The Effects of Elastic Size and Archwire Type on 3-Dimensional Force Systems When Using Class II Interarch Elastics

by

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Abstract

Objectives: An orthodontic simulator (OSIM) device was used to compare the force systems generated by class II elastics on a ½ cusp class II malocclusion using four combinations of two elastic types and two archwire types.

Methods: 3-dimensional forces and moments due to class II elastics were measured individually for each tooth (7-7) using Damon Q brackets on the maxillary and mandibular arches. Four test groups (n=44) were compared, each of a different combination of two elastic types (3/16", 2oz and 4.5oz) and two archwire types (0.014" nickel titanium and 0.019" x 0.025" stainless steel).

Results: Only the upper canines and lower first molars recorded clinically significant forces (≥0.3N) and moments (≥5Nmm). 2oz and 4.5oz class II elastics produced clinically significant vertical extrusive forces and horizontal forces along the archwire to normalize a class II malocclusion. Stainless steel archwire minimized the extrusive forces of the 4.5oz elastics compared to nickel titanium archwire

Conclusions: 2oz and 4oz class II elastics produced clinically significant vertical extrusive forces and horizontal forces along the archwire. Archwire type had no effect on 2oz class II elastics whereas 0.019" x 0.025"stainless steel significantly reduced the vertical extrusive effects of the larger 4.5oz elastics.

Dedication

To Jennifer, this was a tag team effort. Without you none of this would be possible.

To Isaac, Elsa and Maud, you guys are my greatest accomplishment. I hope you can read this someday and be inspired to follow your dreams.

To Mom and Dad, your love and support over the years is immeasurable. I am forever grateful.

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Chapter 1 – Introduction and Literature Review

1.1 Statement of the problem

The correction of class II malocclusions is a common treatment goal for orthodontists. [1] Of the many treatment modalities for class II correction, class II interarch elastics may be the most widely used due to its long history of clinical success, ease of implementation and low financial cost. However, no scientific data exists to guide the clinician in selecting the optimal protocol for class II elastic use. [2] Many studies have shown that class II elastics are effective in the treatment of class II malocclusions. [3] However, outside of expert opinion, the clinician must rely on previous experience and anecdotal evidence when selecting the size and strength of elastics, the size of archwire, the location of elastic attachment and the timing of elastic usage.

1.2 Introduction

The following is an introduction to the basic concepts related to the study of force systems in orthodontics and more specifically, class II elastics. Force and moment are commonly used to describe orthodontic force systems. Understanding the relationship between force and moment is essential in orthodontics as a means to predict how a tooth might move when using orthodontic appliances. The type of tooth movement that occurs given a set of forces and moments can be described using the location of the movements center of rotation in relation to the tooth's center of resistance. These concepts of force, moment, center of rotation and center of resistance are discussed in detail below.

1.2.1 Forces

A force is a push or a pull on an object. Force is a vector quantity, thus it has both magnitude and direction. The magnitude of force in the SI system is measured in Newton's (N). A Newton is the amount of force required to give a 1 kg mass an acceleration of $1 m/s^2$. The direction of a force is a combination of its line of action (the linear plane in which the force is oriented) and its sense (orientation of the force along the line of action). For the purpose of this thesis, the direction of force will be discussed using a 3-dimensional (3-D) X, Y, Z coordinate system. X is a force directed mesio-distally along the archwire, Y is a force directed bucco-lingually and Z is a force directed occluso-gingivally. Directions of all forces are illustrated in Figure 1-1. In orthodontics, forces are often quantified in terms of grams (g) or ounces (oz), however Newton's will be the measurement used throughout this project. 1N = 101.973 g or 3.6 oz.

1.2.2 Center of Resistance, Center of Rotation and Moments

The center of resistance (Cres), as defined in orthodontics, is the point in a tooth through which a single force will produce translation or bodily movement of the tooth where all points on the object will move equally in the same direction as the applied force. [4] If the line of action of an applied force does not pass through the Cres of a tooth, the object will tend to rotate. This rotational tendency is referred to as a moment of force. A moment is a twisting or turning about a point or a fixed fulcrum. [5] Like a force, a moment is described using both magnitude and direction. Moment (M) is calculated by multiplying the magnitude of the applied force (F) in Newton's by the perpendicular distance (d) between the line of action of the force and the Cres of the object, in millimeters (mm). M = F x d = Nmm. Since teeth are constrained within alveolar bone, the Cres is approximately ⅓ to ½ the distance from the alveolar crest to the root apex for single rooted teeth and approximately 1-2mm apical of the furcation of multirooted teeth (figure 1-1).[6] As such, the location of the Cres can vary substantially depending on the height of the alveolar bone. As the height of the alveolar bone migrates apically, the Cres migrates apically. As the Cres migrates apically away from the line of action of a force, the moment of force increases and the tendency for rotation increases. Similarly, as the line of action of a force moves away from the Cres, the moment increases yet the applied force remains the same.

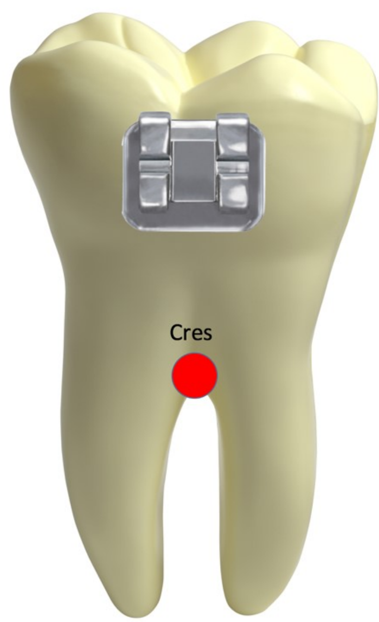

Figure 1- 1: Approximate location of the center of resistance (Cres) for a multirooted tooth

In orthodontics, the direction of the moment is generally labeled by describing the direction in which the crown or root will move. For example, lingual crown or buccal root moments can be used synonymously to describe the same rotational direction of a moment. Throughout this thesis, the direction of moments will be described using the same X,Y,Z coordinate system used to describe forces except that the coordinates describe the axis around which the moment rotates. For example, force X (F_X) is the mesial-distal force along the long axis of the archwire whereas moment X (M_x) is the buccal or lingual crown tipping that occurs around the long axis of the archwire. M_Y is mesial or distal crown tipping. M_Z is rotation around the long axis of the tooth. Figure 1-2 is a diagrammatic representation of the 3-D forces and moments.

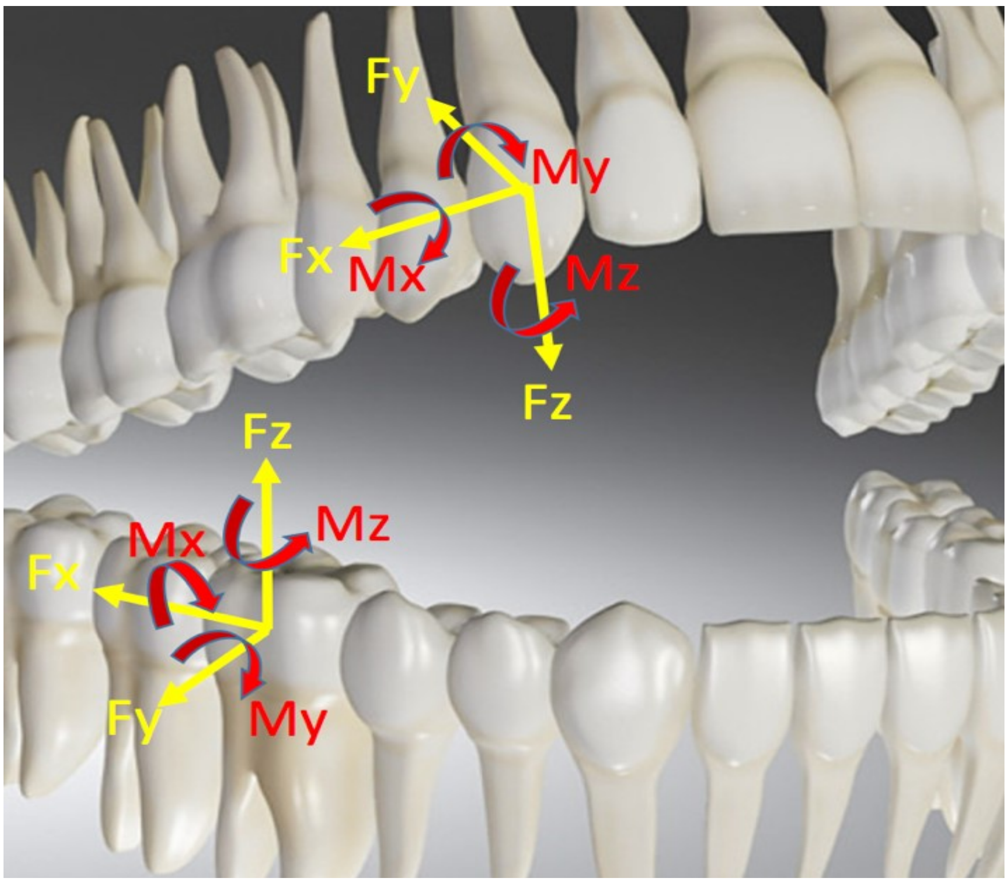

Figure 1- 2: Three-dimensional diagram of forces and moments

When an object or tooth rotates, it does so around a single point. This point is called the center of rotation (Crot). The location of the Crot depends on the combination of translation and rotation that occurs as a result of an applied force. In pure rotation, the Crot exists at the Cres (figure 1-3A). As the Crot moves apically, the tooth begins to translate until pure translation occurs when the Crot is located at infinity (figure 1-3D). Root torqueing occurs when the Crot moves coronal to the Cres and is characterized by the root apex moving a greater distance than the coronal apex (figure 1-3C).

