	0.0035	0.9531
sign_1	1	1	-14.4421	223.8	0.0042	0.9485
sign_2	0	1	0.7074	0.9830	0.5179	0.4717
sign_2	1	0	0	.	.	.
sign_3	0	1	-0.5752	1.6224	0.1257	0.7229
sign_3	1	0	0	.	.	.
sign_4	0	1	11.4298	223.8	0.0026	0.9593
sign_4	1	0	0	.	.	.
sign_5	0	1	1.3023	1.2330	1.1156	0.2909
sign_5	1	0	0	.	.	.
sign_6	0	1	2.0820	1.4443	2.0780	0.1494
sign_6	1	0	0	.	.	.
ner_pos	1	1	-1.0939	0.6335	2.9822	0.0842
ner_pos	2	1	-0.1470	0.6938	0.0449	0.8323
n_r_inv	1	1	-1.9083	1.1108	2.9514	0.0858

Odds Ratio Estimates

Effect	Point Estimate	95% Wald Confidence Limits	
sign_1 0 vs 2	<0.001	<0.001	>999.999
sign_1 1 vs 2	<0.001	<0.001	>999.999
sign_2 0 vs 2	2.029	0.295	13.929
sign_3 0 vs 2	0.563	0.023	13.526
sign_4 0 vs 2	>999.999	<0.001	>999.999
sign_5 0 vs 2	3.678	0.328	41.218
sign_6 0 vs 2	8.021	0.473	136.030
ner_pos 1 vs 3	0.335	0.097	1.159
ner_pos 2 vs 3	0.863	0.222	3.363
n_r_inv 1 vs 2	0.148	0.017	1.308

-------------------------------- tro_width=10 arch_form=2 ---------------------------- ------

The LOGISTIC Procedure
WARNING: The validity of the model fit is questionable.

Association of Predicted Probabilities and Observed Responses

Percent Concordant	70.6	Somers' D	0.491
Percent Discordant	21.5	Gamma	0.533
Percent Tied	7.9	Tau-a	0.182
Pairs	1836	c	0.745

-------------------------------- tro_width=20 arch_form=1 ---------------------------- ------

The LOGISTIC Procedure

Model Information

Data Set	WORK.JIM	
Response Variable	meas	meas
Number of Response Levels	3	
Model	cumulative logit	
Optimization Technique	Fisher's scoring	

Number of Observations Read	100
Number of Observations Used	100

Response Profile

Ordered Value	meas	Total Frequency
1	3	12
2	2	10
3	1	78

Probabilities modeled are cumulated over the lower Ordered Values.

Class Level Information

Class	Value	Design Variables	
sign_1	0	1	0
	1	0	1
	2	0	0
sign_2	0	1	0
	1	0	1
	2	0	0
sign_3	0	1	0
	1	0	1
	2	0	0
sign_4	0	1	0
	1	0	1
	2	0	0
sign_5	0	1	0
	1	0	1

------------------------------------ tro_width=20 arch_form=1 -----------------------------------

The LOGISTIC Procedure

Class Level Information

Class	Value	Design Variables	
	2	0	0
sign_6	0	1	0
	1	0	1
	2	0	0
ner_pos	1	1	0
	2	0	1
	3	0	0
n_r_inv	1	1	
	2	0	

Model Convergence Status

Convergence criterion (GCONV=1E-8) satisfied.

Score Test for the Proportional Odds Assumption

Chi-Square	DF	Pr > ChiSq
57.9659	10	<.0001

Model Fit Statistics

Criterion	Intercept Only	Intercept and Covariates
AIC	139.698	136.577
SC	144.908	167.839
-2 Log L	135.698	112.577

R-Square 0.2064 Max-rescaled R-Square 0.2780

------------------------------------ tro_width=20 arch_form=1 -----------------------------------

The LOGISTIC Procedure

Testing Global Null Hypothesis: BETA=0

Test	Chi-Square	DF	Pr > ChiSq
Likelihood Ratio	23.1210	10	0.0103
Score	18.1045	10	0.0532
Wald	15.6884	10	0.1089

Type 3 Analysis of Effects

Effect	DF	Wald Chi-Square	Pr > ChiSq

sign_1	2	6.8825	0.0320
sign_2	1	1.0038	0.3164
sign_3	1	0.0000	0.9978
sign_4	1	2.2848	0.1306
sign_5	1	1.2240	0.2686
sign_6	1	3.9473	0.0469
ner_pos	2	0.4290	0.8069
n_r_inv	1	2.3510	0.1252

NOTE: The following parameters have been set to 0, since the variables are a linear combination of other variables as shown.

```
sign_21 =  sign_10 + sign_11 - sign_20
sign_31 =  sign_10 + sign_11 - sign_30
sign_41 =  sign_10 + sign_11 - sign_40
sign_51 =  sign_10 + sign_11 - sign_50
sign_61 =  sign_10 + sign_11 - sign_60
```

Analysis of Maximum Likelihood Estimates

Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept	3	1	-0.3687	1.5209	0.0588	0.8084
Intercept	2	1	0.5256	1.5220	0.1192	0.7299
sign_1	0	1	-4.7410	2.4772	3.6628	0.0556
sign_1	1	1	-5.7130	2.4699	5.3503	0.0207
sign_2	0	1	-0.5649	0.5638	1.0038	0.3164
sign_2	1	0	0	.	.	.
sign_3	0	1	0.00367	1.3165	0.0000	0.9978
sign_3	1	0	0	.	.	.

------------------------------------ tro_width=20 arch_form=1 ------------------------------------

The LOGISTIC Procedure

Analysis of Maximum Likelihood Estimates

Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
sign_4	0	1	1.7855	1.1812	2.2848	0.1306
sign_4	1	0	0	.	.	.
sign_5	0	1	0.7854	0.7099	1.2240	0.2686
sign_5	1	0	0	.	.	.
sign_6	0	1	2.2603	1.1377	3.9473	0.0469
sign_6	1	0	0	.	.	.
ner_pos	1	1	-0.3992	0.6404	0.3886	0.5330
ner_pos	2	1	-0.0784	0.7580	0.0107	0.9177
n_r_inv	1	1	-1.7119	1.1165	2.3510	0.1252

Odds Ratio Estimates

Effect	Point Estimate	95% Wald Confidence Limits	
sign_1 0 vs 2	0.009	<0.001	1.121
sign_1 1 vs 2	0.003	<0.001	0.418
sign_2 0 vs 2	0.568	0.188	1.716
sign_3 0 vs 2	1.004	0.076	13.248
sign_4 0 vs 2	5.963	0.589	60.383
sign_5 0 vs 2	2.193	0.546	8.817
sign_6 0 vs 2	9.586	1.031	89.126
ner_pos 1 vs 3	0.671	0.191	2.354
ner_pos 2 vs 3	0.925	0.209	4.085

```
n_r_inv 1 vs 2       0.181       0.020       1.610
```

Association of Predicted Probabilities and Observed Responses

Percent Concordant	78.0	Somers' D	0.583
Percent Discordant	19.7	Gamma	0.596
Percent Tied	2.3	Tau-a	0.216
Pairs	1836	c	0.791

The LOGISTIC Procedure

Model Information

Data Set	WORK.JIM	
Response Variable	meas	meas
Number of Response Levels	3	
Model	cumulative logit	
Optimization Technique	Fisher's scoring	

Number of Observations Read	100
Number of Observations Used	100

Response Profile

Ordered Value	meas	Total Frequency
1	3	12
2	2	10
3	1	78

Probabilities modeled are cumulated over the lower Ordered Values.

Class Level Information

Class	Value	Design Variables	
sign_1	0	1	0
	1	0	1
	2	0	0
sign_2	0	1	0
	1	0	1
	2	0	0
sign_3	0	1	0
	1	0	1
	2	0	0
sign_4	0	1	0
	1	0	1
	2	0	0
sign_5	0	1	0
	1	0	1

The LOGISTIC Procedure

Class Level Information

Class	Value	Design Variables	
	2	0	0
sign_6	0	1	0
	1	0	1
	2	0	0
ner_pos	1	1	0
	2	0	1
	3	0	0
n_r_inv	1	1	
	2	0	

Model Convergence Status

Convergence criterion (GCONV=1E-8) satisfied.

Score Test for the Proportional Odds Assumption

Chi-Square	DF	Pr > ChiSq
38.9299	10	<.0001

Model Fit Statistics

Criterion	Intercept Only	Intercept and Covariates
AIC	139.698	144.447
SC	144.908	175.709
-2 Log L	135.698	120.447

R-Square 0.1414 Max-rescaled R-Square 0.1905

----------------------------------- tro_width=20 arch_form=2 ----------------------------------

The LOGISTIC Procedure

Testing Global Null Hypothesis: BETA=0

Test	Chi-Square	DF	Pr > ChiSq
Likelihood Ratio	15.2508	10	0.1232
Score	11.8874	10	0.2927
Wald	10.6333	10	0.3868

Type 3 Analysis of Effects

Effect	DF	Wald Chi-Square	Pr > ChiSq
sign_1	2	3.6058	0.1648
sign_2	1	0.9476	0.3303
sign_3	1	1.3880	0.2387
sign_4	1	0.8047	0.3697

sign_5	1	0.3730	0.5413
sign_6	1	0.0111	0.9160
ner_pos	2	1.5519	0.4603
n_r_inv	1	3.4612	0.0628

NOTE: The following parameters have been set to 0, since the variables are a linear combination of other variables as shown.

```
sign_21 =  sign_10 + sign_11 - sign_20
sign_31 =  sign_10 + sign_11 - sign_30
sign_41 =  sign_10 + sign_11 - sign_40
sign_51 =  sign_10 + sign_11 - sign_50
sign_61 =  sign_10 + sign_11 - sign_60
```

Analysis of Maximum Likelihood Estimates

Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept	3	1	-1.4894	0.6094	5.9735	0.0145
Intercept	2	1	-0.6711	0.5821	1.3292	0.2489
sign_1	0	1	-2.2924	2.0009	1.3126	0.2519
sign_1	1	1	-3.3444	1.9585	2.9160	0.0877
sign_2	0	1	0.7026	0.7218	0.9476	0.3303
sign_2	1	0	0	.	.	.
sign_3	0	1	1.1157	0.9470	1.3880	0.2387
sign_3	1	0	0	.	.	.