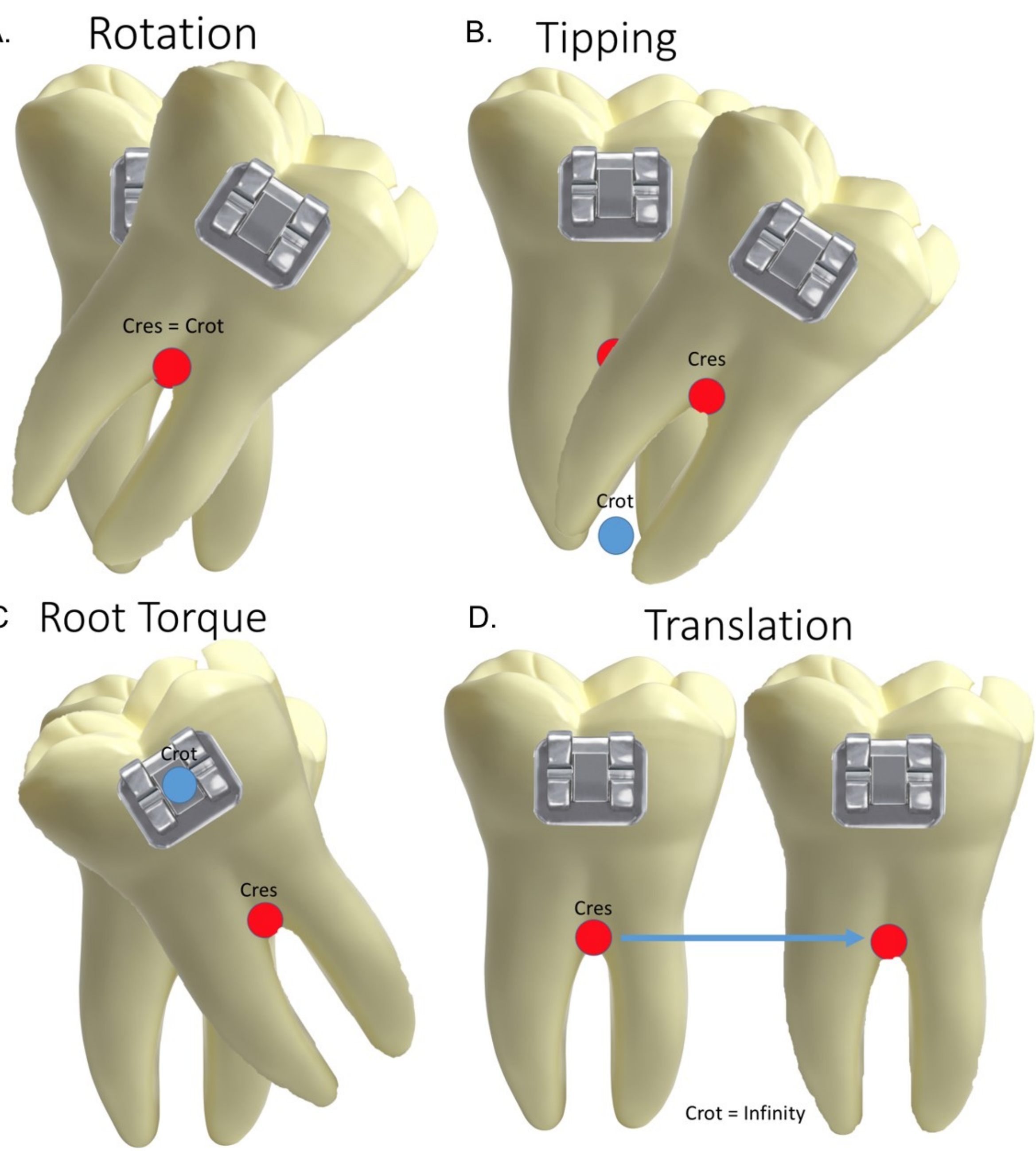

Figure 1- 3: Location of center of resistance (Cres) and center of rotation (Crot) for A) rotation B) tipping C) root torque and D) translation movements

1.2.3 Couples

A couple consists of two forces of equal magnitude with parallel but non-collinear lines of action and opposite senses. [6] A couple acting on a free body creates a moment that will produce pure rotation at the center of mass. The net moment produced by a couple is calculated by multiplying the magnitude of one of the forces by the distance between the two forces. The point of application of the couple on the body has no effect on the net moment that is produced by the couple. Therefore, unlike moments that are calculated as a function of their distance from the tooth's Cres, a couple is considered a "free vector" in that its position on the tooth is irrelevant.[6] This concept is depicted in figure 1-4 where a two forces of 100 N are acting 5mm apart which creates a moment at the Cres of 500 Nmm.

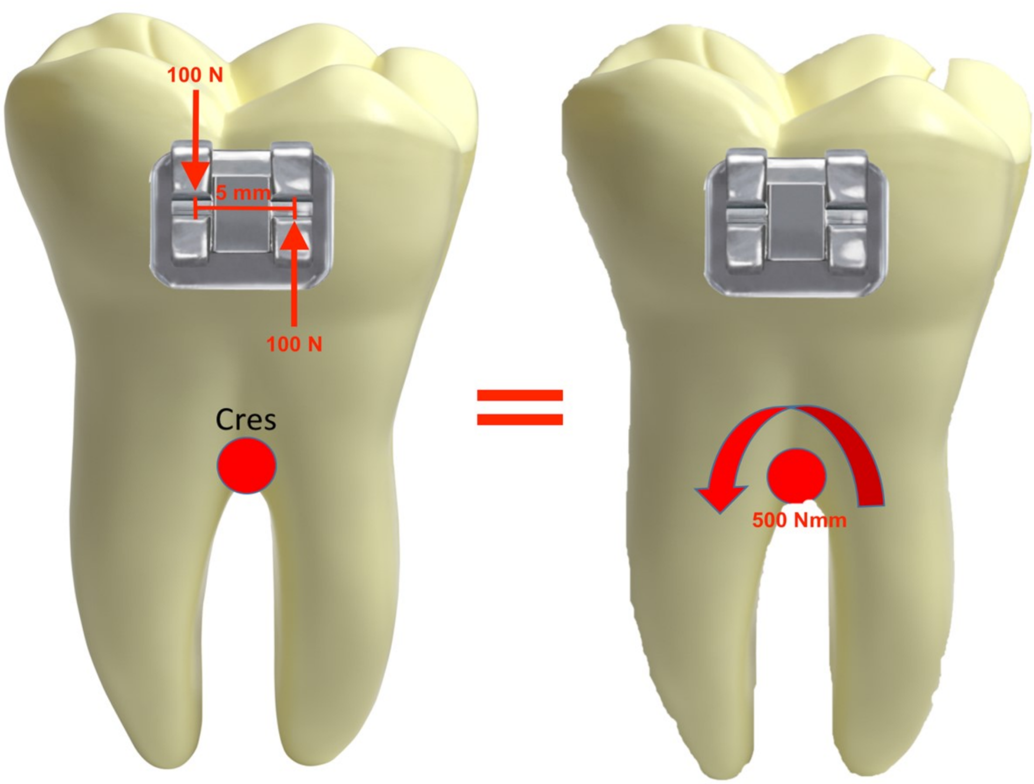

Figure 1- 4 Schematic representation of the moment that is created as a result of a couple located at the bracket.

In the previous sections, we discussed how changing the location of the line of action of a force in relation to the Cres would modify the degree to which a tooth is rotated or translated. In reality, the Cres of a tooth is located within the tooth root that is constrained within alveolar bone. Therefore, it is not possible to apply a single force directly to the Cres. We are limited to applying orthodontic forces to the exposed dental crown. As a result, any single force applied to the tooth causes some degree of rotation or moment due to the distance of the line of action of the force from the Cres.

To control for rotation, translation and tipping, orthodontists can apply a couple to the crown through fixed brackets and dimensional archwires. Orthodontic brackets contain a rectangular slot in to which dimensional archwires are inserted. When the archwire is rotated around its long axis (X-axis), the corners of the archwire will contact the occlusal and gingival walls of the bracket slot and produce a couple. First and second order couples are also created within the bracket when the archwire is rotated around the Y and Z-axis. When a couple is applied to an orthodontic bracket, the magnitude of that couple is equal to a moment of the same magnitude and direction located at the Cres. Therefore, a couple applied at the bracket can be used to control/counteract the moment of force that is produced as a result of applying a force away from the Cres. If the couple creates a moment (Mc) that is equal in magnitude to the moment of force (Mf) but opposite in direction (Mc/Mf=1), the couple and moment will cancel and the result will be pure translation with the Crot extending to infinity. If the moment of force is much larger than the moment of the couple (Mc/Mf=0), the Crot will be located near the Cres and uncontrolled tipping with result. To achieve torqueing of the root, where the root apex moves further than the crown, the moment of the couple must be greater than that of the moment of force (Mc/Mf >1). As such, the type of tooth movement that occurs is the result of a delicate balancing act between the applied forces and their counter acting couples. Therefore, to achieve tight control of tooth movements, an accurate knowledge of the force systems applied to each tooth within the straight-wire appliance is extremely important.

1.2.4 Force Systems

If an object is either moving at a constant velocity or not moving at all, it is in a state of equilibrium where the sum of all forces acting upon it are zero. When continuous straight wire mechanics are used in orthodontics, in the absence of soft tissue or bone derived anchorage devices, the sum of the forces within the system is equal to zero. At the level of the tooth, the forces and moments applied via the orthodontic appliance are equal and opposite to the forces and moments applied via the supporting periodontal apparatus. Likewise, at the level of the orthodontic appliance, the forces or moments applied to one tooth must be balanced by the forces or moments elsewhere on the appliance via tooth, bone or soft tissue anchorage. Therefore, in the absence of bone or soft tissue anchorage, a force or moment applied to one tooth or multiple teeth will create a balancing set of forces and moments on the other teeth within the appliance. If we assume the force placed on one tooth is desirable we cannot however assume the balancing or reciprocal forces placed on the other teeth are desirable. For example, in the case of a high canine engaged in a continuous light wire, the desirable force is directed occlusally to extrude the canine to the plane of occlusion. Reciprocating the extrusive force on the canine will be an unwanted intrusive force on the adjacent teeth. This example is a highly simplified two-dimensional analysis of an extremely complex three-dimensional system of forces and moments.

There are simple systems in orthodontics that are considered statically determinant, meaning that all the moments and forces can be readily discerned, measured and evaluated. [7] Such systems are called “one-couple systems” as they involve a couple at one end and a single force at the other. An example is an intrusion arch with a v-bend close to the molar tube. The molar tube will create a couple at the distal segment and a single intrusive force at the anterior segment.

If the system consists of 2 couples, the complexity of the system increases and it is considered to be statically indeterminate. An indeterminate system is too complex for precise calculation of all forces and moments involved in the equilibrium. [7] For orthodontic indeterminate systems, we are typically only able to determine the direction of net moments and approximate net force levels and directions.

1.2.5 Class II Malocclusion

Affecting between 15 and 30% of the population, class II malocclusion is the most prevalent malocclusion in Caucasian populations. [1] The etiology of this malocclusion can be multifactorial, including a variety of skeletal and dentoalveolar factors which result in an anterior-posterior occlusal disharmony where the mandibular dentition is positioned posteriorly in relation to the maxillary dentition. Skeletally, retrognathia of the mandible associated with either an absolute mandibular length deficiency or a vertical direction of mandibular growth can precipitate class II malocclusion. The most common features associated with class II malocclusion includes, excessive overjet, deep bite, retrognathic mandible and convex soft tissue profile. [8] Due to the common nature of this malocclusion and the variability of its clinical presentation, there are a variety of appliances and treatment protocols that the clinician can employ to normalize a class II malocclusion. One of the most commonly used treatment protocols is full fixed appliances with class II interarch elastics.

Class II elastics have been used by orthodontists since the early 20th century. [9] A systematic review published in 2013 concluded that class II elastics where capable of predictably correcting up to a ½ cusp class II malocclusion mainly through dentoalveolar movements. [6] A very basic examination of the force systems generated by class II elastics involves opposing horizontal and vertical forces on maxillary and mandibular arches. The horizontal forces serve to correct the anterior-posterior occlusal disharmony while the vertical forces can be attributed to generally less desirable extrusive forces on the upper canine and the lower first molar. Several other possible undesirable side effects have been reported, such as: proclining the mandibular incisors,[10]retroclining maxillary incisors and extruding the mandibular molars and maxillary incisors, causing the occlusal plane to cant clockwise and the lower anterior face height to increase.[8,11]A better understanding of the force systems created by class II elastics and how they can be modified via elastic size and archwire type may improve the orthodontists ability to minimize the undesirable side effect and maximize the desirable ones.

1.3 Significance

No research on the optimum class II elastic forces that are required for class II correction exists. [2] However, it is generally agreed that light forces are more desirable than heavy forces to achieve predictable tooth movement while minimizing the potential for pain and root resorption that has been reported relating to heavy forces. [12] The Tweed technique uses light elastics (1-2oz) with steel archwire. This suggests that light elastics can be effective in correcting class II malocclusion. However, the introduction of elastics into class II treatment is recommended to be delayed to work up to the rigid steel archwire. [8,13] Since elastics are patient compliance dependent, any steps that can be taken to increase compliance are valuable. Some have advocated the use of early elastics on light wire as a means of introducing the patient to elastics while they are still excited and motivated opposed to later in treatment when compliance may wane due to "burn out". [14] The objective of this study was to provide the orthodontist with 3-dimensional force and moment data using light and heavy class II elastics on light and heavy archwires.

1.4 Research Aims

To evaluate forces measured at the teeth when using four configurations of class II elastics (2 elastic types and 2 wire types). Also, to make suggestions towards the most efficient, the most effective and the most comfortable treatment recommendations for the correction of class II using class II elastics

1.5 Hypothesis

H_o: There is no difference in 3-D forces and moments throughout the maxillary and mandibular arches between the four study groups: 1) light archwire with light elastics; 2) light archwire with heavy elastics; 3) heavy archwire with light elastics and 4) heavy archwire with heavy elastics.

1.6 Literature Review

1.6.1 Class II Elastics

In 1845, Stephen Perry patented the rubber band and by the early 1900's Baker was using interarch rubber bands to treat class II malocclusions.[9]In 1907, Angle popularized interarch elastics in his book Treatment of Malocclusion of the Teeth where he endorsed the use of interarch elastics to replace headgear in the treatment of maxillary dental protrusion.[15]

In 1938, Brodie published a series of class II patients treated with class II elastics. [16] He reported that pre and post treatment cephalograms showed that the majority of the class II correction was achieved by mesialization of the lower dentition with little stimulation of mandibular growth or distalization of the upper dentition. As a result, various treatment protocols and schools of thought were developed to account for the excess anchorage loss in the mandibular dentition. Tweed developed a “dynamic anchorage” technique that involved tipping back the lower molars in an effort to decrease their mesial migration. [17,18] Fisher advocated for the use of headgear only, without the use of elastics for the correction of class II malocclusion. [19] However, in the first half of the 20th century, the majority of orthodontists were using a combination of headgear, class II elastics and either lingual holding arches or molar tip backs for lower molar anchorage. [17]

Today, interarch elastics remain an important tool in the correction of class II malocclusions. However, Proffit encourages the orthodontist to exercise caution in selecting cases for the use of class II elastics to minimize the potentially negative side effects. [7] These negative effects refer to the tendency for class II elastics to produce proclination of the lower incisors, extrusion of the maxillary incisors, extrusion of the lower first molars and a clockwise rotation of the occlusal and mandibular plane.

In a long-term follow-up comparing Begg type class II elastic treatment and the Herbst appliance to an untreated class II control group, Nelson *et al.* (2007) found that both class II elastics and Herbst appliance produced retroclination of the maxillary incisors by 7 degrees and an improvement in jaw-base relationship but no improvement in mandibular projection compared to control group. [8] It was also found that class II elastics produced a short-term increase in lower face height and mandibular plane angle compared to Herbst, but the mandibular plane angle normalized over the long-term compared to both the Herbst and control group. Combrink *et al*. (2006) used heavier 4oz class II elastics and observed posterior movement of A point (decrease in SNA of 1.5 degrees) and proclination of the lower incisors but there were no vertical changes in the lower face or steepening of the mandibular plane angle.[20]

In 2013, Jansen *et al.* published a systematic review that investigated the correction of class II malocclusion with class II elastics.[3] The review included 11 studies which lead the authors to the following conclusions: 1) class II elastics are effective in correcting class II malocclusions up to an Angle ½ cusp class II; 2) the main effects of class II elastics are dentoalveolar, including lingual tipping, retrusion and extrusion of the maxillary incisors, labial tipping and intrusion of the mandibular incisors, and mesialization and extrusion of the mandibular molars; 3) in the long-term, the effects of class II elastics are similar to those produced by functional appliances from a skeletal and dentoalveolar perspective.

Of the 11 studies included in Jansen's review, only 5 provided the strength of elastics used during treatment. Meistrell *et al.* (1986) and Nelson *et al.* (2007) used the Begg inspired 1-2oz elastics protocol,[8,13] Serbesis-Tsarudis and Pancherz (2008) used 2.5oz elastics,[21] Uzel *et al.* (2007) used 3.5oz elastics[22] and Combrink *et al.* (2006) used 4oz elastics.[23] Comparing the results of the various strengths of elastics does not provide information that might guide an orthodontist toward using one strength over another. The two studies using 1-2oz elastics differed in their effect on lower face height (LFH) and mandibular plane (MP) angle. Nelson *et al.* (2007) reported an increase in LFH and MP angle whereas Meistrell *et al.* (1986) did not. Regarding the heavier elastics used in the other 3 studies, the 3.5oz elastics increased LFH but the 2.5oz and 4.0oz elastics had no effect on LFH. With respect to archwire, the results are also contradictory as the similar 3.5oz and 4.0oz studies both used 0.016" x 0.022" stainless steel (SS) wire but the 3.5oz elastic group had an increased LFH whereas the 4.0oz group did not.

The Jansen *et al.* (2013) review leaves the practitioner wondering if there is an optimal protocol for the use of class II elastics. Of the present studies with the highest available level of evidence we find that class II malocclusions of at least ½ cusp can be corrected using elastics that range in strength from 1-2oz to 4oz without a clinically significant increase in LFH. Oesterle *et al.* (2012) suggests that prescribing force levels for intermaxillary elastics might be more art than science.[2]

Angle was the first to promote the importance of light forces to create a physiologic tooth movement.[15]High forces are believed to be associated with excessive compression of the PDL and supporting bone, creating an area of ischemia and necrosis due to blocked blood vessels. [24] It is also well known that high force levels are more likely to cause pain and root resorption. [7] As a result, an optimum force will be one that is high enough to cause physiologic tooth movement and low enough to minimize pain and root resorption. However, determining a single optimum level of force is probably not possible. Oesterle *et al.* (2012) states,

> "Specific descriptions of optimal force magnitudes for interarch elastics are difficult to find in the literature and are found primarily in textbooks. Nanda stated, "An accurate measure of the optimal force eludes determination." Mulligan acknowledged the difficulty in defining optimal force values when he stated that "an acceptable range of response…. can vary greatly with each individual." Graber and Vanarsdall make a similar statement regarding optimal force magnitudes but provided no specific, measureable forces."[2]

Despite the complexities involved in determining optimal forces, many experts within the field of orthodontics have made recommendations. Proffit recommends using 250g (8.8oz) per side when using a larger rectangular archwire and half that (125g/4.4oz) when using light round wires. [7] Stating that this force is required to displace one arch relative to the other, Proffit offers no rationale for his recommendation. Langlade, using a more quantitative approach, multiplied the resorptive root surface area of the maxillary and mandibular dentition by the Ricketts recommended 150g of force per cm^2 of resorptive root surface area. [25] The resulting force was calculated to be 318g (11.2oz) of force per side. These levels of force recommended by Proffit and Langlade are much higher than the 1-2oz used in Begg mechanics and the more recent recommendation of 2.5oz per side maximum by Pitts.[14,26,27] Various published studies and case reports show that the correction of class II malocclusion is possible using either of the aforementioned protocols.[3] This leaves one to wonder how orthodontists decide how much force to use and on which archwire to use it.

Oesterle conducted a study to determine how closely the forces prescribed by orthodontists for interarch elastics conformed to the recommendations of the perceived experts.[2] Orthodontists were given a model of a ½ step class II malocclusion and a model of a ½ cusp class III malocclusion, each of which had bonded brackets. A questionnaire explained 2 scenarios for each model and each orthodontist was asked to provide the size of elastics and the location of elastic anchorage for each scenario. One scenario had a light 0.018" SS wire and the other scenario had a heavy 0.018" x 0.025" SS wire. Despite the wide variation of responses, the mean results for the class II malocclusion most closely conformed to Proffit's recommendations of 125g per side on light archwire and 250g per side on heavy archwire. One trend that was consistent across all orthodontists was the use of lighter forces when using light archwires and heavier forces when using heavy archwires. The theory behind this trend is that a larger and more rigid archwire will provide more anchorage and will therefore resist side effects localized to the anchor points of the elastics. [7] Given the wide range of forces from 1oz to 11oz per side that are capable of correcting class II malocclusions, as evidenced by the literature, how does the orthodontist choose the most appropriate level of force? Training, mentoring and personal experience probably play a major role.[2]

1.6.2 Quantitative and Qualitative Measurement of Force Systems

Various models and techniques have been developed and tested in an attempt to observe and quantify the complex force systems that are created by the straight wire orthodontic appliance. Improvements in technology have moved us from models using teeth in wax, to complicated computer programs capable of running very complex algorithms such as those used in the Finite Element Model (FEM) analysis. The following is a brief history of the study of orthodontic force systems.

The earliest attempts to understand the forces generated by the straight wire appliance were qualitative in nature. The goal was to observe the direction and location of the forces. Teeth placed in a typodont made of wax or other elastic materials were commonly used. The use of photo-elastic material allowed for visualization of the forces that are transmitted from the teeth to the supporting material surrounding the tooth roots.[28,29]These studies provided a very generalized understanding of how orthodontic appliances might exert forces upon the supporting dentoalveolar structures. However, these over simplified models that used a single homogeneous material to represent the periodontal apparatus do not accurately replicate the heterogeneous structures such as the PDL and alveolar bone. In its most basic forms, alveolar bone can be categorized into cortical and medullary bone. However, the modulus of elasticity of cortical and medullary bone can vary depending on location within the mouth and is variable from person to person.