------------------------------- tro_width=20 arch_form=2 ----------------------------------

The LOGISTIC Procedure

Analysis of Maximum Likelihood Estimates

Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
sign_4	0	1	1.0785	1.2023	0.8047	0.3697
sign_4	1	0	0	.	.	.
sign_5	0	1	0.5339	0.8742	0.3730	0.5413
sign_5	1	0	0	.	.	.
sign_6	0	1	0.0847	0.8025	0.0111	0.9160
sign_6	1	0	0	.	.	.
ner_pos	1	1	-0.6758	0.6174	1.1981	0.2737
ner_pos	2	1	-0.0121	0.6708	0.0003	0.9856
n_r_inv	1	1	-2.1107	1.1345	3.4612	0.0628

Odds Ratio Estimates

Effect	Point Estimate	95% Wald Confidence Limits	
sign_1 0 vs 2	0.101	0.002	5.100
sign_1 1 vs 2	0.035	<0.001	1.639
sign_2 0 vs 2	2.019	0.491	8.309
sign_3 0 vs 2	3.052	0.477	19.525
sign_4 0 vs 2	2.940	0.279	31.028
sign_5 0 vs 2	1.706	0.307	9.462
sign_6 0 vs 2	1.088	0.226	5.246
ner_pos 1 vs 3	0.509	0.152	1.706
ner_pos 2 vs 3	0.988	0.265	3.679
n_r_inv 1 vs 2	0.121	0.013	1.120

Association of Predicted Probabilities and Observed Responses

```
                    Percent Concordant     71.8    Somers' D    0.473
                    Percent Discordant     24.6    Gamma        0.490
                    Percent Tied            3.6    Tau-a        0.175
                    Pairs                  1836    c            0.736
                              The SAS System         15:32 Friday, April 20,
2007  19

--------------------------------- tro_width=40 arch_form=1 -----------------------------
------

                              The LOGISTIC Procedure

                                 Model Information

                 Data Set                      WORK.JIM
                 Response Variable             meas                 meas
                 Number of Response Levels     3
                 Model                         cumulative logit
                 Optimization Technique        Fisher's scoring


                         Number of Observations Read         100
                         Number of Observations Used         100


                                  Response Profile

                            Ordered                      Total
                              Value          meas     Frequency

                                  1             3            12
                                  2             2            10
                                  3             1            78

         Probabilities modeled are cumulated over the lower Ordered Values.


                              Class Level Information

                                                     Design
                             Class        Value     Variables

                             sign_1       0          1      0
                                          1          0      1
                                          2          0      0

                             sign_2       0          1      0
                                          1          0      1
                                          2          0      0

                             sign_3       0          1      0
                                          1          0      1
                                          2          0      0

                             sign_4       0          1      0
                                          1          0      1
                                          2          0      0

                             sign_5       0          1      0
                                          1          0      1
                              The SAS System         15:32 Friday, April 20,
2007  20

--------------------------------- tro_width=40 arch_form=1 -----------------------------
------

                              The LOGISTIC Procedure

                              Class Level Information

                                                     Design
```

Class	Value	Variables	
	2	0	0
sign_6	0	1	0
	1	0	1
	2	0	0
ner_pos	1	1	0
	2	0	1
	3	0	0
n_r_inv	1	1	
	2	0	

Model Convergence Status

Quasi-complete separation of data points detected.

WARNING: The maximum likelihood estimate may not exist.
WARNING: The LOGISTIC procedure continues in spite of the above warning. Results shown are
based on the last maximum likelihood iteration. Validity of the model fit is questionable.

Score Test for the Proportional Odds Assumption

Chi-Square	DF	Pr > ChiSq
32.3664	10	0.0003

Model Fit Statistics

Criterion	Intercept Only	Intercept and Covariates
AIC	139.698	140.481
SC	144.908	171.743
-2 Log L	135.698	116.481

The SAS System 15:32 Friday, April 20, 2007 21

-------------------------------- tro_width=40 arch_form=1 ----------------------------------

The LOGISTIC Procedure

WARNING: The validity of the model fit is questionable.

R-Square 0.1748 Max-rescaled R-Square 0.2354

Testing Global Null Hypothesis: BETA=0

Test	Chi-Square	DF	Pr > ChiSq
Likelihood Ratio	19.2169	10	0.0376
Score	14.7109	10	0.1430
Wald	9.5503	10	0.4808

Type 3 Analysis of Effects

Effect	DF	Wald Chi-Square	Pr > ChiSq
sign_1	2	0.6278	0.7306
sign_2	1	0.9391	0.3325
sign_3	1	0.0048	0.9446

sign_4	1	1.2005	0.2732
sign_5	1	0.1740	0.6766
sign_6	1	0.3564	0.5505
ner_pos	2	1.1172	0.5720
n_r_inv	1	2.5038	0.1136

NOTE: The following parameters have been set to 0, since the variables are a linear combination of other variables as shown.

```
sign_21 =  sign_10 + sign_11 - sign_20
sign_31 =  sign_10 + sign_11 - sign_30
sign_41 =  sign_10 + sign_11 - sign_40
sign_51 =  sign_10 + sign_11 - sign_50
sign_61 =  sign_10 + sign_11 - sign_60
```


---------------------------------- tro_width=40 arch_form=1 ----------------------------------

The LOGISTIC Procedure

WARNING: The validity of the model fit is questionable.

Analysis of Maximum Likelihood Estimates

Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept	3	1	-0.7356	0.8466	0.7549	0.3849
Intercept	2	1	0.0936	0.8400	0.0124	0.9112
sign_1	0	1	-14.3493	165.6	0.0075	0.9309
sign_1	1	1	-14.9451	165.6	0.0081	0.9281
sign_2	0	1	0.5901	0.6090	0.9391	0.3325
sign_2	1	0	0	.	.	.
sign_3	0	1	11.5055	165.6	0.0048	0.9446
sign_3	1	0	0	.	.	.
sign_4	0	1	1.3292	1.2131	1.2005	0.2732
sign_4	1	0	0	.	.	.
sign_5	0	1	0.3386	0.8118	0.1740	0.6766
sign_5	1	0	0	.	.	.
sign_6	0	1	0.5152	0.8629	0.3564	0.5505
sign_6	1	0	0	.	.	.
ner_pos	1	1	-0.4887	0.6271	0.6072	0.4359
ner_pos	2	1	0.1776	0.7180	0.0612	0.8046
n_r_inv	1	1	-1.7840	1.1274	2.5038	0.1136

Odds Ratio Estimates

Effect	Point Estimate	95% Wald Confidence Limits	
sign_1 0 vs 2	<0.001	<0.001	>999.999
sign_1 1 vs 2	<0.001	<0.001	>999.999
sign_2 0 vs 2	1.804	0.547	5.952
sign_3 0 vs 2	>999.999	<0.001	>999.999
sign_4 0 vs 2	3.778	0.350	40.720
sign_5 0 vs 2	1.403	0.286	6.888
sign_6 0 vs 2	1.674	0.308	9.083
ner_pos 1 vs 3	0.613	0.179	2.097
ner_pos 2 vs 3	1.194	0.292	4.878
n_r_inv 1 vs 2	0.168	0.018	1.531

```
--------------------------------- tro_width=40 arch_form=1 -----------------------------
------

                                 The LOGISTIC Procedure
WARNING: The validity of the model fit is questionable.

                 Association of Predicted Probabilities and Observed Responses

                       Percent Concordant     76.5    Somers' D    0.551
                       Percent Discordant     21.4    Gamma        0.563
                       Percent Tied            2.1    Tau-a        0.204
                       Pairs                  1836    c            0.776
                                     The SAS System         15:32 Friday, April 20,
2007  24

--------------------------------- tro_width=40 arch_form=2 -----------------------------
------

                                 The LOGISTIC Procedure

                                    Model Information

                    Data Set                      WORK.JIM
                    Response Variable             meas                 meas
                    Number of Response Levels     3
                    Model                         cumulative logit
                    Optimization Technique        Fisher's scoring


                         Number of Observations Read        100
                         Number of Observations Used        100


                                     Response Profile

                            Ordered                     Total
                              Value          meas    Frequency

                                  1             3           12
                                  2             2           10
                                  3             1           78

              Probabilities modeled are cumulated over the lower Ordered Values.


                                 Class Level Information

                                                  Design
                             Class       Value   Variables

                             sign_1      0          1      0
                                         1          0      1
                                         2          0      0

                             sign_2      0          1      0
                                         1          0      1
                                         2          0      0

                             sign_3      0          1      0
                                         1          0      1
                                         2          0      0

                             sign_4      0          1      0
                                         1          0      1
                                         2          0      0

                             sign_5      0          1      0
                                         1          0      1
                                     The SAS System         15:32 Friday, April 20,
2007  25
```

---------------------------------- tro_width=40 arch_form=2 ----------------------------------

The LOGISTIC Procedure

Class Level Information

Class	Value	Design Variables	
	2	0	0
sign_6	0	1	0
	1	0	1
	2	0	0
ner_pos	1	1	0
	2	0	1
	3	0	0
n_r_inv	1	1	
	2	0	

Model Convergence Status

Convergence criterion (GCONV=1E-8) satisfied.

Score Test for the Proportional Odds Assumption

Chi-Square	DF	Pr > ChiSq
18.2529	10	0.0508

Model Fit Statistics

Criterion	Intercept Only	Intercept and Covariates
AIC	139.698	141.022
SC	144.908	172.284
-2 Log L	135.698	117.022

R-Square 0.1704 Max-rescaled R-Square 0.2294

---------------------------------- tro_width=40 arch_form=2 ----------------------------------

The LOGISTIC Procedure

Testing Global Null Hypothesis: BETA=0

Test	Chi-Square	DF	Pr > ChiSq
Likelihood Ratio	18.6759	10	0.0446
Score	14.3017	10	0.1597
Wald	12.0845	10	0.2794

Type 3 Analysis of Effects

Effect	DF	Wald Chi-Square	Pr > ChiSq

sign_1	2	1.1903	0.5515
sign_2	1	0.0301	0.8623
sign_3	1	3.1705	0.0750
sign_4	1	2.1832	0.1395
sign_5	1	1.8391	0.1751
sign_6	1	1.0282	0.3106
ner_pos	2	1.1471	0.5635
n_r_inv	1	3.2064	0.0733

NOTE: The following parameters have been set to 0, since the variables are a linear combination of other variables as shown.

```
sign_21 =  sign_10 + sign_11 - sign_20
sign_31 =  sign_10 + sign_11 - sign_30
sign_41 =  sign_10 + sign_11 - sign_40
sign_51 =  sign_10 + sign_11 - sign_50
sign_61 =  sign_10 + sign_11 - sign_60
```

Analysis of Maximum Likelihood Estimates

Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept	3	1	-2.1274	0.6688	10.1171	0.0015
Intercept	2	1	-1.2691	0.6293	4.0672	0.0437
sign_1	0	1	-2.2617	2.6638	0.7209	0.3958
sign_1	1	1	-2.1418	1.9724	1.1792	0.2775
sign_2	0	1	-0.1200	0.6914	0.0301	0.8623
sign_2	1	0	0	.	.	.
sign_3	0	1	-1.8663	1.0481	3.1705	0.0750
sign_3	1	0	0	.	.	.

--------------------------------- tro_width=40 arch_form=2 ----------------------------------

The LOGISTIC Procedure

Analysis of Maximum Likelihood Estimates

Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
sign_4	0	1	1.8417	1.2465	2.1832	0.1395
sign_4	1	0	0	.	.	.
sign_5	0	1	1.9917	1.4687	1.8391	0.1751
sign_5	1	0	0	.	.	.
sign_6	0	1	1.2986	1.2807	1.0282	0.3106
sign_6	1	0	0	.	.	.
ner_pos	1	1	-0.1754	0.6260	0.0785	0.7793
ner_pos	2	1	0.5441	0.7182	0.5739	0.4487
n_r_inv	1	1	-2.0939	1.1694	3.2064	0.0733

Odds Ratio Estimates

Effect	Point Estimate	95% Wald Confidence Limits	
sign_1 0 vs 2	0.104	<0.001	19.281
sign_1 1 vs 2	0.117	0.002	5.607
sign_2 0 vs 2	0.887	0.229	3.439
sign_3 0 vs 2	0.155	0.020	1.207
sign_4 0 vs 2	6.308	0.548	72.587
sign_5 0 vs 2	7.328	0.412	130.346
sign_6 0 vs 2	3.664	0.298	45.097
ner_pos 1 vs 3	0.839	0.246	2.862
ner_pos 2 vs 3	1.723	0.422	7.041

n_r_inv 1 vs 2	0.123	0.012	1.219

Association of Predicted Probabilities and Observed Responses

Percent Concordant	76.5	Somers' D	0.570
Percent Discordant	19.4	Gamma	0.595
Percent Tied	4.1	Tau-a	0.212
Pairs	1836	c	0.785

Appendix B- SPSS Inter-rater reliability

Reliability--TWO RATERS-- SIGN 1 ORIGINAL

Notes

[DataSet1] **INTER-RATER RELIABILITY FOR TWO RATERS**

Scale: ALL VARIABLES

Case Processing Summary

arch_form	tro_width			N	%
CUSTOMIZED	10	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
	20	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
	40	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
AVERAGE	10	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
	20	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
	40	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0

a Listwise deletion based on all variables in the procedure.