Holographic Interferometry

In 1981, Dermaut developed a model to study the forces of class II elastics on the maxilla and surrounding bones.[30] Dermaut improved upon the typodont models by observing forces/stresses within dry skulls using a technique called Holographic Interferometry. When forces are placed upon the skull, the bone deforms. Holographic interferometry is capable of measuring the amount of boney displacement/deformation to an accuracy of ½ wavelength or 514nm. Using established norms for the elastic modulus of teeth, cancellous bone and cortical bone, Dermaut was able to quantify the forces responsible for the boney deformations. This model was a clear improvement over the previous typodont models; however, there were many limitations. For example, a dry skull will be similar to that of a living person in that the basic structure and trabecular patterns of the bone will be maintained; however, the dry skull is devoid of any cartilaginous or fibrous tissue.

Dermaut's model used a material of homogenous composition throughout the entire PDL. Araldit 208 and harder 965 were used to replicate modulus of elasticity of the PDL. However, PDL has been shown to exhibit variations in its modulus of elasticity at a single tooth.[31]. Also, the synthetic PDL would have no effect on the tension side of the tooth whereas the natural PDL would exert tension on the supporting bone opposite the areas of pressure.

Finite element computer modeling

The finite element model (FEM) is a computer-generated model of a structure that has been subdivided into a finite number of 3-D units called elements. Each element is given properties, such as a modulus of elasticity and Poisson's ratio, which dictate how that element will respond to and interact with adjacent elements when the object is subject to forces or displacements. These models permit the estimation of the stresses generated within the different tissue structures, such as alveolar bone, periodontal ligament, and teeth as a result of orthodontic appliances. [32] For single tooth models a computer aided design (CAD) model can be obtained from a 3-D digital scan of a tooth. [32] For multiple teeth or full arch models, CBCT scans are used to create the CAD model. [33]

FEM is only as good as the accuracy with which the model and the properties ascribed to each element represent reality. Since the models cannot account for everything, there will be a discrepancy between FEM and reality. However, the availability of higher computing power, enhanced CAD (computer aided design), and CT imaging, allows for more anatomically accurate patient based models. Canales *et al*. (2012) increased the complexity of FEM models by incorporating a straight wire orthodontic appliance using a technique they developed called the "birth-death technique". [34] CAD brackets are placed on four anatomically correct computer models of teeth (21, 22, 23, and 24) that allows for the virtual placement of active archwires into the bracket slot. FEM can then be used to analyze the effects of the appliance on the tooth and supporting structures. In past FEM studies, it was common to fuse the contacts between the teeth so they act as a unit. Canales used frictionless contact points that more closely approximate reality when compared to fused contacts. However, to decrease the computing requirements, the interaction between wire and bracket was deemed to be frictionless.[34]

FEM is very good at simulating small models but it is difficult to account for all variables involved in the straight wire orthodontic appliance. The properties of the wire, the position of the bracket, the bracket-wire interaction within the slot and the transfer of forces through the bracket has to be accounted for to determine the amount of forces that are actually acting on the tooth prior to inputting these forces into the FEM to analyse the resulting forces acting on the tooth and supporting structures.

Orthodontic Simulators

Where the finite element method hopes to solve statically indeterminate force systems by approximating complicated mechanics, orthodontic simulators attempt to experimentally measure the actual forces and moments produced by an orthodontic appliance. An early example of such a device was developed in 1976 for the purpose of measuring uniplanar force systems within a statically indeterminate two-couple system. [35] The researchers reported less than 2% error compared to theoretical calculations for cantilevers.

In 1991, the orthodontic measurement and simulation system (OMSS) was developed for the purpose of measuring the 3-D forces and moments of two-couple systems. [36] They simulated a mesially tipped molar and compared the force systems of three types of molar uprighting mechanics. Using the force and moment data, they calculated how the teeth might move. They then reset the teeth into the new theoretical positions and tested the force system of the appliance again. This process was repeated until the molar was fully uprighted. They found that the modified Burstone uprighting spring prevented extrusion and produced a consistent force system throughout uprighting. The conventional uprighting spring produced excessive extrusion forces and lingual tipping moments. The straight wire appliance produced excessive extrusion forces and required twice as many simulation cycles to upright the molar.

A team at Indiana University developed a similar force measuring system. Custom models are created and up to two teeth are individually attached to force sensors. These two teeth are then detached from the model that allows the sensor to measure forces and moments placed upon those teeth. They have published studies comparing various T-loop and straight-wire techniques for space closure, in addition to studies comparing the forces and moments generated by pre-torqued and straight archwires on various popular bracket prescriptions (MBT, Roth, and

Edgewise).[37,38] The major limitation of this force measurement system is its inability to measure more than two teeth simultaneously. The authors stated that space constraints due to the size of the sensors and the high costs of the sensors where the main reason for this limitation.

In 2009, Badawi *et al.* developed the first full arch orthodontic simulator (OSIM) capable of measuring 3-D forces and moments of all 14 teeth within the dental arch simultaneously.[39] Many studies using data from the OSIM have since been published. Passive versus conventional ligation in a high canine model found that there were more unwanted forces associated with the conventional ligation.[39-41] Conventional ligation produced a lower level of the desirable extrusion force on the canine and produced an increase in the five other forces and moments. Most notably, conventional ligation produced an increased mesially directed force which may result in proclination of the anterior segment in a clinical situation.

Another OSIM study tested the differences between passive and conventional ligation involving a single lingually displaced lateral incisor.[42] It was found that conventional ligation produced statistically greater forces and moments for all forces and moments. The mean increase of mesiodistal and buccolingual forces for conventional ligation was also clinically significant. In addition, the forces and moments were found to propagate further along the arch from the displaced incisor compared to those of the passive ligation.

The OSIM was also used to study the effect of wire size in a simulated high canine model.[43] It was found that changes in copper nickel titanium (CuNiTi) wire size did not affect the force/moment distribution in a linear relationship. An increase in wire size did not produce a proportional increase of the applied forces and moments. It was hypothesized that this non-linear relationship was due to the intrinsic non-linear material behavior of CuNiTi.

Researchers in Italy feel they have improved upon the aforementioned *in vitro* force testing mechanisms. [44] Like the OSIM, they are able to measure 3-D forces and moments of all 14 teeth within the arch simultaneously. However, they use an actual cast model of a dental arch which has had the individual teeth sectioned. This allows the examiners to test orthodontic appliances on real world malocclusions. In their study they tested various superelastic archwires on a high canine model. They also tested the force system produced by placing a divot in a clear aligner to rotate a central incisor. The OSIM is very capable of reproducing a malocclusion but it is not yet able to test clear aligners.[45]

In Vivo Testing

While in vitro simulations and finite element modeling are valuable orthodontic research tools that enable the researcher to conduct well-controlled and financially responsible studies, there are limitations in how closely the dynamic oral environment can be simulated. As such, the ideal orthodontic force measurement instrument would fit seamlessly into clinical orthodontic appliances and record and store real-time measurements to a remote device. Attempts to measure in vivo force systems have had minimal success.

In 1999, Friedrich *et al.* developed a novel system for measuring in vivo force systems that was capable of measuring the 3-D forces and moments at a single tooth.[46]The two major components of this system included a 1) bracket that could be detached and reattached to the bracket base and an 2) extra oral instrument capable of clamping the bracket firmly in order to measure the forces acting upon it. To minimize movement of the head, the patient would be restrained within a chin cup and forehead support while biting on a bite fork. The measuring instrument would then clamp on to the detachable bracket. When the bracket was detached from the bracket base, the measuring instrument then received the load from the bracket and the force and moment data was recorded.

There are many limitations with this method. The instrument is only capable of measuring the force system at one bracket at a time. The process involves many moving parts. For example, the bracket must be disengaged from the bracket base, which could cause minor movement of the bracket. Also, the patient is attached to the measuring device and despite the forehead and chin support and the bite fork there will inevitably be patient movement that can drastically affect the accuracy of the measurements. The researchers state that movements of the measuring systems as small as 0.04 mm could result in a clinically significant change in force of 1.5N.

Smart Brackets

The smart bracket is a concept that will allow real time in vivo measurement of forces and moments at each tooth simultaneously within the dental arch.[47,48]Each bracket will contain a microelectronic stress sensor for 3D force and moments measurement. To date the smart bracket has undergone accuracy testing at the in vitro level. Researchers have compared the performance of the smart bracket to that of a finite element model and have found poor accuracy for forces in the buccal-lingual direction. [48] Another challenge facing the smart bracket is the transfer of data from the bracket in the in vivo setting. Current in vitro models transmit data via flexible cable. Due to the cumbersome nature of cables and the potential for cables to induce their own forces on the brackets, an ideal in vivo smart bracket would be capable of wireless data transmission. As such, the realization of a functional in vivo smart bracket is dependent on the advancement of micro-technologies.

1.7 Conclusion

Class II elastics have been used to correct class II malocclusions since the early 1900's and they have been shown to predictably correct up to a ½ cusp class II malocclusion. [3] Despite their long history in orthodontics, a consensus regarding the most effective protocol for their use has yet to be established. [2] Cases in the published literature have demonstrated the ability of elastics to correct class II malocclusion using sizes ranging from 1oz to 11oz per side while on a variety of archwire sizes. [8,13,25] To fully understand the differences between these treatment protocols one must understand the force systems that are generated by them. Since the force system of any straight-wire appliance is considered statically indeterminate, the ability of researchers to quantify the force systems created by class II elastics has not been possible. FEM analysis is a valuable tool in understanding how forces are passed from orthodontic appliances to teeth and ultimately to the periodontal apparatus. However, FEM analysis is a simplified simulation of an extremely complex system. As the power of computers and programming increase and our knowledge of the properties of the dentoalveolar complex improves, FEM analysis will become proportionately more accurate. Although we may never have the ability to measure the forces exerted on the periodontal apparatus in real-time, orthodontic simulators are advancing our understanding of the complex, statically indeterminate, force systems exerted on teeth by the straight-wire appliance. The ability to test actual orthodontic appliances and measure their force systems on teeth in real-time may move us closer to optimal treatment protocols for a number of appliances, including class II elastics.

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Chapter 2: The Treatment of Class II Malocclusion Using Conventional Interarch Class II Elastics: A Systematic Review

2.1 Introduction

Class II malocclusions affect between 15 and 30% of the population. [1] Because of the associated features that often include excessive overjet, deep bite, retrognathic mandible and convex soft tissue profile, [2] it is to no surprise that patients with a class II malocclusion commonly seek orthodontic treatment.

The morphology of class II malocclusions is of a variety of skeletal and dentoalveolar combinations that create an anterior-posterior occlusal disharmony between the teeth. [3] This large variety of associated conditions logically implies a similarly large number of treatment protocols to eliminate or improve this dentofacial disharmony. One such treatment option is the use of class II inter-arch elastics concomitant with fixed orthodontic appliances.

Class II elastics are small rubber or latex bands that are anchored between the upper and lower teeth either directly on bracket hooks or indirectly on hooks on the archwire or on distalizing appliances such as the Wilsons appliance or the Carriere appliance. The purpose of these elastics is to create the orthodontic force vectors necessary to correct the dentoalveolar anterior-posterior discrepancy, between the upper and lower jaws, that is characteristic of the class II malocclusion. Class II elastics have been shown to be able to normalize the dental, mainly, and skeletal relationships of class II subjects. [2] However, several possible undesirable side effects have been reported, such as: proclining the mandibular incisors, [4] retroclining maxillary incisors and extruding the mandibular molars and maxillary incisors, causing the occlusal plane to cant clockwise and the lower anterior face height to increase.[3,5]

The most recent review of this topic was published in 2013; [6] however, its search of the databases was performed in August 2010. Supported by studies of low level evidence, the review concluded that class II elastics were not only effective in the treatment of class II malocclusion, but they were also equally effective as many popular functional appliances. Additionally, it was determined that the effects of class II elastics on soft tissues were poorly documented in the literature.

As the last review of this subject was conducted nearly four years ago, we felt that an updated review of the literature is warranted. Updated conclusions could be formulated based on the available new evidence. The objective of this systematic review is therefore to investigate the effectiveness of inter-arch class II elastics in the treatment of the dentoalveolar and skeletal presentations associated with a class II malocclusion.

2.2 Methods

The PRISMA checklist[7] was used as a template.

Protocol and registration

No Protocol or systematic review registration was completed.

Eligibility criteria

Studies eligible for inclusion included controlled human retrospective and prospective clinical trials evaluating the non-surgical and non-extraction correction of class II malocclusion, using only full fixed appliances and class II interarch elastics, without limits on study date, language or publication status. Studies were also required to provide details regarding the strength, wear time and total duration of use.

Information sources and search

With aid from a health sciences librarian, a search strategy was developed and the following databases were searched: Pubmed, Embase via OvidSP, The Cochrane Library and Scopus via Elsevier. Appendix A contains the unique search strategy details for each database. The final search of the databases was conducted April 18, 2016.

Study selection

The screening process for selecting studies involved two examiners (JS and NN). Both examiners independently selected or eliminated studies based on the inclusion criteria denoted above after reading each abstract. If the two examiners arrived at differing conclusions regarding the inclusion/exclusion of a study, a third examiner (DL) was involved in resolving the conflict. The remaining articles were then read in full, utilizing the same described inclusion criteria and selection process to further eliminate articles that may look promising based on the abstract information, but when read in full it was clear that the articles should not be included.

Data items

The characteristics of each study, such as sample characteristics, orthodontic appliance characteristics, elastic prescription details, treatment duration, results and the conclusions drawn by each study are presented in Table 2-1.

Data collection process

The two examiners (JS, NN) independently extracted information from the articles, which was then compared for homogeneity. Discrepancies between the collected information were investigated collaboratively by the examiners to identify the correct information.

Risk of bias in individual studies

Each study was assessed individually for risk of bias using a non-validated methodologic checklist derived from Saltaji, *et al.* [8] This checklist is consistent with the criteria proposed in the "Cochrane Handbook for Systematic Reviews of Interventions".[9]

Summary measures

The principal summary measures were mean changes in lateral cephalometric measurements, dental occlusion measurements and soft tissue profile measurements.

Data synthesis

If the available information warranted it, a meta-analysis was planned.

2.3 Results

Study Selection

The search results and the final number of studies selected is shown in Figure 2-1. From the 23 articles that were retrieved for in-depth screening, only two[10,11] were finally selected for the review. Two studies met the majority of the criteria, but did not have control groups. [3,12] In fact, a lack of an untreated control group was the reason for rejection for the majority of the studies. Another common shortcoming among the 23 studies included for stage 2 was the use of additional appliances in conjunction with class II elastics, i.e. headgear.

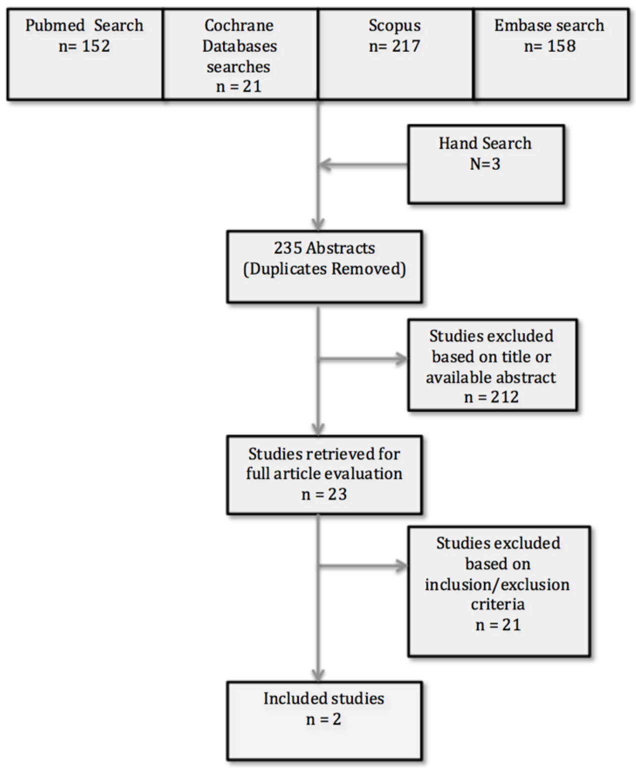

Figure 2- 1: Flow chart for article exclusion

Risk of Bias Assessment

A methodological quality checklist[8] was used to evaluate the articles Table 2-3 The articles scored 50% (Serbesis-Tsarudis) and 63% (Uzel *et al.* (2007)), which represents only a moderate quality methodological assessment score for both. A moderate risk of bias was therefore assumed.

Study Characteristics

Detailed characteristics and data for the two studies can be found in Table 2-1 and 2-2.

The Serbesis-Tsarudis and Pancherz (2008) study studied the effects of the Herbst appliance compared to class II interarch elastics on TMJ and chin position. They found that the class II elastics group had a statistically significant superior and posterior movement of the condylar point (Co) when the mandible was superimposed on stable bone structures of the mandible and an inferior movement of pogonion (Pg) when the head films were superimposed on the anterior cranial base. There was a statistically significant increase in anterior movement of Pg and posterior movement of Co in the Herbst and control group compared to the elastic group. Neither group exhibited significant mandibular growth rotation as measured from RL line (a line from the incisal edge of the lower central incisor to the distobuccal cusp of the first upper molar).

<table>
<tr><th>Article (Date of Publication)</th><th>Sample Characteristics</th><th>Description and Length of Treatment</th><th>Results</th><th>Authors' Conclusion</th></tr>
<tr>
<td>Uzel et al. (2007)

Prospective Clinical Trial</td>
<td>-Class II div 1 malocclusion
-Non-extraction treatment
-Reduced or normal lower face height with deep bite

<u>Elastics only</u>
-15 subjects (7M, 8F)
-Mean age 11.4 ± 1.3

<u>Elastics + RMCC appliance</u>
-15 subjects (9M, 6F)
-Mean age 13.2 ± 1.7

<u>Control</u>
-15 untreated patients awaiting treatment (7F, 8M)
-Mean age 11.2 ± 0.5</td>
<td>-Roth Omni brackets
-0.016x0.022 inch SS archwires with utility hooks distal to Mx laterals
-45 degree tip-back bends in distal of Mx arch.

<u>Elastics Only</u>
-3.5 oz, 24hr/day
-8.5 months wear

<u>Elastics + RMCC</u>
-3.5 oz
- Interarch elastics Attached to hooks on Mx archwire when awake. Elastics attached to RMCC when sleeping
-4.6 months wear</td>
<td>
<table>
<tr><th colspan="4">Skeletal Changes</th></tr>
<tr><th></th><th>Elastics</th><th>RMCC</th><th>Control</th></tr>
<tr><td>ANB°</td><td>-1.1</td><td>-0.4</td><td>0</td></tr>
<tr><td><u>Pg-PTV</u></td><td>0.9</td><td>0.5</td><td>0.6</td></tr>
<tr><td>PP-FH°</td><td>-0.1</td><td>0.1</td><td>0.2</td></tr>
<tr><td>LFH°</td><td>1.9**</td><td>1.7**</td><td>0.0</td></tr>
<tr><td>FMA°</td><td>0.6</td><td>1.0</td><td>0.8</td></tr>
</table>
<table>
<tr><th colspan="4">Dentoalveolar Changes</th></tr>
<tr><th></th><th>Elastics</th><th>RMCC</th><th>Control</th></tr>
<tr><td>U1-FH°</td><td>-7.4*</td><td>-6.4***</td><td>0.0</td></tr>
<tr><td><u>U1-PTV</u></td><td>-2.7**</td><td>-2.1***</td><td>0.4</td></tr>
<tr><td>IMPA°</td><td>4.0*</td><td>6.6**</td><td>-3.0</td></tr>
<tr><td><u>L1-PTV</u></td><td>2.4*</td><td>2.5*</td><td>1.0</td></tr>
<tr><td><u>Overbite</u></td><td>-3.5***</td><td>-2.4**</td><td>0.2</td></tr>
<tr><td><u>Overjet</u></td><td>-5.2***</td><td>-4.7***</td><td>0.0</td></tr>
<tr><td><u>U6-FH</u></td><td>0.5</td><td>-0.4**</td><td>1.1</td></tr>
<tr><td><u>U6-PTV</u></td><td>-0.3**</td><td>-2.3***</td><td>0.8</td></tr>
<tr><td>U6-FH°</td><td>-3.5***</td><td>-8.0***</td><td>0.0</td></tr>
<tr><td>L6-MP°</td><td>-6.1</td><td>3.4*</td><td>-0.2</td></tr>
<tr><td><u>L6-MP</u></td><td>1.7***</td><td>1.3**</td><td>0.0</td></tr>
<tr><td><u>L6-PTV</u></td><td>1.7*</td><td>2.2**</td><td>0.7</td></tr>
<tr><td>OP-FH°</td><td>3.2**</td><td>2.6**</td><td>-0.6</td></tr>
<tr><td><u>Molar Relation</u></td><td>-2.0**</td><td>-4.5***</td><td>0.5</td></tr>
</table>
<table>
<tr><th colspan="4">Soft Tissue Changes</th></tr>
<tr><th></th><th>Elastics</th><th>RMCC</th><th>Control</th></tr>
<tr><td><u>LL-E</u></td><td>-0.3</td><td>0.4</td><td>-0.5</td></tr>
<tr><td>Nasolabial°</td><td>-3.3</td><td>-1.6</td><td>-2.0</td></tr>
<tr><td>Labiomental°</td><td>17.8*</td><td>14.7**</td><td>-1.6</td></tr>
</table>
RMCC – Reciprocal Mini-Chin Cup
Underlined measurements are in mm
PVT – Vertical line though the most posterior point of the pterygomaxillary fissure and perpendicular to SN
(+) – Indicates anterior or superior movement
* P = 0.5, ** P = 0.01, *** P = 0.001
Bold italicized values – Significant difference between Elastic and RMCC groups
</td>
<td>-The correction of class II malocclusion in both treatment groups was accomplished mainly through dentoalveolar changes.