Reliability Statistics

arch_form	tro_width	Cronbach's Alpha	N of Items
CUSTOMIZED	10	.457	2
	20	.378	2
	40	.061	2
AVERAGE	10	.858	2
	20	.608	2
	40	.482	2

Intraclass Correlation Coefficient

				95% Confidence Interval		F Test with True Value 0			
arch_form	tro_width		Intraclass Correlation(a)	Upper Bound	Value	df1	df2	Sig	Lower Bound
CUSTOMIZED	10	Single Measures	.296(b)	-.157	.646	1.840	19	19	.096
		Average Measures	.457(c)	-.373	.785	1.840	19	19	.096
	20	Single Measures	.233(b)	-.222	.605	1.608	19	19	.155
		Average Measures	.378(c)	-.571	.754	1.608	19	19	.155
	40	Single Measures	.031(b)	-.407	.458	1.065	19	19	.446
		Average Measures	.061(c)	-1.373	.628	1.065	19	19	.446
AVERAGE	10	Single Measures	.751(b)	.472	.894	7.043	19	19	.000
		Average Measures	.858(c)	.641	.944	7.043	19	19	.000
	20	Single Measures	.437(b)	.005	.731	2.550	19	19	.024
		Average Measures	.608(c)	.009	.845	2.550	19	19	.024
	40	Single Measures	.317(b)	-.134	.659	1.929	19	19	.081
		Average Measures	.482(c)	-.310	.795	1.929	19	19	.081

Two-way mixed effects model where people effects are random and measures effects are fixed.
a Type C intraclass correlation coefficients using a consistency definition-the between-measure variance is excluded from the denominator variance.
b The estimator is the same, whether the interaction effect is present or not.
c This estimate is computed assuming the interaction effect is absent, because it is not estimable otherwise.

```
RELIABILITY
  /VARIABLES=sign_2Fo sign_2So
  /SCALE('ALL VARIABLES')  ALL/MODEL=ALPHA
```

```
/ICC=MODEL(MIXED) TYPE(CONSISTENCY) CIN=95 TESTVAL=0 .
```

Reliability--TWO RATERS--SIGN 2 ORIGINAL

Notes

```
taSet1]
```

Scale: ALL VARIABLES

Case Processing Summary

arch_form	tro_width			N	%
CUSTOMIZED	10	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
	20	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
	40	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
AVERAGE	10	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
	20	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
	40	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0

a Listwise deletion based on all variables in the procedure.

Reliability Statistics

arch_form	tro_width	Cronbach's Alpha	N of Items
CUSTOMIZED	10	.640	2

	20	.711	2
	40	.588	2
AVERAGE	10	.965	2
	20	.785	2
	40	.602	2

Intraclass Correlation Coefficient

arch_form	tro_width		Intraclass Correlation(a)	95% Confidence Interval		F Test with True Value 0			
				Upper Bound	Value	df1	df2	Sig	Lower Bound
CUSTOMIZED	10	Single Measures	.471(b)	.047	.751	2.778	19	19	.016
		Average Measures	.640(c)	.090	.858	2.778	19	19	.016
	20	Single Measures	.552(b)	.156	.795	3.462	19	19	.005
		Average Measures	.711(c)	.270	.886	3.462	19	19	.005
	40	Single Measures	.416(b)	-.021	.719	2.425	19	19	.030
		Average Measures	.588(c)	-.042	.837	2.425	19	19	.030
AVERAGE	10	Single Measures	.932(b)	.837	.973	28.500	19	19	.000
		Average Measures	.965(c)	.911	.986	28.500	19	19	.000
	20	Single Measures	.646(b)	.296	.843	4.649	19	19	.001
		Average Measures	.785(c)	.457	.915	4.649	19	19	.001
	40	Single Measures	.431(b)	-.003	.728	2.513	19	19	.026
		Average Measures	.602(c)	-.005	.842	2.513	19	19	.026

Two-way mixed effects model where people effects are random and measures effects are fixed.
a Type C intraclass correlation coefficients using a consistency definition-the between-measure variance is excluded from the denominator variance.
b The estimator is the same, whether the interaction effect is present or not.
c This estimate is computed assuming the interaction effect is absent, because it is not estimable otherwise.

```
RELIABILITY
  /VARIABLES=sign_3Fo sign_3So
  /SCALE('ALL VARIABLES')  ALL/MODEL=ALPHA
  /ICC=MODEL(MIXED) TYPE(CONSISTENCY) CIN=95 TESTVAL=0 .
```

Reliability--TWO RATERS--SIGN 3 ORIGINAL

Notes

[DataSet1]

Scale: ALL VARIABLES

Case Processing Summary

arch_form	tro_width			N	%
CUSTOMIZED	10	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
	20	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
	40	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
AVERAGE	10	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
	20	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
	40	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0

a Listwise deletion based on all variables in the procedure.

Reliability Statistics

arch_form	tro_width	Cronbach's Alpha(a)	N of Items
CUSTOMIZED	10	.387	2
	20	-.115	2
	40	.443	2
AVERAGE	10	.847	2
	20	.717	2

	40	.576	2

a The value is negative due to a negative average covariance among items. This violates reliability model assumptions. You may want to check item codings.

Intraclass Correlation Coefficient

arch_form	tro_width		Intraclass Correlation(a)	95% Confidence Interval Upper Bound	Value	F Test with True Value 0 df1	df2	Sig	Lower Bound
CUSTOMIZED	10	Single Measures	.240(b)	-.215	.610	1.632	19	19	.147
		Average Measures	.387(c)	-.548	.757	1.632	19	19	.147
	20	Single Measures	-.055(b)	-.476	.387	.897	19	19	.593
		Average Measures	-.115(c)	-1.818	.559	.897	19	19	.593
	40	Single Measures	.285(b)	-.169	.639	1.797	19	19	.105
		Average Measures	.443(c)	-.406	.780	1.797	19	19	.105
AVERAGE	10	Single Measures	.735(b)	.443	.886	6.542	19	19	.000
		Average Measures	.847(c)	.614	.939	6.542	19	19	.000
	20	Single Measures	.559(b)	.166	.798	3.533	19	19	.004
		Average Measures	.717(c)	.285	.888	3.533	19	19	.004
	40	Single Measures	.404(b)	-.034	.713	2.358	19	19	.034
		Average Measures	.576(c)	-.071	.832	2.358	19	19	.034

Two-way mixed effects model where people effects are random and measures effects are fixed.
a Type C intraclass correlation coefficients using a consistency definition-the between-measure variance is excluded from the denominator variance.
b The estimator is the same, whether the interaction effect is present or not.
c This estimate is computed assuming the interaction effect is absent, because it is not estimable otherwise.

```
RELIABILITY
  /VARIABLES=sign_4Fo sign_4So
  /SCALE('ALL VARIABLES')  ALL/MODEL=ALPHA
  /ICC=MODEL(MIXED) TYPE(CONSISTENCY) CIN=95 TESTVAL=0 .
```

Reliability--TWO RATERS--SIGN 4 ORIGINAL

Notes

[DataSet1]

Scale: ALL VARIABLES

Case Processing Summary

arch_form	tro_width			N	%
CUSTOMIZED	10	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
	20	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
	40	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
AVERAGE	10	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
	20	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
	40	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0

a Listwise deletion based on all variables in the procedure.

Reliability Statistics

arch_form	tro_width	Cronbach's Alpha(a)	N of Items
CUSTOMIZED	10	.000	2
	20	-.353	2
	40	.497	2
AVERAGE	10	.894	2
	20	.648	2
	40	.276	2

a The value is negative due to a negative average covariance among items. This violates reliability model assumptions. You may want to check item codings.

Intraclass Correlation Coefficient

arch_form	tro_width		Intraclass Correlation(a)	95% Confidence Interval Upper Bound	Value	F Test with True Value 0 df1	df2	Sig	Lower Bound
CUSTOMIZED	10	Single Measures	.000(b)	-.433	.433	1.000	19	19	.500
		Average Measures	.000(c)	-1.526	.604	1.000	19	19	.500
	20	Single Measures	-.150(b)	-.547	.302	.739	19	19	.742
		Average Measures	-.353(c)	-2.418	.464	.739	19	19	.742
	40	Single Measures	.331(b)	-.119	.668	1.988	19	19	.072
		Average Measures	.497(c)	-.271	.801	1.988	19	19	.072
AVERAGE	10	Single Measures	.809(b)	.578	.920	9.460	19	19	.000
		Average Measures	.894(c)	.733	.958	9.460	19	19	.000
	20	Single Measures	.479(b)	.059	.756	2.842	19	19	.014
		Average Measures	.648(c)	.111	.861	2.842	19	19	.014
	40	Single Measures	.160(b)	-.293	.554	1.381	19	19	.244
		Average Measures	.276(c)	-.829	.713	1.381	19	19	.244

Two-way mixed effects model where people effects are random and measures effects are fixed.
a Type C intraclass correlation coefficients using a consistency definition-the between-measure variance is excluded from the denominator variance.
b The estimator is the same, whether the interaction effect is present or not.
c This estimate is computed assuming the interaction effect is absent, because it is not estimable otherwise.

```
RELIABILITY
  /VARIABLES=sign_5Fo sign_5So
  /SCALE('ALL VARIABLES')  ALL/MODEL=ALPHA
  /ICC=MODEL(MIXED) TYPE(CONSISTENCY) CIN=95 TESTVAL=0 .
```

Reliability--TWO RATERS--SIGN 5 ORIGINAL

Notes

```
[DataSet1]
```

Scale: ALL VARIABLES

Case Processing Summary

arch_form	tro_width			N	%
CUSTOMIZED	10	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
	20	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
	40	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
AVERAGE	10	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
	20	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
	40	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0

a Listwise deletion based on all variables in the procedure.