-Increased LFH° is the only significant skeletal change for the treatment groups compared to control

-Increased labiomental angle was the only soft tissue change in the treatment groups

-The RMCC group had greater change in molar relation and distalization and distal tipping of the upper first molars

-RMCC was approx. twice as fast as elastics in correcting class II malocclusion.</td>
</tr>
</table>

Table 2- 1: Summary of Uzel *et al.*(2007) article

<table>
<tr><th>Article (Date of Publication)</th><th>Sample Characteristics</th><th>Description and Length of Treatment</th><th>Results</th><th>Authors' Conclusion</th></tr>
<tr>
<td>Serbesis-Tsarudis and Pancherz (2008)

Retrospective Clinical Trial</td>
<td>-At least ½ cusp class II molar in permanent dentition
-At least ¾ cusp class II if E's still present
-No extractions
-No syndromes

<u>Elastics</u>
-24 (9M, 15F)
-Mean age 12.3 ± 3.1
-Selected from a pool of patients treated at the University of Giessen (Germany).

<u>Herbst</u>
-40 (20M, 20F)
-Mean age 12.4 ±1.3
-Seleted randomly from a pool of 118 patients treated at the University of Malmo(Sweden)

<u>Control</u>
-Bolton Standards group of 16M and 16F subjects with ideal occlusion measured at 12 and 15 years old.</td>
<td><u>Elastics</u>
-multibracket - appliance in Mx and Md
-2.5 oz elastics
-2.6 years total Tx time

<u>Herbst</u>
-Herbst then Multibracket appliance Mx and Md
-0.6 years with Herbst
-2.0 years fixed brackets, no mention of class II elastics</td>
<td>-All subjects in both groups finished treatment with class I occlusion, normal overbite and overjet

<table>
<tr><th></th><th>Elastic</th><th>Herbst</th><th>Control</th></tr>
<tr><td>Vertical(mm)</td><td></td><td></td><td></td></tr>
<tr><td>Co/RL</td><td>+6.7***</td><td>+7.5***</td><td>+7.5</td></tr>
<tr><td>Pg/RL</td><td>-6.0***</td><td>-6.2**</td><td>-6.3</td></tr>
<tr><td>Horizontal[A]</td><td></td><td></td><td></td></tr>
<tr><td>Co/RLp</td><td>-1.1**</td><td>-2.7**</td><td>-3.5</td></tr>
<tr><td>Pg/RLp</td><td>+1.2~</td><td>+3.8**</td><td>+3.8</td></tr>
<tr><td>Rotation(mm)</td><td></td><td></td><td></td></tr>
<tr><td>RL (°)</td><td>-0.1</td><td>+0.7</td><td>-0.3</td></tr>
</table>
P-value was not calculated for control group
(+) – indicates anterior or superior movement or clockwise rotation
Co – Condylar point, Pg – Pogonion
RL – Line from incisal edge of lower central incisor to distobuccal cusp of the first upper molar
RLp – Line perpendicular to RL through Sella point
*** P <.001, ** P < ,01, * P <.05

Bold italicized values – Significant difference between elastic and herbst groups</td>
<td>-Co moved more superiorly and posteriorly in the Herbst and control group

-Pg moved more inferiorly and anteriorly in the Herbst and control group.

-RL line rotated slightly clockwise in the Herbst group and slightly counterclockwise in the elastic and control groups</td>
</tr>
</table>

Table 2- 2: Summary of Serbesis-Tsarudis and Pancherez (2008) article

Uzel *et al.* (2007) observed a wide range of skeletal, dentoalveolar and soft tissue changes following the use of class II elastics or the use of the Reciprocal Mini-Chin Cup (RMCC) appliance in addition to class II elastics. They found that the majority of the class II correction came by way of significant dentoalveolar changes compared to those of the control group. Significant dentoalveolar changes were; retroclination of upper incisors, proclination of lower incisors, distalization, distal tipping and extrusion of upper first molars, mesialization, extrusion of lower first molars and clockwise rotation of the mandibular plane and occlusal plane. Compared to control, the only statistically significant skeletal and soft tissue change was an increased LFH° and an increased labiomental angle. When comparing treatment groups, there were three changes that were significantly greater towards the correction of class II for the

RMCC group: the upper first molar tipped distally 2° more, there was 2.5mm more molar relation correction and the lower first molar tipped mesially in the RMCC group.

Methodologic Quality Item	**Serbesis-Tsarudis & Pancherz (2008)**	**Uzel *et al.* (2007)**
Eligibiligy Criteria – clearly described; adequate	✓	✓
Sample size – Calculated; adequate	− ≠	− ≠
Timing—prospective; long-term follow-up	− −	✓ −
Randomization or consecutive selection – stated	−	−
Blinding of assessor – stated	−	−
Intervention details – clearly described	✓	✓
Outcome measures – clearly described; appropriate	✓ ✓	✓ ✓
Selective reporting – avoided	✓	✓
Withdrawls – reported	−	−
Data analysis – appropriate	−	✓
Point estimates and variability – P value; variability measures, SD or CI	✓ ✓	✓ ✓
Quality score (Max. 15)	7.5 / 50%	9.5 / 63%

✓ Fulfilled satisfactorily the methodological criteria (1 check point)
≠ Partially fulfilled the methodological criteria (0.5 check point)
− Did not fulfill the methodological criteria (0 check point)

Table 2- 3: Methodological quality checklist

2.4 Discussion

The purpose of this review was to critically analyze the literature pertaining to the use of interarch class II elastics in the correction of class II malocclusions using a non-extraction approach. The results of our review found two studies[10,11] that compared changes produced by interarch class II elastics to that of an untreated control group. Both studies report little or no skeletal changes due to interarch class II elastics and one of the studies reported that class II malocclusion was mainly corrected through dentoalveolar compensation.[11] Due to the stated methodological limitations, caution needs to be exercised when extrapolating these results into clinical practice.

Following a search of the databases, it was found that there are many published studies that employed interarch class II elastics for the correction of class II malocclusion; however, many of them used, either before or concomitantly, other class II approaches in conjunction with class II elastics or they lack a proper control group to account for normal growth changes. The two studies accepted for this review[10,11] were deemed to be of moderate risk of bias. Common methodological issues between the two studies were lack of long term follow-up, randomization, assessor blinding and sample size calculations.

The Uzel *et al.* (2007) study is a prospective study that used a well-matched untreated class II control group compared to the less methodologically sound retrospective study of Serbesis-Tsarudis and Pancherz (2008) which utilized a control group that was drawn from a previous growth study of class I subjects with ideal occlusion.

Skeletal

Comparing the two selected studies, the change in anterior position of Pg in the class II elastic groups was very similar at 0.9mm[11] and 1.2mm[10] but neither were statistically significant changes. These results are consistent with studies that were excluded due to lack of an untreated control group. These studies found an anterior change in Pg of 1.64mm[14], 1.62mm[15] and 2.1mm[16].

The only statistically significant skeletal change compared to control was found in the vertical dimension in the form of an increased LFH°[11] of 1.9mm in the Uzel *et al.* (2007) study . The Serbesis-Tsarudis and Pancherz (2008) study observed a 6.0mm inferior movement of Pg but there was no significant difference compared to the class I control group at 6.3mm. [10] These findings are very similar to the 6.18 mm of total inferior change of Pg found by Ellen *et al.* (1998) [14]

The Serbesis-Tsarudis and Pancherz (2008) study found that the horizontal changes in the position of Pg and Co were greater in both the Herbst and control group compared to the elastic group. These results suggest that class II elastics had negative impact on the anterior direction of mandibular growth. However, studies have shown that mandibular growth of untreated class II malocclusions can be 0.4 mm per year less than that of class I mandibular growth. [13] Therefore, the results of this study may imply that the interarch class II elastics did not stimulate (or inhibit) mandibular growth, and that the untreated class I control group exhibited more anterior movement of Pg than the class II elastic treatment group. This study also failed to calculate the P-value to compare the significance of the observed changes between the treatment and control groups.

Dentoalveolar

Only the Uzel *et al.* (2007) study quantified dentoalveolar changes[11]. However, it is worth noting that the treatment group characteristics of the Serbesis-Tsarudis and Pancherz (2008) study included only subjects with ½ cusp class II molar relationships or greater. Since they reported that all subjects were treated to class I occlusion with normal overjet and overbite, one can speculate that this correction was achieved through dentoalveolar compensation, as there were no significant skeletal changes reported to account for this correction.

Significant treatment changes leading to class II correction in the Uzel *et al.* (2007) study included upper incisor retrusion and retroclination and lower incisor protrusion, proclination and intrusion leading to significant decreases in overjet (5.2mm) and overbite (3.5mm). The lower first molar was mesialized and extruded whereas the upper molar remained stable in the vertical and sagittal dimension, but did have a significant 3.5° distal tip. These dentoalveolar changes are also supported by excluded studies that have no control group. [14,16] However, the amount of extrusion of the first molars and mesialization of the lower first molars was greater in the Ellen *et al.* (1998) study.[14]

Soft tissue

Of the two included studies, Soft tissue changes were only recorded in the Uzel *et al.* (2007) study. Of the three recorded measurements, lower lip to E-line, nasolabial angle and labiomental angle, only the latter experienced significant change that resulted in a flattened labiomental fold.

General Considerations

Both of the selected studies had a second treatment group with class II occlusion. One group was treated with a fixed functional appliance (Herbst) and the other with an extra-oral anchorage appliance (RMCC). In both studies, class II elastics required more time to correct the class II malocclusion; 8.5 months versus 4.6 months for the RMCC group and 2.6 years versus 0.6 years for the Herbst group. Please note that the specific duration of class II elastic use was not stated for the 2.6 years of active treatment. In comparing inter-arch class II elastics to the RMCC group, the only statistically significant differences were an increase in the correction of molar relation of 4.5 mm versus 2.0 mm and an increase in the distalization of the first upper molar of 2.3 mm versus 0.3mm. The most significant difference between the Herbst treatment group and the class II elastic group was increased distal movement of the condyle and anterior movement of pogonion. The statistical significance of these differences, however, was not provided.