Reliability Statistics

arch_form	tro_width	Cronbach's Alpha	N of Items
CUSTOMIZED	10	.700	2
	20	.580	2
	40	.550	2
AVERAGE	10	.968	2
	20	.587	2
	40	.560	2

Intraclass Correlation Coefficient

arch_form	tro_width		Intraclass Correlation(a)	95% Confidence Interval		F Test with True Value 0			
				Upper Bound	Value	df1	df2	Sig	Lower Bound
CUSTOMIZED	10	Single Measures	.538(b)	.138	.788	3.333	19	19	.006
		Average Measures	.700(c)	.242	.881	3.333	19	19	.006
	20	Single Measures	.409(b)	-.030	.715	2.381	19	19	.033
		Average Measures	.580(c)	-.061	.834	2.381	19	19	.033
	40	Single Measures	.379(b)	-.064	.697	2.220	19	19	.045
		Average Measures	.550(c)	-.138	.822	2.220	19	19	.045
AVERAGE	10	Single Measures	.939(b)	.852	.975	31.667	19	19	.000
		Average Measures	.968(c)	.920	.988	31.667	19	19	.000
	20	Single Measures	.415(b)	-.021	.719	2.421	19	19	.031
		Average Measures	.587(c)	-.044	.837	2.421	19	19	.031
	40	Single Measures	.389(b)	-.053	.704	2.274	19	19	.041
		Average Measures	.560(c)	-.111	.826	2.274	19	19	.041

Two-way mixed effects model where people effects are random and measures effects are fixed.
a Type C intraclass correlation coefficients using a consistency definition-the between-measure variance is excluded from the denominator variance.
b The estimator is the same, whether the interaction effect is present or not.
c This estimate is computed assuming the interaction effect is absent, because it is not estimable otherwise.

```
RELIABILITY
  /VARIABLES=sign_6Fo sign_6So
  /SCALE('ALL VARIABLES')  ALL/MODEL=ALPHA
  /ICC=MODEL(MIXED) TYPE(CONSISTENCY) CIN=95 TESTVAL=0 .
```

Reliability--TWO RATERS--SIGN 6 ORIGINAL

Notes

```
[DataSet1]
```

Scale: ALL VARIABLES

Case Processing Summary

arch_form	tro_width			N	%
CUSTOMIZED	10	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
	20	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
	40	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
AVERAGE	10	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
	20	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
	40	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0

a Listwise deletion based on all variables in the procedure.

Reliability Statistics

arch_form	tro_width	Cronbach's Alpha(a)	N of Items
CUSTOMIZED	10	-.667	2
	20	-.600	2
	40	.581	2
AVERAGE	10	.913	2
	20	.510	2
	40	.485	2

a The value is negative due to a negative average covariance among items. This violates reliability model assumptions. You may want to check item codings.

Intraclass Correlation Coefficient

arch_form	tro_width	Intraclass Correlation(a)	95% Confidence Interval	F Test with True Value 0

				Upper Bound	Value	df1	df2	Sig	Lower Bound
CUSTOMIZED	10	Single Measures	-.250(b)	-.616	.205	.600	19	19	.863
		Average Measures	-.667(c)	-3.211	.340	.600	19	19	.863
	20	Single Measures	-.231(b)	-.603	.225	.625	19	19	.843
		Average Measures	-.600(c)	-3.042	.367	.625	19	19	.843
	40	Single Measures	.410(b)	-.028	.716	2.389	19	19	.033
		Average Measures	.581(c)	-.058	.834	2.389	19	19	.033
AVERAGE	10	Single Measures	.839(b)	.638	.933	11.435	19	19	.000
		Average Measures	.913(c)	.779	.965	11.435	19	19	.000
	20	Single Measures	.342(b)	-.106	.675	2.042	19	19	.064
		Average Measures	.510(c)	-.237	.806	2.042	19	19	.064
	40	Single Measures	.321(b)	-.130	.662	1.943	19	19	.078
		Average Measures	.485(c)	-.300	.796	1.943	19	19	.078

Two-way mixed effects model where people effects are random and measures effects are fixed.
a Type C intraclass correlation coefficients using a consistency definition-the between-measure variance is excluded from the denominator variance.
b The estimator is the same, whether the interaction effect is present or not.
c This estimate is computed assuming the interaction effect is absent, because it is not estimable otherwise.

```
RELIABILITY
  /VARIABLES=sign_1Fr sign_1Sr
  /SCALE('ALL VARIABLES')  ALL/MODEL=ALPHA
  /ICC=MODEL(MIXED) TYPE(CONSISTENCY) CIN=95 TESTVAL=0 .
```

Reliability--TWO RATERS--SIGN 1 REPEAT

Notes

```
[DataSet1]
```

Scale: ALL VARIABLES

Case Processing Summary

arch_form	tro_width	N	%

CUSTOMIZED	10	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
	20	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
	40	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
AVERAGE	10	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
	20	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
	40	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0

a Listwise deletion based on all variables in the procedure.

Reliability Statistics

arch_form	tro_width	Cronbach's Alpha(a)	N of Items
CUSTOMIZED	10	.226	2
	20	-.404	2
	40	-.015	2
AVERAGE	10	.882	2
	20	.484	2
	40	.412	2

a The value is negative due to a negative average covariance among items. This violates reliability model assumptions. You may want to check item codings.

Intraclass Correlation Coefficient

				95% Confidence Interval		F Test with True Value 0			
arch_form	tro_width		Intraclass Correlation(a)	Upper Bound	Value	df1	df2	Sig	Lower Bound
CUSTOMIZED	10	Single	.127(b)	-.323	.531	1.292	19	19	.291

		Measures							
		Average Measures	.226(c)	-.956	.694	1.292	19	19	.291
	20	Single Measures	-.168(b)	-.560	.286	.712	19	19	.767
		Average Measures	-.404(c)	-2.547	.444	.712	19	19	.767
	40	Single Measures	-.008(b)	-.439	.427	.985	19	19	.513
		Average Measures	-.015(c)	-1.565	.598	.985	19	19	.513
AVERAGE	10	Single Measures	.789(b)	.541	.911	8.473	19	19	.000
		Average Measures	.882(c)	.702	.953	8.473	19	19	.000
	20	Single Measures	.319(b)	-.132	.661	1.938	19	19	.079
		Average Measures	.484(c)	-.304	.796	1.938	19	19	.079
	40	Single Measures	.259(b)	-.196	.622	1.700	19	19	.128
		Average Measures	.412(c)	-.486	.767	1.700	19	19	.128

Two-way mixed effects model where people effects are random and measures effects are fixed.
a Type C intraclass correlation coefficients using a consistency definition-the between-measure variance is excluded from the denominator variance.
b The estimator is the same, whether the interaction effect is present or not.
c This estimate is computed assuming the interaction effect is absent, because it is not estimable otherwise.

```
RELIABILITY
  /VARIABLES=sign_2Fr sign_2Sr
  /SCALE('ALL VARIABLES')  ALL/MODEL=ALPHA
  /ICC=MODEL(MIXED) TYPE(CONSISTENCY) CIN=95 TESTVAL=0 .
```

Reliability--TWO RATERS--SIGN 2 REPEAT

Notes

```
[DataSet1]
```

Scale: ALL VARIABLES

Case Processing Summary

arch_form	tro_width			N	%
CUSTOMIZED	10	Cases	Valid	20	100.0
			Excluded(a)	0	.0

			Total	20	100.0
	20	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
	40	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
AVERAGE	10	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
	20	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
	40	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0

a Listwise deletion based on all variables in the procedure.

Reliability Statistics

arch_form	tro_width	Cronbach's Alpha(a)	N of Items
CUSTOMIZED	10	-.029	2
	20	.742	2
	40	-.234	2
AVERAGE	10	.969	2
	20	.697	2
	40	.473	2

a The value is negative due to a negative average covariance among items. This violates reliability model assumptions. You may want to check item codings.

Intraclass Correlation Coefficient

				95% Confidence Interval		F Test with True Value 0			
arch_form	tro_width		Intraclass Correlation(a)	Upper Bound	Value	df1	df2	Sig	Lower Bound
CUSTOMIZED	10	Single Measures	-.014(b)	-.444	.421	.972	19	19	.524
		Average Measures	-.029(c)	-1.599	.593	.972	19	19	.524

	20	Single Measures	.590(b)	.211	.815	3.880	19	19	.002
		Average Measures	.742(c)	.349	.898	3.880	19	19	.002
	40	Single Measures	-.105(b)	-.514	.344	.810	19	19	.675
		Average Measures	-.234(c)	-2.119	.511	.810	19	19	.675
AVERAGE	10	Single Measures	.941(b)	.856	.976	32.667	19	19	.000
		Average Measures	.969(c)	.923	.988	32.667	19	19	.000
	20	Single Measures	.535(b)	.133	.786	3.300	19	19	.006
		Average Measures	.697(c)	.234	.880	3.300	19	19	.006
	40	Single Measures	.309(b)	-.142	.655	1.896	19	19	.086
		Average Measures	.473(c)	-.332	.791	1.896	19	19	.086

Two-way mixed effects model where people effects are random and measures effects are fixed.
a Type C intraclass correlation coefficients using a consistency definition-the between-measure variance is excluded from the denominator variance.
b The estimator is the same, whether the interaction effect is present or not.
c This estimate is computed assuming the interaction effect is absent, because it is not estimable otherwise.

```
RELIABILITY
  /VARIABLES=sign_3Fr sign_3Sr
  /SCALE('ALL VARIABLES')  ALL/MODEL=ALPHA
  /ICC=MODEL(MIXED) TYPE(CONSISTENCY) CIN=95 TESTVAL=0 .
```

Reliability--TWO RATERS--SIGN 3 REPEAT

Notes

[DataSet1]

Scale: ALL VARIABLES

Case Processing Summary

arch_form	tro_width			N	%
CUSTOMIZED	10	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
	20	Cases	Valid	20	100.0

			Excluded(a)	0	.0
			Total	20	100.0
	40	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
AVERAGE	10	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
	20	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
	40	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0

a Listwise deletion based on all variables in the procedure.

Reliability Statistics

arch_form	tro_width	Cronbach's Alpha	N of Items
CUSTOMIZED	10	.702	2
	20	1.000	2
	40	.031	2
AVERAGE	10	.958	2
	20	.821	2
	40	.598	2

Intraclass Correlation Coefficient

				95% Confidence Interval		F Test with True Value 0			
arch_form	tro_width		Intraclass Correlation(a)	Upper Bound	Value	df1	df2	Sig	Lower Bound
CUSTOMIZED	10	Single Measures	.541(b)	.141	.789	3.353	19	19	.006
		Average Measures	.702(c)	.246	.882	3.353	19	19	.006
	20	Single Measures	1.000(b)	1.000	1.000	.	19	.	.
		Average Measures	1.000(c)	1.000	1.000	.	19	.	.
	40	Single	.016(b)	-.420	.446	1.032	19	19	.473

		Measures								
		Average Measures	.031(c)	-1.448	.616	1.032	19	19	.473
AVERAGE	10	Single Measures	.920(b)	.809	.967	23.915	19	19	.000
		Average Measures	.958(c)	.894	.983	23.915	19	19	.000
	20	Single Measures	.696(b)	.377	.868	5.588	19	19	.000
		Average Measures	.821(c)	.548	.929	5.588	19	19	.000
	40	Single Measures	.427(b)	-.007	.726	2.489	19	19	.027
		Average Measures	.598(c)	-.015	.841	2.489	19	19	.027

Two-way mixed effects model where people effects are random and measures effects are fixed.
a Type C intraclass correlation coefficients using a consistency definition-the between-measure variance is excluded from the denominator variance.
b The estimator is the same, whether the interaction effect is present or not.
c This estimate is computed assuming the interaction effect is absent, because it is not estimable otherwise.

```
RELIABILITY
  /VARIABLES=sign_4Fr sign_4Sr
  /SCALE('ALL VARIABLES')  ALL/MODEL=ALPHA
  /ICC=MODEL(MIXED) TYPE(CONSISTENCY) CIN=95 TESTVAL=0 .
```

Reliability--TWO RATERS--SIGN 4 REPEAT

Notes

[DataSet1]

Scale: ALL VARIABLES

Case Processing Summary

arch_form	tro_width			N	%
CUSTOMIZED	10	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
	20	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
	40	Cases	Valid	20	100.0

			Excluded(a)	0	.0
			Total	20	100.0
AVERAGE	10	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
	20	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
	40	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0

a Listwise deletion based on all variables in the procedure.

Reliability Statistics

arch_form	tro_width	Cronbach's Alpha(a)	N of Items
CUSTOMIZED	10	-.292	2
	20	.000	2
	40	.169	2
AVERAGE	10	.952	2
	20	.805	2
	40	.658	2

a The value is negative due to a negative average covariance among items. This violates reliability model assumptions. You may want to check item codings.

Intraclass Correlation Coefficient

				95% Confidence Interval		F Test with True Value 0			
arch_form	tro_width		Intraclass Correlation(a)	Upper Bound	Value	df1	df2	Sig	Lower Bound
CUSTOMIZED	10	Single Measures	-.127(b)	-.531	.323	.774	19	19	.709
		Average Measures	-.292(c)	-2.263	.489	.774	19	19	.709
	20	Single Measures	.000(b)	-.433	.433	1.000	19	19	.500
		Average Measures	.000(c)	-1.526	.604	1.000	19	19	.500
	40	Single Measures	.092(b)	-.355	.505	1.204	19	19	.345
		Average Measures	.169(c)	-1.099	.671	1.204	19	19	.345

AVERAGE	10	Single Measures	.909(b)	.785	.963	21.000	19	19	.000
		Average Measures	.952(c)	.880	.981	21.000	19	19	.000
	20	Single Measures	.674(b)	.340	.857	5.128	19	19	.000
		Average Measures	.805(c)	.507	.923	5.128	19	19	.000
	40	Single Measures	.490(b)	.073	.762	2.924	19	19	.012
		Average Measures	.658(c)	.136	.865	2.924	19	19	.012

Two-way mixed effects model where people effects are random and measures effects are fixed.
a Type C intraclass correlation coefficients using a consistency definition-the between-measure variance is excluded from the denominator variance.
b The estimator is the same, whether the interaction effect is present or not.
c This estimate is computed assuming the interaction effect is absent, because it is not estimable otherwise.

```
RELIABILITY
  /VARIABLES=sign_5Fr sign_5Sr
  /SCALE('ALL VARIABLES')  ALL/MODEL=ALPHA
  /ICC=MODEL(MIXED) TYPE(CONSISTENCY) CIN=95 TESTVAL=0 .
```

Reliability--TWO RATERS--SIGN 5 REPEAT

Notes

[DataSet1]

Warnings

For split file arch_form=CUSTOMIZED,tro_width=20, scale has zero variance items.

Scale: ALL VARIABLES

Case Processing Summary

arch_form	tro_width			N	%
CUSTOMIZED	10	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
	20	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0

	40	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
AVERAGE	10	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
	20	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
	40	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0

a Listwise deletion based on all variables in the procedure.

Reliability Statistics

arch_form	tro_width	Cronbach's Alpha(a)	N of Items
CUSTOMIZED	10	.345	2
	20	4.39E-016	2
	40	-.894	2
AVERAGE	10	.908	2
	20	.801	2
	40	.279	2

a The value is negative due to a negative average covariance among items. This violates reliability model assumptions. You may want to check item codings.

Intraclass Correlation Coefficient

				95% Confidence Interval	F Test with True Value 0				
arch_form	tro_width		Intraclass Correlation(a)	Upper Bound	Value	df1	df2	Sig	Lower Bound
CUSTOMIZED	10	Single Measures	.209(b)	-.246	.588	1.527	19	19	.182
		Average Measures	.345(c)	-.654	.741	1.527	19	19	.182
	20	Single Measures	.000(b)	-.433	.433	1.000	19	19	.500
		Average Measures	.000(c)	-1.526	.604	1.000	19	19	.500
	40	Single Measures	-.309(b)	-.654	.143	.528	19	19	.913

		Average Measures	-.894(c)	-3.785	.250	.528	19	19	.913
AVERAGE	10	Single Measures	.831(b)	.621	.929	10.813	19	19	.000
		Average Measures	.908(c)	.766	.963	10.813	19	19	.000
	20	Single Measures	.668(b)	.331	.854	5.031	19	19	.000
		Average Measures	.801(c)	.498	.921	5.031	19	19	.000
	40	Single Measures	.162(b)	-.291	.556	1.388	19	19	.241
		Average Measures	.279(c)	-.821	.715	1.388	19	19	.241

Two-way mixed effects model where people effects are random and measures effects are fixed.
a Type C intraclass correlation coefficients using a consistency definition-the between-measure variance is excluded from the denominator variance.
b The estimator is the same, whether the interaction effect is present or not.
c This estimate is computed assuming the interaction effect is absent, because it is not estimable otherwise.

```
RELIABILITY
  /VARIABLES=sing_6Fr sign_6Sr
  /SCALE('ALL VARIABLES')  ALL/MODEL=ALPHA
  /ICC=MODEL(MIXED) TYPE(CONSISTENCY) CIN=95 TESTVAL=0 .
```

Reliability--TWO RATERS--SIGN 6 REPEAT

Notes

[DataSet1]

Scale: ALL VARIABLES

Case Processing Summary

arch_form	tro_width			N	%
CUSTOMIZED	10	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
	20	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
	40	Cases	Valid	20	100.0
			Excluded(a)	0	.0

			Total	20	100.0
AVERAGE	10	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
	20	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
	40	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0

a Listwise deletion based on all variables in the procedure.

Reliability Statistics

arch_form	tro_width	Cronbach's Alpha(a)	N of Items
CUSTOMIZED	10	.447	2
	20	.305	2
	40	-.032	2
AVERAGE	10	.938	2
	20	.832	2
	40	.681	2

a The value is negative due to a negative average covariance among items. This violates reliability model assumptions. You may want to check item codings.

Intraclass Correlation Coefficient

arch_form	tro_width		Intraclass Correlation(a)	95% Confidence Interval Upper Bound	Value	F Test with True Value 0 df1	df2	Sig	Lower Bound
CUSTOMIZED	10	Single Measures	.288(b)	-.166	.641	1.808	19	19	.103
		Average Measures	.447(c)	-.397	.781	1.808	19	19	.103
	20	Single Measures	.180(b)	-.274	.569	1.440	19	19	.217
		Average Measures	.305(c)	-.755	.725	1.440	19	19	.217
	40	Single Measures	-.016(b)	-.446	.420	.969	19	19	.527
		Average Measures	-.032(c)	-1.607	.592	.969	19	19	.527
AVERAGE	10	Single Measures	.883(b)	.728	.952	16.033	19	19	.000

		Average Measures	.938(c)	.842	.975	16.033	19	19	.000
	20	Single Measures	.712(b)	.404	.875	5.947	19	19	.000
		Average Measures	.832(c)	.575	.933	5.947	19	19	.000
	40	Single Measures	.516(b)	.107	.776	3.133	19	19	.008
		Average Measures	.681(c)	.194	.874	3.133	19	19	.008

Two-way mixed effects model where people effects are random and measures effects are fixed.

a Type C intraclass correlation coefficients using a consistency definition-the between-measure variance is excluded from the denominator variance.

b The estimator is the same, whether the interaction effect is present or not.

c This estimate is computed assuming the interaction effect is absent, because it is not estimable otherwise.

Appendix C- SPSS Inter-rater reliability measurements

Reliability--TWO RATERS--MEASUREMENT GROUP ORIGINAL

Notes

```
[DataSet1]
```

Scale: ALL VARIABLES

Case Processing Summary

		N	%
Cases	Valid	20	100.0
	Excluded(a)	0	.0
	Total	20	100.0

a Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	N of Items
.718	2

Intraclass Correlation Coefficient

	Intraclass Correlation	95% Confidence Interval		F Test with True Value 0			
		Upper Bound	Value	df1	df2	Sig	Lower Bound
Single Measures	.465	.049	.746	2.737	19	20	.015
Average Measures	.635	.093	.854	2.737	19	20	.015

One-way random effects model where people effects are random.

```
RELIABILITY
  /VARIABLES=ner_ps_Fo ner_ps_So
```

```
  /SCALE('ALL VARIABLES')  ALL/MODEL=ALPHA
  /ICC=MODEL(ONEWAY) CIN=95 TESTVAL=0 .
```

Reliability--TWO RATERS--NERVE POSITION ORIGINAL

Notes

[DataSet1]

Scale: ALL VARIABLES

Case Processing Summary

		N	%
Cases	Valid	20	100.0
	Excluded(a)	0	.0
	Total	20	100.0

a Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	N of Items
.739	2

Intraclass Correlation Coefficient

	Intraclass Correlation	95% Confidence Interval		F Test with True Value 0			
		Upper Bound	Value	df1	df2	Sig	Lower Bound
Single Measures	.470	.056	.749	2.776	19	20	.014
Average Measures	.640	.106	.856	2.776	19	20	.014

One-way random effects model where people effects are random.

```
RELIABILITY
  /VARIABLES=n_r_inv_Fo n_r_inv_So
  /SCALE('ALL VARIABLES')  ALL/MODEL=ALPHA
  /ICC=MODEL(ONEWAY) CIN=95 TESTVAL=0 .
```

Reliability--TWO RATERS--NERVE TO ROOT ASSOC ORIGINAL

Notes

```
[DataSet1]
```

Scale: ALL VARIABLES

Case Processing Summary

		N	%
Cases	Valid	20	100.0
	Excluded(a)	0	.0
	Total	20	100.0

a Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	N of Items
.557	2

Intraclass Correlation Coefficient

	Intraclass Correlation	95% Confidence Interval		F Test with True Value 0			
		Upper Bound	Value	df1	df2	Sig	Lower Bound
Single Measures	.337	-.103	.670	2.018	19	20	.064
Average Measures	.504	-.230	.802	2.018	19	20	.064

One-way random effects model where people effects are random.

```
RELIABILITY
  /VARIABLES=meas_Fr meas_Sr
  /SCALE('ALL VARIABLES')  ALL/MODEL=ALPHA
  /ICC=MODEL(ONEWAY) CIN=95 TESTVAL=0 .
```

Reliability--TWO RATERS--MEASUREMENT GROUP REPEAT

Notes

```
[DataSet1]
```

Scale: ALL VARIABLES

Case Processing Summary

		N	%
Cases	Valid	20	100.0
	Excluded(a)	0	.0
	Total	20	100.0

a Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	N of Items
.338	2

Intraclass Correlation Coefficient

	Intraclass Correlation	95% Confidence Interval		F Test with True Value 0			
		Upper Bound	Value	df1	df2	Sig	Lower Bound
Single Measures	.218	-.229	.593	1.558	19	20	.167
Average Measures	.358	-.593	.744	1.558	19	20	.167

One-way random effects model where people effects are random.

```
RELIABILITY
  /VARIABLES=ner_ps_Fr ner_ps_Sr
  /SCALE('ALL VARIABLES')  ALL/MODEL=ALPHA
  /ICC=MODEL(ONEWAY) CIN=95 TESTVAL=0 .
```

Reliability--TWO RATERS--NERVE POSITION REPEAT

Notes

```
[DataSet1]
```

Scale: ALL VARIABLES

Case Processing Summary

		N	%
Cases	Valid	20	100.0
	Excluded(a)	0	.0
	Total	20	100.0

a Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	N of Items
.857	2

Intraclass Correlation Coefficient

	Intraclass Correlation	95% Confidence Interval		F Test with True Value 0			
		Upper Bound	Value	df1	df2	Sig	Lower Bound
Single Measures	.594	.226	.816	3.931	19	20	.002
Average Measures	.746	.369	.899	3.931	19	20	.002

One-way random effects model where people effects are random.

```
RELIABILITY
  /VARIABLES=n_r_inv_Fr n_r_inv_Sr
  /SCALE('ALL VARIABLES')  ALL/MODEL=ALPHA
  /ICC=MODEL(ONEWAY) CIN=95 TESTVAL=0 .
```

Reliability--TWO RATERS--NERVE TO ROOT ASSOC REPEAT

Notes

[DataSet1]

Scale: ALL VARIABLES

Case Processing Summary

	N	%

Cases	Valid	20	100.0
	Excluded(a)	0	.0
	Total	20	100.0

a Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	N of Items
.780	2

Intraclass Correlation Coefficient

	Intraclass Correlation	95% Confidence Interval		F Test with True Value 0			
		Upper Bound	Value	df1	df2	Sig	Lower Bound
Single Measures	.624	.270	.831	4.316	19	20	.001
Average Measures	.768	.425	.908	4.316	19	20	.001

One-way random effects model where people effects are random.