Mean sample ages of the selected studies were 11.4 ± 1.3 and 12.3 ± 3.1 years. It can be assumed that all or most of the subjects within the sample are, to some extent, growing and therefore, the observed effects of class II elastics in this review extend only to growing individuals. Unknown, is the stage of craniofacial growth of the individuals within the samples. This is important as chronological age is not a perfect predictor of stage of growth. [17] Not knowing the stage of craniofacial growth prevents us from making more precise recommendations regarding treatment timing.

Our review did not find studies whose primary objective was to determine the amount of class II molar correction possible using class II elastics. As previously mentioned, the subjects in the Serbesis-Tsarudis and Pancherz (2008) treatment group where initially ½ cusp class II or greater and were all treated to class I molar relationship. There are three other studies with similar sample characteristics of ½ class II malocclusion or greater and mean ages between 13.7 and 12.2 years were also successful in correcting the malocclusion to class I molar.[12,16,18] This evidence suggests that class II elastics are capable of correcting up to ½ cusp class II molar relationship in individuals who are approximately 12 to 14 years old.

It was found that the description of the elastics used and the method in which the elastics were used was incomplete. The Uzel *et al.* (2007) and the Serbesis-Tsarudis and Pancherz (2008) study described the strength of elastics but not the length/lumen diameter of the elastic or the average length to which the elastics which stretched during treatment. This information is important as it would provide us with the actual force levels generated by the elastics.

The information contained in this review closely reflect the conclusions made by a recently published systematic review on the same topic. [6] One observation/conclusion that is not found in this current review is the extrusion of maxillary incisors. In fact, the Uzel *et al.* (2007) study found that there was 0.6mm more extrusion of the maxillary incisors. Differences in the included studies between the two reviews may account for the variation in observations. The Janson *et al.* (2013) review accepted studies without untreated control groups; whereas, this study did not.[6] This allowed the earlier review to include additional studies that compared the effects of class II interarch elastics to the effects of various class II functional appliances. The authors acknowledge that this is a valuable comparison; however, the goal of the present study was to investigate the effects of class II elastics and the only way to properly accomplish that is to compare a class II treatment group with a comparable class II untreated control group. Prospective clinical trials with well-matched untreated control groups and double blinding are required to better support the findings of the two related systematic reviews.

2.5 Conclusions

The following conclusions are based on only two studies selected for this systematic review. The studies present a moderate risk of bias and therefore the conclusions should be considered with caution.

- Dentoalveolar changes are primarily responsible for class II correction with class II elastics
- Class II elastics can be used to correct up to ½ cusp class II malocclusions in adolescents.
- Class II elastics do not cause changes in sagittal skeletal growth
- An increase in LFH/Pg is the only vertical skeletal change produced by class II elastics.

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Chapter 3 - The Effects of Elastic Size and Archwire Type on 3-Dimensional Force Systems When Using Class II Interarch Elastics

3.1 Introduction

Interarch elastics have been used in the treatment of class II malocclusion since the early 1900's. A recent systematic review has confirmed that class II elastics are effective in the treatment of class II malocclusion up to a ½ cusp correction. [1,2] Despite this longstanding history of success, an optimal treatment protocol regarding the use of class II elastics has yet to be determined. Variables in the treatment protocol include: timing of class II elastic implementation, location and method of elastic anchorage, type and size of archwire used in conjunction with class II elastics, and strength and size of the elastics. Orthodontic experts, such as Proffit and Ricketts, have made recommendations regarding ideal archwire type and elastic type, but little or no evidence has been provided for their conclusions and no research comparing these recommendations to other protocols exist. [3,4]

Side effects that have been attributed to class II elastics include: extrusion of maxillary incisors, mesial tipping and extrusion of mandibular molars, proclination of mandibular incisors, backward rotation of the occlusal plane and mandibular plane and lengthening of the lower 1/3 of the face, and pain and root resorption which are also common to all orthodontic treatments. [5-7] As originally suggested by Angle, light forces have been shown to reduce pain and root resorption, while moving the teeth as fast or faster than heavy forces through a more physiologic stimulation of bone-cells. [8] As a result, optimal forces for class II elastics should be large enough to produce tooth movement, but low enough to reduce potential pain and root resorption. In theory, the ideal protocol for class II elastics would produce only desirable forces that are light and clinically significant while minimizing or eliminating undesirable forces. Attempts have been made to quantify the forces and moments exerted on teeth via orthodontic appliances in hopes of better understanding how these appliances work. Examples include *in vivo* force measurements at single teeth and computer modeling using finite element model analysis. [9-11] However, limitations in measuring devices and overly simplistic models have not allowed for the measurement of force and moment for each individual tooth within the arch simultaneously.

The purpose of this study was to quantitatively compare four combinations of two elastic types and two archwire types on a ½ cusp class II model using a full arch orthodontic simulator device (OSIM) (figure 3-1). The OSIM is capable of measuring three-dimensional forces and moments at each tooth within the arch simultaneously. It was developed by researchers at the University of Alberta and is described in detail by Badawi *et al*. (2009) [12] It has previously been used to compare forces and moments produced by various ligation types on a high canine model and on a lingually displaced incisor model. [13-16]

3.2 Materials and methods

3.2.1 Experimental design

Four treatment groups in a 2x2 design was used to compare the forces and moments of two archwire types (0.014″ nickel titanium (Niti) and 0.019″x0.025″ stainless steel (SS)) and two elastics types (2.0oz and 4.5oz, 3/16” non-latex) when simulating the correction of class II malocclusion.

A pilot study of 10 samples using the SS archwire and 4.5oz elastics and 7 samples using SS archwire and 2.0oz elastics was performed and the My data was used to calculate an appropriate sample size. The power was fixed at 90% and the type I error rate was fixed at 5%.

The difference to be detected among 4 groups was set at 0.2Nmm. The calculation (Appendix B) found a sample size of 44 to be adequate for this study.

3.2.2 Materials and Equipment

A set of Damon Q (ORMCO, Orange CA) maxillary and mandibular 7-7 brackets was used to passively ligate Damon arch form 0.019″x0.025″ SS and 0.014″ Niti archwires on an **O**rthodontic **SIM**ulator (OSIM) device.[12] Ormco 2.0oz and 4.5 oz 3/16" non-latex elastics were stretched between the hooks on the maxillary canines to the hooks on the mandibular first molars to simulate a class II elastic configuration.

The OSIM is a single arch model of a human dentition consisting of 14 load cells representing 14 teeth that is capable 3-dimensional force and moment measurements at each tooth/load cell simultaneously. Each load cell/tooth assembly consists of an 1) aluminum peg to which orthodontic appliances can be bonded and a 2) horizontal (M-631.00 PI, Germany) and a 3) vertical micrometer (M-631.00 PI, Germany) which allows for horizontal and vertical positioning of the pegs. Since the brackets are bonded to the pegs at a distance from the Nano 17 load cell (ATI automation, NC), a coordinate measurement machine (Platinum 4ft FaroArm, Lake Mary, FL) was used to measure the position of each bracket relative to its corresponding load cell. This information was then entered into the custom OSIM software and a Jacobian transformation matrix was used to transform the force systems measured at each load cell into force systems measured at each bracket or point of application. The custom software displayed force and moment data in real time or exported real time measurements into Excel files.

3.2.3 Preparing the OSIM

Alignment of the brackets was accomplished by placing all brackets on a single straight 0.019″x0.025″ SS wire. While engaged on the straight wire all brackets were bonded simultaneously to individual aluminum dowels using Lactate E-60HP Hysol Epoxy (Henkel, Dusseldorf Germany). The bonding surface of the dowels had 5 pre-torqued configurations to account for the torque within the bracket, thereby minimizing the bond thickness (figure 3-2).

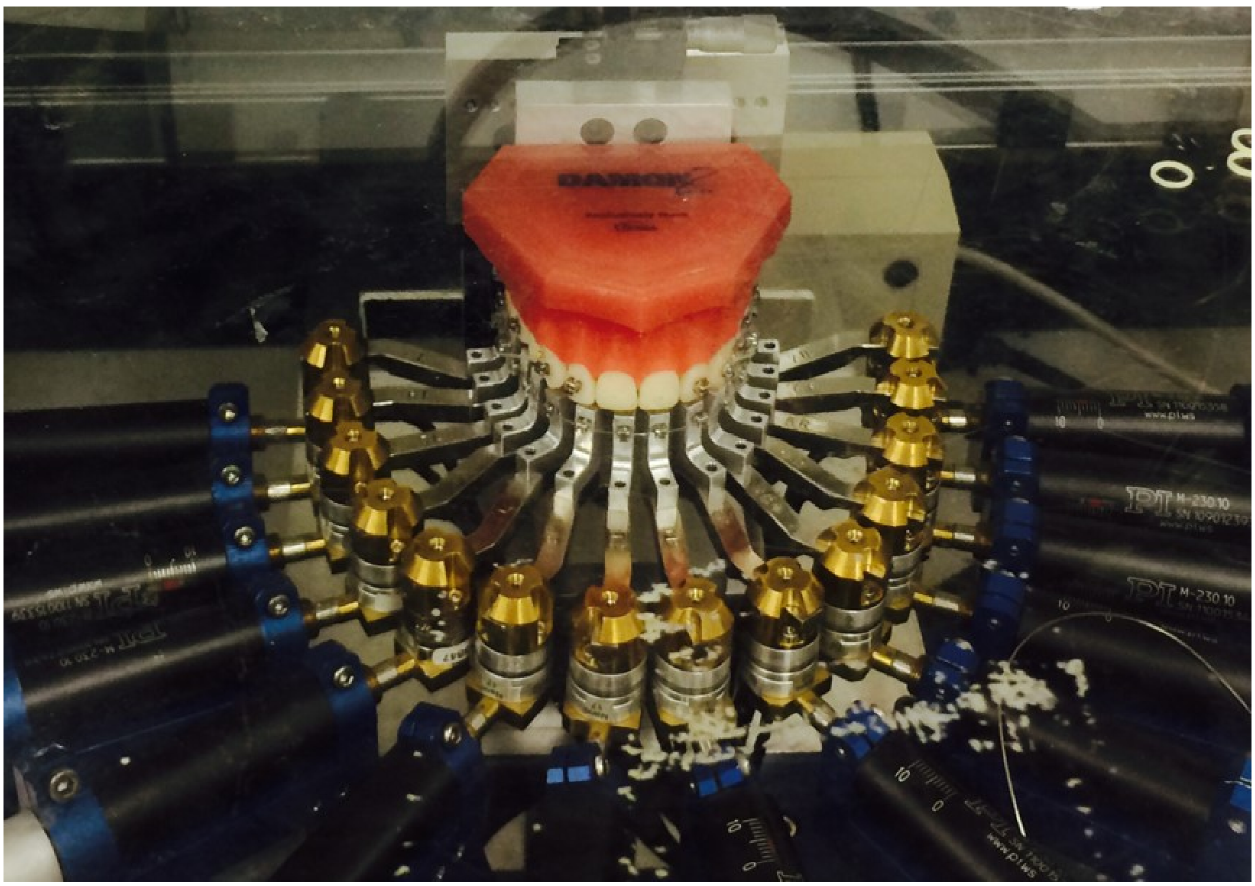

Figure 3- 1: OSIM in Plexiglas chamber set up for measurement of the mandibular arch