Appendix D- Intra-rater reliability

Reliability--FARMAN--MEASUREMENT GROUP

Notes

[DataSet1]

Scale: ALL VARIABLES

Case Processing Summary

		N	%
Cases	Valid	20	100.0
	Excluded(a)	0	.0
	Total	20	100.0

a Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	N of Items
.628	2

Intraclass Correlation Coefficient

	Intraclass Correlation	95% Confidence Interval		F Test with True Value 0			
		Upper Bound	Value	df1	df2	Sig	Lower Bound
Single Measures	.443	.022	.734	2.593	19	20	.020
Average Measures	.614	.043	.846	2.593	19	20	.020

One-way random effects model where people effects are random.

```
RELIABILITY
  /VARIABLES=meas_So meas_Sr
  /SCALE('ALL VARIABLES')  ALL/MODEL=ALPHA
  /ICC=MODEL(ONEWAY) CIN=95 TESTVAL=0 .
```

Reliability--CHANDIRMANI--MEASUREMENT GROUP

Notes

[DataSet1]

Scale: ALL VARIABLES

Case Processing Summary

		N	%
Cases	Valid	20	100.0
	Excluded(a)	0	.0
	Total	20	100.0

a Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	N of Items
.927	2

Intraclass Correlation Coefficient

	Intraclass Correlation	95% Confidence Interval		F Test with True Value 0			
		Upper Bound	Value	df1	df2	Sig	Lower Bound
Single Measures	.863	.692	.943	13.632	19	20	.000
Average Measures	.927	.818	.971	13.632	19	20	.000

One-way random effects model where people effects are random.

```
RELIABILITY
  /VARIABLES=ner_ps_Fo ner_ps_Fr
  /SCALE('ALL VARIABLES')  ALL/MODEL=ALPHA
  /ICC=MODEL(ONEWAY) CIN=95 TESTVAL=0 .
```

Reliability--FARMAN--NERVE POSITION

Notes

[DataSet1]

Scale: ALL VARIABLES

Case Processing Summary

		N	%
Cases	Valid	20	100.0
	Excluded(a)	0	.0
	Total	20	100.0

a Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	N of Items
.771	2

Intraclass Correlation Coefficient

	Intraclass Correlation	95% Confidence Interval		F Test with True Value 0			
		Upper Bound	Value	df1	df2	Sig	Lower Bound
Single Measures	.638	.292	.838	4.526	19	20	.001
Average Measures	.779	.452	.912	4.526	19	20	.001

One-way random effects model where people effects are random.

```
RELIABILITY
  /VARIABLES=ner_ps_So ner_ps_Sr
  /SCALE('ALL VARIABLES')  ALL/MODEL=ALPHA
  /ICC=MODEL(ONEWAY) CIN=95 TESTVAL=0 .
```

Reliability--CHANDIRMANI--NERVE POSITION

Notes

[DataSet1]

Scale: ALL VARIABLES

Case Processing Summary

		N	%
Cases	Valid	20	100.0
	Excluded(a)	0	.0
	Total	20	100.0

a Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	N of Items
.972	2

Intraclass Correlation Coefficient

	Intraclass Correlation	95% Confidence Interval		F Test with True Value 0			
		Upper Bound	Value	df1	df2	Sig	Lower Bound
Single Measures	.945	.869	.978	35.526	19	20	.000
Average Measures	.972	.930	.989	35.526	19	20	.000

One-way random effects model where people effects are random.

```
RELIABILITY
  /VARIABLES=n_r_inv_Fo n_r_inv_Fr
  /SCALE('ALL VARIABLES')  ALL/MODEL=ALPHA
  /ICC=MODEL(ONEWAY) CIN=95 TESTVAL=0 .
```

Reliability--FARMAN--NERVE TO ROOT ASSOC

Notes

```
[DataSet1]
```

Scale: ALL VARIABLES

Case Processing Summary

		N	%
Cases	Valid	20	100.0
	Excluded(a)	0	.0
	Total	20	100.0

a Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	N of Items
.791	2

Intraclass Correlation Coefficient

	Intraclass Correlation	95% Confidence Interval		F Test with True Value 0			
		Upper Bound	Value	df1	df2	Sig	Lower Bound
Single Measures	.655	.317	.846	4.789	19	20	.001
Average Measures	.791	.482	.917	4.789	19	20	.001

One-way random effects model where people effects are random.

```
RELIABILITY
  /VARIABLES=n_r_inv_So n_r_inv_Sr
  /SCALE('ALL VARIABLES')  ALL/MODEL=ALPHA
  /ICC=MODEL(ONEWAY) CIN=95 TESTVAL=0 .
```

Reliability--CHANDIRMANI--NERVE TO ROOT ASSOC

Notes

Scale: ALL VARIABLES

Case Processing Summary

		N	%
Cases	Valid	20	100.0
	Excluded(a)	0	.0
	Total	20	100.0

a Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	N of Items
1.000	2

Intraclass Correlation Coefficient

	Intraclass Correlation	95% Confidence Interval		F Test with True Value 0			
		Upper Bound	Value	df1	df2	Sig	Lower Bound
Single Measures	1.000	1.000	1.000	.	19	.	.
Average Measures	1.000	1.000	1.000	.	19	.	.

One-way random effects model where people effects are random.

Appendix E- Intra-rater reliability repeat

Reliability--FARMAN--SIGN 1

Notes

[DataSet1] **INTRA-RATER RELIABILITY FOR TWO RATERS**

Scale: ALL VARIABLES

Case Processing Summary

arch_form	tro_width			N	%
CUSTOMIZED	10	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
	20	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
	40	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
AVERAGE	10	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
	20	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
	40	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0

a Listwise deletion based on all variables in the procedure.

Reliability Statistics

arch_form	tro_width	Cronbach's Alpha	N of Items
CUSTOMIZED	10	.877	2
	20	.590	2
	40	.511	2
AVERAGE	10	.881	2
	20	.831	2
	40	.676	2

Intraclass Correlation Coefficient

				95% Confidence Interval		F Test with True Value 0			
arch_form	tro_width		Intraclass Correlation	Upper Bound	Value	df1	df2	Sig	Lower Bound
CUSTOMIZED	10	Single Measures	.790	.549	.911	8.526	19	20	.000
		Average Measures	.883	.709	.953	8.526	19	20	.000
	20	Single Measures	.436	.013	.730	2.549	19	20	.022
		Average Measures	.608	.026	.844	2.549	19	20	.022
	40	Single Measures	.364	-.073	.686	2.144	19	20	.049
		Average Measures	.534	-.158	.814	2.144	19	20	.049
AVERAGE	10	Single Measures	.784	.538	.908	8.263	19	20	.000
		Average Measures	.879	.700	.952	8.263	19	20	.000
	20	Single Measures	.717	.420	.877	6.079	19	20	.000
		Average Measures	.835	.592	.934	6.079	19	20	.000
	40	Single Measures	.485	.074	.757	2.882	19	20	.012
		Average Measures	.653	.139	.862	2.882	19	20	.012

One-way random effects model where people effects are random.

```
RELIABILITY
  /VARIABLES=sign_1So sign_1Sr
  /SCALE('ALL VARIABLES')  ALL/MODEL=ALPHA.

RELIABILITY
  /VARIABLES=sign_1So sign_1Sr
```

```
/SCALE('ALL VARIABLES')  ALL/MODEL=ALPHA
/ICC=MODEL(ONEWAY) CIN=95 TESTVAL=0 .
```

Reliability--CHANDIRMANI--SIGN 1

Notes

[DataSet1]

Scale: ALL VARIABLES

Case Processing Summary

arch_form	tro_width			N	%
CUSTOMIZED	10	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
	20	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
	40	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
AVERAGE	10	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
	20	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
	40	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0

a Listwise deletion based on all variables in the procedure.

Reliability Statistics

arch_form	tro_width	Cronbach's Alpha(a)	N of Items

CUSTOMIZED	10	.654	2
	20	-.264	2
	40	.516	2
AVERAGE	10	.889	2
	20	.331	2
	40	-.148	2

a The value is negative due to a negative average covariance among items. This violates reliability model assumptions. You may want to check item codings.

Intraclass Correlation Coefficient

				95% Confidence Interval		F Test with True Value 0			
arch_form	tro_width		Intraclass Correlation	Upper Bound	Value	df1	df2	Sig	Lower Bound
CUSTOMIZED	10	Single Measures	.465	.049	.746	2.737	19	20	.015
		Average Measures	.635	.093	.854	2.737	19	20	.015
	20	Single Measures	-.188	-.568	.264	.684	19	20	.794
		Average Measures	-.462	-2.628	.417	.684	19	20	.794
	40	Single Measures	.255	-.192	.617	1.684	19	20	.128
		Average Measures	.406	-.474	.763	1.684	19	20	.128
AVERAGE	10	Single Measures	.753	.482	.894	7.105	19	20	.000
		Average Measures	.859	.651	.944	7.105	19	20	.000
	20	Single Measures	.172	-.274	.561	1.415	19	20	.224
		Average Measures	.293	-.754	.718	1.415	19	20	.224
	40	Single Measures	-.071	-.482	.370	.867	19	20	.620
		Average Measures	-.153	-1.862	.540	.867	19	20	.620

One-way random effects model where people effects are random.

```
RELIABILITY
  /VARIABLES=sign_2Fo sign_2Fr
  /SCALE('ALL VARIABLES')  ALL/MODEL=ALPHA
  /ICC=MODEL(ONEWAY) CIN=95 TESTVAL=0 .
```

Reliability--FARMAN--SIGN 2

Notes

[DataSet1]

Scale: ALL VARIABLES

Case Processing Summary

arch_form	tro_width			N	%
CUSTOMIZED	10	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
	20	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
	40	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
AVERAGE	10	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
	20	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
	40	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0

a Listwise deletion based on all variables in the procedure.

Reliability Statistics

arch_form	tro_width	Cronbach's Alpha	N of Items
CUSTOMIZED	10	.508	2
	20	.733	2
	40	.718	2
AVERAGE	10	.901	2
	20	.719	2

40	.653	2

Intraclass Correlation Coefficient

arch_form	tro_width		Intraclass Correlation	95% Confidence Interval Upper Bound	Value	F Test with True Value 0 df1	df2	Sig	Lower Bound
CUSTOMIZED	10	Single Measures	.363	-.074	.686	2.140	19	20	.050
		Average Measures	.533	-.160	.814	2.140	19	20	.050
	20	Single Measures	.592	.223	.815	3.905	19	20	.002
		Average Measures	.744	.364	.898	3.905	19	20	.002
	40	Single Measures	.571	.192	.804	3.663	19	20	.003
		Average Measures	.727	.322	.891	3.663	19	20	.003
AVERAGE	10	Single Measures	.823	.612	.926	10.316	19	20	.000
		Average Measures	.903	.759	.961	10.316	19	20	.000
	20	Single Measures	.577	.201	.807	3.727	19	20	.003
		Average Measures	.732	.334	.893	3.727	19	20	.003
	40	Single Measures	.495	.087	.762	2.957	19	20	.010
		Average Measures	.662	.161	.865	2.957	19	20	.010

One-way random effects model where people effects are random.

```
RELIABILITY
  /VARIABLES=sign_2So sign_2Sr
  /SCALE('ALL VARIABLES')  ALL/MODEL=ALPHA
  /ICC=MODEL(ONEWAY) CIN=95 TESTVAL=0 .
```

Reliability--CHANDIRMANI--SIGN 2

Notes

```
[DataSet1]
```

Scale: ALL VARIABLES

Case Processing Summary

arch_form	tro_width			N	%
CUSTOMIZED	10	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
	20	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
	40	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
AVERAGE	10	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
	20	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
	40	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0

a Listwise deletion based on all variables in the procedure.

Reliability Statistics

arch_form	tro_width	Cronbach's Alpha	N of Items
CUSTOMIZED	10	.658	2
	20	.525	2
	40	.522	2
AVERAGE	10	.962	2
	20	.714	2
	40	.545	2

Intraclass Correlation Coefficient

arch_form	tro_width	Intraclass Correlation	95% Confidence Interval	F Test with True Value 0

				Upper Bound	Value	df1	df2	Sig	Lower Bound
CUSTOMIZED	10	Single Measures	.395	-.037	.705	2.305	19	20	.036
		Average Measures	.566	-.077	.827	2.305	19	20	.036
	20	Single Measures	.363	-.074	.686	2.140	19	20	.050
		Average Measures	.533	-.160	.814	2.140	19	20	.050
	40	Single Measures	.373	-.063	.692	2.188	19	20	.045
		Average Measures	.543	-.134	.818	2.188	19	20	.045
AVERAGE	10	Single Measures	.931	.837	.972	27.895	19	20	.000
		Average Measures	.964	.911	.986	27.895	19	20	.000
	20	Single Measures	.544	.155	.790	3.389	19	20	.005
		Average Measures	.705	.268	.882	3.389	19	20	.005
	40	Single Measures	.345	-.095	.675	2.053	19	20	.059
		Average Measures	.513	-.209	.806	2.053	19	20	.059

One-way random effects model where people effects are random.

```
RELIABILITY
  /VARIABLES=sign_3Fr sign_3So
  /SCALE('ALL VARIABLES')  ALL/MODEL=ALPHA
  /ICC=MODEL(ONEWAY) CIN=95 TESTVAL=0 .

RELIABILITY
  /VARIABLES=sign_3Fo sign_3Fr
  /SCALE('ALL VARIABLES')  ALL/MODEL=ALPHA
  /ICC=MODEL(ONEWAY) CIN=95 TESTVAL=0 .
```

Reliability--FARMAN--SIGN 3

Notes

```
[DataSet1]
```

Scale: ALL VARIABLES

Case Processing Summary

arch_form	tro_width			N	%
CUSTOMIZED	10	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
	20	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
	40	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
AVERAGE	10	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
	20	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
	40	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0

a Listwise deletion based on all variables in the procedure.

Reliability Statistics

arch_form	tro_width	Cronbach's Alpha(a)	N of Items
CUSTOMIZED	10	-.250	2
	20	.472	2
	40	.704	2
AVERAGE	10	.933	2
	20	.681	2
	40	.882	2

a The value is negative due to a negative average covariance among items. This violates reliability model assumptions. You may want to check item codings.

Intraclass Correlation Coefficient

arch_form	tro_width	Intraclass Correlation	95% Confidence Interval	F Test with True Value 0

				Upper Bound	Value	df1	df2	Sig	Lower Bound
CUSTOMIZED	10	Single Measures	-.086	-.493	.357	.842	19	20	.644
		Average Measures	-.188	-1.947	.527	.842	19	20	.644
	20	Single Measures	.309	-.134	.652	1.895	19	20	.082
		Average Measures	.472	-.310	.790	1.895	19	20	.082
	40	Single Measures	.559	.175	.797	3.536	19	20	.004
		Average Measures	.717	.298	.887	3.536	19	20	.004
AVERAGE	10	Single Measures	.869	.704	.946	14.263	19	20	.000
		Average Measures	.930	.826	.972	14.263	19	20	.000
	20	Single Measures	.533	.139	.783	3.283	19	20	.006
		Average Measures	.695	.244	.879	3.283	19	20	.006
	40	Single Measures	.778	.526	.905	8.000	19	20	.000
		Average Measures	.875	.690	.950	8.000	19	20	.000

One-way random effects model where people effects are random.

```
RELIABILITY
  /VARIABLES=sign_3So sign_3Sr
  /SCALE('ALL VARIABLES')  ALL/MODEL=ALPHA
  /ICC=MODEL(ONEWAY) CIN=95 TESTVAL=0 .
```

Reliability--CHANDIRMANI--SIGN 3

Notes

```
[DataSet1]
```

Scale: ALL VARIABLES

Case Processing Summary

arch_form	tro_width			N	%
CUSTOMIZED	10	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0

				N	%
	20	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
	40	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
AVERAGE	10	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
	20	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
	40	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0

a Listwise deletion based on all variables in the procedure.

Reliability Statistics

arch_form	tro_width	Cronbach's Alpha(a)	N of Items
CUSTOMIZED	10	.447	2
	20	-.111	2
	40	-.209	2
AVERAGE	10	.986	2
	20	.804	2
	40	.286	2

a The value is negative due to a negative average covariance among items. This violates reliability model assumptions. You may want to check item codings.

Intraclass Correlation Coefficient

				95% Confidence Interval		F Test with True Value 0			
arch_form	tro_width		Intraclass Correlation	Upper Bound	Value	df1	df2	Sig	Lower Bound
CUSTOMIZED	10	Single Measures	.307	-.137	.651	1.884	19	20	.084
		Average Measures	.469	-.317	.788	1.884	19	20	.084
	20	Single Measures	-.027	-.448	.408	.947	19	20	.545

		Average Measures	-.056	-1.620	.579	.947	19	20	.545
	40	Single Measures	-.073	-.483	.369	.865	19	20	.623
		Average Measures	-.157	-1.871	.539	.865	19	20	.623
AVERAGE	10	Single Measures	.972	.933	.989	71.316	19	20	.000
		Average Measures	.986	.965	.994	71.316	19	20	.000
	20	Single Measures	.630	.279	.834	4.400	19	20	.001
		Average Measures	.773	.436	.909	4.400	19	20	.001
	40	Single Measures	.191	-.256	.574	1.472	19	20	.199
		Average Measures	.320	-.687	.729	1.472	19	20	.199

One-way random effects model where people effects are random.

```
RELIABILITY
  /VARIABLES=sign_4Fo sign_4Fr
  /SCALE('ALL VARIABLES')  ALL/MODEL=ALPHA
  /ICC=MODEL(ONEWAY) CIN=95 TESTVAL=0 .
```

Reliability--FARMAN--SIGN 4

Notes

[DataSet1]

Warnings

For split file arch_form=CUSTOMIZED,tro_width=20, scale has zero variance items.

Scale: ALL VARIABLES

Case Processing Summary

arch_form	tro_width			N	%
CUSTOMIZED	10	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
	20	Cases	Valid	20	100.0
			Excluded(	0	.0

			a)		
			Total	20	100.0
	40	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
AVERAGE	10	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
	20	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
	40	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0

a Listwise deletion based on all variables in the procedure.

Reliability Statistics

arch_form	tro_width	Cronbach's Alpha	N of Items
CUSTOMIZED	10	.000	2
	20	.000	2
	40	.655	2
AVERAGE	10	.950	2
	20	.698	2
	40	.732	2

Intraclass Correlation Coefficient

arch_form	tro_width		Intraclass Correlation	95% Confidence Interval		F Test with True Value 0			
				Upper Bound	Value	df1	df2	Sig	Lower Bound
CUSTOMIZED	10	Single Measures	.000	-.426	.430	1.000	19	20	.498
		Average Measures	.000	-1.482	.601	1.000	19	20	.498
	20	Single Measures	.000	-.426	.430	1.000	19	20	.498
		Average Measures	.000	-1.482	.601	1.000	19	20	.498
	40	Single Measures	.500	.094	.765	3.000	19	20	.009

		Average Measures	.667	.173	.867	3.000	19	20	.009
AVERAGE	10	Single Measures	.905	.779	.961	19.947	19	20	.000
		Average Measures	.950	.876	.980	19.947	19	20	.000
	20	Single Measures	.553	.167	.794	3.478	19	20	.004
		Average Measures	.712	.286	.885	3.478	19	20	.004
	40	Single Measures	.578	.202	.807	3.737	19	20	.003
		Average Measures	.732	.336	.893	3.737	19	20	.003

One-way random effects model where people effects are random.

```
RELIABILITY
  /VARIABLES=sign_4So sign_4Sr
  /SCALE('ALL VARIABLES')  ALL/MODEL=ALPHA
  /ICC=MODEL(ONEWAY) CIN=95 TESTVAL=0 .
```

Reliability--CHANDIRMANI--SIGN 4

Notes

[DataSet1]

Scale: ALL VARIABLES

Case Processing Summary

arch_form	tro_width			N	%
CUSTOMIZED	10	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
	20	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
	40	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
AVERAGE	10	Cases	Valid	20	100.0
			Excluded(	0	.0

			a)		
			Total	20	100.0
	20	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
	40	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0

a Listwise deletion based on all variables in the procedure.

Reliability Statistics

arch_form	tro_width	Cronbach's Alpha	N of Items
CUSTOMIZED	10	.478	2
	20	.356	2
	40	.051	2
AVERAGE	10	.985	2
	20	.795	2
	40	.227	2

Intraclass Correlation Coefficient

				95% Confidence Interval		F Test with True Value 0			
arch_form	tro_width		Intraclass Correlation	Upper Bound	Value	df1	df2	Sig	Lower Bound
CUSTOMIZED	10	Single Measures	.307	-.136	.651	1.887	19	20	.084
		Average Measures	.470	-.315	.789	1.887	19	20	.084
	20	Single Measures	.224	-.222	.597	1.579	19	20	.159
		Average Measures	.367	-.572	.748	1.579	19	20	.159
	40	Single Measures	.017	-.411	.444	1.035	19	20	.468
		Average Measures	.034	-1.398	.615	1.035	19	20	.468
AVERAGE	10	Single Measures	.970	.927	.988	65.842	19	20	.000
		Average Measures	.985	.962	.994	65.842	19	20	.000
	20	Single Measures	.660	.326	.849	4.883	19	20	.000
		Average	.795	.492	.918	4.883	19	20	.000

		Measures							
	40	Single Measures	.149	-.296	.544	1.349	19	20	.256
		Average Measures	.259	-.840	.705	1.349	19	20	.256

One-way random effects model where people effects are random.

```
RELIABILITY
  /VARIABLES=sign_5Fo sign_5Fr
  /SCALE('ALL VARIABLES')  ALL/MODEL=ALPHA
  /ICC=MODEL(ONEWAY) CIN=95 TESTVAL=0 .
```

Reliability--FARMAN--SIGN 5

Notes

[DataSet1]

Scale: ALL VARIABLES

Case Processing Summary

arch_form	tro_width			N	%
CUSTOMIZED	10	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
	20	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
	40	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
AVERAGE	10	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
	20	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
	40	Cases	Valid	20	100.0

	Excluded(a)	0	.0
	Total	20	100.0

a Listwise deletion based on all variables in the procedure.

Reliability Statistics

arch_form	tro_width	Cronbach's Alpha	N of Items
CUSTOMIZED	10	.749	2
	20	.385	2
	40	.371	2
AVERAGE	10	.931	2
	20	.831	2
	40	.645	2

Intraclass Correlation Coefficient

				95% Confidence Interval		F Test with True Value 0			
arch_form	tro_width		Intraclass Correlation	Upper Bound	Value	df1	df2	Sig	Lower Bound
CUSTOMIZED	10	Single Measures	.518	.118	.775	3.147	19	20	.007
		Average Measures	.682	.211	.873	3.147	19	20	.007
	20	Single Measures	.260	-.187	.620	1.702	19	20	.123
		Average Measures	.412	-.459	.766	1.702	19	20	.123
	40	Single Measures	.251	-.196	.614	1.669	19	20	.132
		Average Measures	.401	-.487	.761	1.669	19	20	.132
AVERAGE	10	Single Measures	.871	.707	.946	14.474	19	20	.000
		Average Measures	.931	.829	.972	14.474	19	20	.000
	20	Single Measures	.717	.420	.877	6.079	19	20	.000
		Average Measures	.835	.592	.934	6.079	19	20	.000
	40	Single Measures	.434	.011	.728	2.536	19	20	.023
		Average Measures	.606	.021	.843	2.536	19	20	.023

One-way random effects model where people effects are random.

```
RELIABILITY
  /VARIABLES=sign_5So sign_5Sr
  /SCALE('ALL VARIABLES')  ALL/MODEL=ALPHA
  /ICC=MODEL(ONEWAY) CIN=95 TESTVAL=0 .
```

Reliability--CHANDIRMANI--SIGN 5

Notes

[DataSet1]

Warnings

For split file arch_form=CUSTOMIZED,tro_width=20, scale has zero variance items.

Scale: ALL VARIABLES

Case Processing Summary

arch_form	tro_width			N	%
CUSTOMIZED	10	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
	20	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
	40	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
AVERAGE	10	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
	20	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
	40	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0

a Listwise deletion based on all variables in the procedure.

Reliability Statistics

arch_form	tro_width	Cronbach's Alpha	N of Items
CUSTOMIZED	10	.382	2
	20	4.39E-016	2
	40	.148	2
AVERAGE	10	.908	2
	20	.687	2
	40	.264	2

Intraclass Correlation Coefficient

				95% Confidence Interval		F Test with True Value 0			
arch_form	tro_width		Intraclass Correlation	Upper Bound	Value	df1	df2	Sig	Lower Bound
CUSTOMIZED	10	Single Measures	.088	-.351	.499	1.193	19	20	.349
		Average Measures	.162	-1.081	.666	1.193	19	20	.349
	20	Single Measures	-.226	-.594	.226	.632	19	20	.839
		Average Measures	-.583	-2.930	.369	.632	19	20	.839
	40	Single Measures	.064	-.372	.481	1.137	19	20	.388
		Average Measures	.120	-1.183	.649	1.137	19	20	.388
AVERAGE	10	Single Measures	.790	.549	.911	8.537	19	20	.000
		Average Measures	.883	.709	.953	8.537	19	20	.000
	20	Single Measures	.539	.147	.787	3.339	19	20	.005
		Average Measures	.701	.257	.881	3.339	19	20	.005
	40	Single Measures	.125	-.317	.527	1.287	19	20	.290
		Average Measures	.223	-.929	.690	1.287	19	20	.290

One-way random effects model where people effects are random.

```
RELIABILITY
  /VARIABLES=sign_6Fo sing_6Fr
  /SCALE('ALL VARIABLES')  ALL/MODEL=ALPHA
```

```
/ICC=MODEL(ONEWAY) CIN=95 TESTVAL=0 .
```

Reliability--FARMAN--SIGN 6

Notes

[DataSet1]

Scale: ALL VARIABLES

Case Processing Summary

arch_form	tro_width			N	%
CUSTOMIZED	10	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
	20	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
	40	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
AVERAGE	10	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
	20	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
	40	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0

a Listwise deletion based on all variables in the procedure.

Reliability Statistics

arch_form	tro_width	Cronbach's Alpha	N of Items
CUSTOMIZED	10	.545	2

	20	.608	2
	40	.665	2
AVERAGE	10	.919	2
	20	.766	2
	40	.664	2

Intraclass Correlation Coefficient

				95% Confidence Interval		F Test with True Value 0			
arch_form	tro_width		Intraclass Correlation	Upper Bound	Value	df1	df2	Sig	Lower Bound
CUSTOMIZED	10	Single Measures	.397	-.035	.706	2.316	19	20	.035
		Average Measures	.568	-.072	.828	2.316	19	20	.035
	20	Single Measures	.444	.023	.734	2.596	19	20	.020
		Average Measures	.615	.044	.846	2.596	19	20	.020
	40	Single Measures	.511	.109	.771	3.088	19	20	.008
		Average Measures	.676	.196	.871	3.088	19	20	.008
AVERAGE	10	Single Measures	.837	.639	.932	11.263	19	20	.000
		Average Measures	.911	.780	.965	11.263	19	20	.000
	20	Single Measures	.637	.290	.837	4.505	19	20	.001
		Average Measures	.778	.449	.912	4.505	19	20	.001
	40	Single Measures	.476	.064	.752	2.819	19	20	.013
		Average Measures	.645	.119	.859	2.819	19	20	.013

One-way random effects model where people effects are random.

```
RELIABILITY
  /VARIABLES=sign_6So sign_6Sr
  /SCALE('ALL VARIABLES')  ALL/MODEL=ALPHA
  /ICC=MODEL(ONEWAY) CIN=95 TESTVAL=0 .
```

Reliability--CHANDIRMANI--SIGN 6

Notes

[DataSet1]

Scale: ALL VARIABLES

Case Processing Summary

arch_form	tro_width			N	%
CUSTOMIZED	10	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
	20	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
	40	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
AVERAGE	10	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
	20	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0
	40	Cases	Valid	20	100.0
			Excluded(a)	0	.0
			Total	20	100.0

a Listwise deletion based on all variables in the procedure.

Reliability Statistics

arch_form	tro_width	Cronbach's Alpha(a)	N of Items
CUSTOMIZED	10	.447	2
	20	-.320	2
	40	.234	2
AVERAGE	10	.950	2
	20	.799	2
	40	.333	2

a The value is negative due to a negative average covariance among items. This violates reliability model assumptions. You may want to check item codings.

Intraclass Correlation Coefficient

arch_form	tro_width		Intraclass Correlation	95% Confidence Interval Upper Bound	Value	F Test with True Value 0 df1	df2	Sig	Lower Bound
CUSTOMIZED	10	Single Measures	.307	-.137	.651	1.884	19	20	.084
		Average Measures	.469	-.317	.788	1.884	19	20	.084
	20	Single Measures	-.118	-.517	.329	.789	19	20	.695
		Average Measures	-.267	-2.144	.495	.789	19	20	.695
	40	Single Measures	.125	-.318	.527	1.286	19	20	.291
		Average Measures	.222	-.931	.690	1.286	19	20	.291
AVERAGE	10	Single Measures	.905	.779	.961	19.947	19	20	.000
		Average Measures	.950	.876	.980	19.947	19	20	.000
	20	Single Measures	.665	.334	.852	4.977	19	20	.000
		Average Measures	.799	.501	.920	4.977	19	20	.000
	40	Single Measures	.224	-.222	.597	1.579	19	20	.159
		Average Measures	.367	-.572	.748	1.579	19	20	.159

CURRICULUM VITAE
Ryan L. Snyder, D.M.D., MAJ DC
May, 2007

University of Louisville Orthodontic residency
Second year resident
ryan.snyder@us.army.mil

CURRENT POSITION	-Orthodontic resident University of Louisville Orthodontic residency
EDUCATION	-Advanced Education General Dentistry Residency 1yr Program Ft. Benning, GA SEP99-SEP00
	-University of Pittsburgh School of Dental Medicine Pittsburgh, PA Doctorate of Dental Medicine AUG95-JUN99
	-University of Pittsburgh at Bradford Bradford, PA B.S. Biology, Minor: Chemistry AUG91-MAY95
CERTIFICATIONS	-National Board Certified General Dentist -North East Region Board Certified General Dentist -Advanced Cardiac Life Support Certified -Basic Life Support Instructor Certified -Advanced Trauma Life Support Certified -Basic Trauma Life Support Certified

HONORS and AWARDS

-Bronze Star Medal
-Meritorious Service Medal
-National Defense Service Medal
-Global War On Terrorism Expeditionary Medal
-Global War On Terrorism Service Medal
-Army Service Ribbon
-Overseas Service Ribbon
-German Proficiency Badge
-Graduated Cum Laude B.S. Biology 1995
-Member Alpha Lambda Delta-
National Honorary Society for freshman with GPA 3.5 or higher in first term

RELEVANT EXPERIENCE

-General Dentist
Company Commander
U.S. Army Dental Corps
DENTAC
Ft. Hood, TX
Provided comprehensive and emergency dental care to the soldiers at DC#5, Ft. Hood, TX.
In charge of all U.S. Army DENTAC personnel and administrative actions at the Ft. Hood DENTAC.

-General Dentist
Platoon Leader
U.S. Army Dental Corps
561st MED CO (DS)
Vilseck, Germany
Provided comprehensive and emergency dental care to the Grafenwoehr and

Vilseck communities.
OCT00-OCT03

-Deployed to IRAQ and provided
emergency and routine dental care to U.S. and
Coalition soldiers.

-General Dentist Resident
AEGD 1yr. program
U.S. Army Dental Corps
DENTAC
Ft. Benning, GA
Provided comprehensive dental care to active
duty soldiers on Ft. Benning Army post and
completed a 1 yr. AEGD residency.
SEP99-SEP00

-Volunteer Student Professor
University of Pittsburgh School of Dental Medicine
Served as a Restorative preclinical advisor to
first year dental students while completing
final year in dental school
AUG98-MAY99

-Dental Assistant
Katsur Dental
Pittsburgh, PA
Provided dental assisting duties for a 12 chair
private practice
FEB97-JUN99

OTHER EXPERIENCE

-Student dental anesthesiologist
1 year elective
University of Pittsburgh School of Dental Medicine

	Provided I.V. conscious sedation to dental patients in a clinical setting 50+ documented cases MAY98-MAY99
PROFESSIONAL ASSOCIATIONS	-Member Academy of General Dentistry -Member Alpha Phi Omega-National Service Fraternity
PRESENTATIONS	-Provided continuing education to Ft. Benning DENTAC with the presentation "Management of I.V. Sedation Complications" JUL00
RECENT RESEARCH	-Conducted research and formulated a publishable paper titled "Altered Sensations Following Mandibular Third Molar Extractions" NOV99-JUL00
COURSES TAUGHT	-Volunteer Student Professor University of Pittsburgh School of Dental Medicine Served as a Restorative preclinical advisor to first year dental students while completing my final year in dental school AUG98-MAY99
OTHER DUTIES	-561st MED CO (DS) Unit Movement Officer -93rd Medical Battalion Airlift Load Planning Officer -561st MED CO Airlift Load Planning Officer