The dowels were attached to the OSIM and the 0.019″x0.025″ SS arch wire was used to align the pegs for rotations prior to final tightening of the dowels. An acrylic Odontoform of Damon arch form was affixed to a mounting jig capable of vertical and horizontal (side to side and front to back) movements. The mandibular odontoform was positioned over the OSIM to replicate a 1/2 cusp class II malocclusion with the opposing first molars oriented directly vertical to each other (figure 3-3). The vertical distance between opposing brackets was calculated based on 3mm of anterior opening which translates to 1.5 mm opening in the posterior (2:1 ratio). [3,17] To ensure that the position of the odontoform relative to the OSIM was consistent with a true ½ cusp class II malocclusion, a dual arch odontoform was fixed into a ½ cusp class II malocclusion and the coordinate measurement machine (Platinum 4ft FaroArm, Lake Mary, FL) was used to measure the distance between the post on the maxillary canine to the hook on the mandibular first molar. This measurement was consistent with distance measured between the maxillary canine and mandibular first molar when the odontoform was setup in ½ cusp class II relationship with the OSIM.

Figure 3- 2: Brackets bonded to aluminum dowels

.

The OSIM was placed in a Plexiglas chamber and warmed to 37 degrees Celsius for at least 1.5 hours (Figure 3-1). The micrometers were leveled and aligned by eye and a maxillary 0.019″x0.025″ SS wire was placed into the bracket slots. The bracket doors were then closed and the position of the micrometers were adjusted until force outputs (Fx, Fy and Fz) were below 0.10N and moment outputs (Mx, My and Mz) were below 3.0Nmm. When testing of the 0.019″x0.025″ SS wire was complete, a 0.014″ Niti archwire was prepared for testing using the same procedure performed with the 0.019″x0.025″ SS wire. Detailed descriptions of force and moment directions are provided in Table 3-1 and Figure 3-4

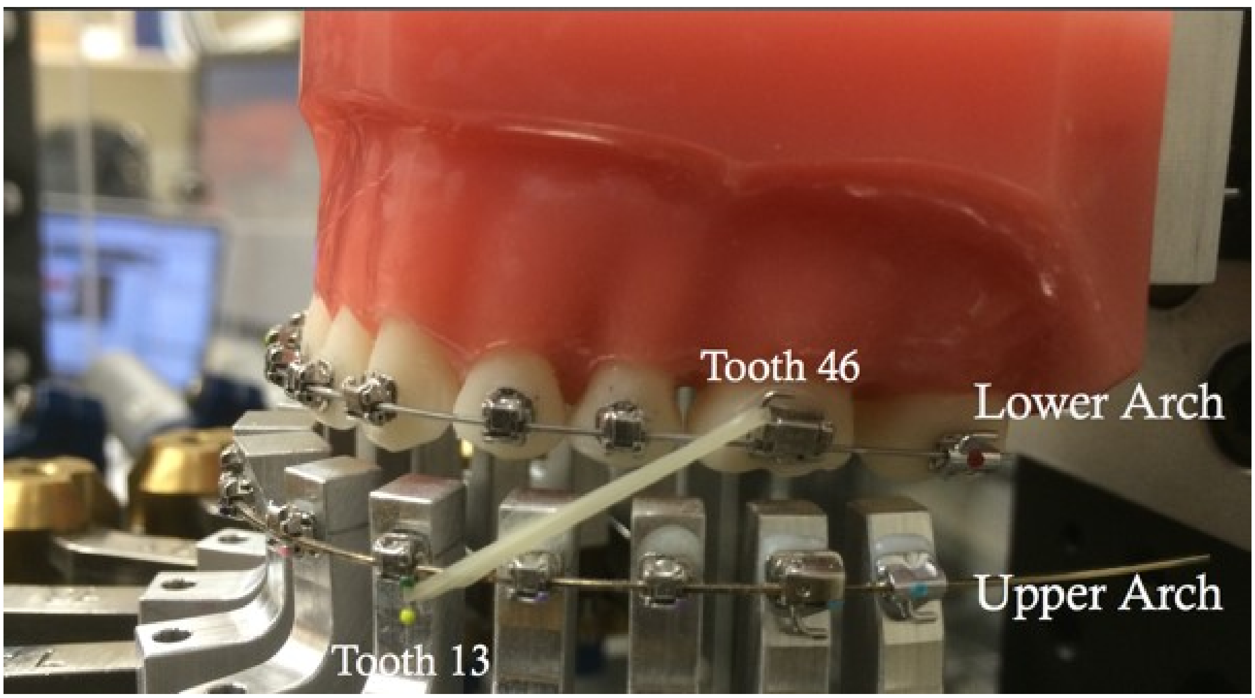

Figure 3- 3: OSIM setup for testing of maxillary arch with 0.019” x 0.025”

Preparation of the OSIM for the mandibular arch testing involved the same procedures identified for the maxillary archwires, except that a mandibular odontoform was replaced by a maxillary odontoform and the brackets were bonded on the dowels right-side up.

Direction	Fx	Fy	Fz	Mx	My	Mz
Positive	Distal	Buccal	Occlusal	Lingual Crown Tip	Mesial Crown Tip	Mesial in/Distal out rotation
Negative (-)	Mesial	Lingual	Gingival	Buccal Crown Tip	Distal Crown Tip	Distal in/Mesial out rotation

Table 3- 1: Description and direction of forces and moments

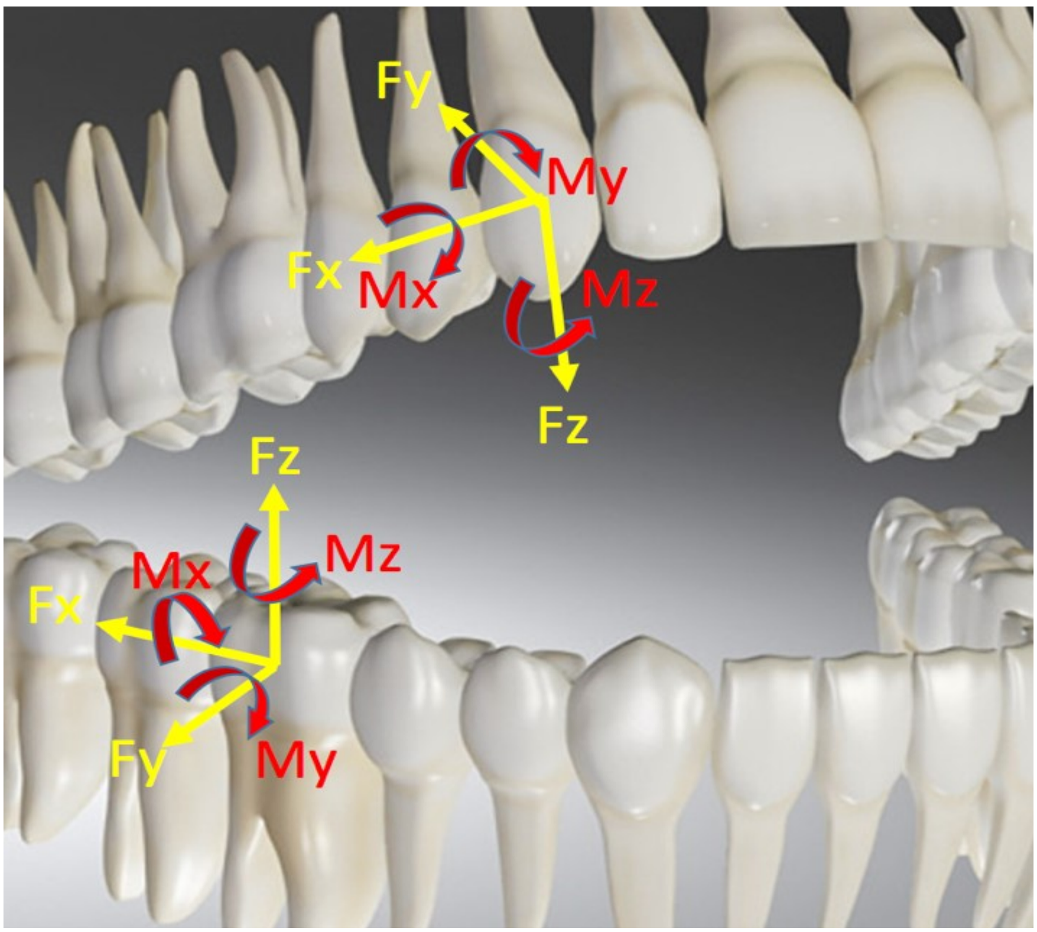

Figure 3- 4: Three-dimensional diagram of forces and moments

3.2.4 Testing

The sequence of testing light and heavy elastics was randomly generated. Each trial involved the following steps: 1) Micrometers were zeroed 2) 100 baseline measurements were recorded over a period of approximately 3 seconds 3) 1 new, unused elastic were attached between the hooks on the maxillary 3 and mandibular 6 on both the right and left side 4) 100 experimental measurements were recorded over a period of approximately 3 seconds 5) The elastics were removed and discarded.

44 LE samples and 44 HE samples were tested on both the SS and Niti archwires for both the maxillary and mandibular arch.

3.2.5 Statistical Analysis

Statistical analysis was carried out using IBM's SPSS v22 software with a statistical significance level of $\alpha = 0.05$. Repeated measures multivariate analysis of variance (MANOVA) was used to determine mean differences in forces (Fx, Fy and Fz) and moments (My) between the four treatment groups for each tooth. Assumptions testing involved box plots and Kolmogorov-Smirnov test to test for normal distribution of the data and Box's M test for equality of covariance matrices. Despite a lack of normal distribution and a significant Box's M test, we continued with the repeated measures MANOVA as it is robust to violations in normality if the sample sizes are large and of equal size. A Tamhane correction was used during post hoc testing.

3.3 Results

3.3.1 Minimum Clinical Threshold for Tooth Movement

Due to the large amount of data collected using OSIM, only clinically significant loads of interest are reported here. Full force and moment data for all teeth are provided in Appendix B-E. Clinically effective torque has been reported to be 5-20Nmm, whereas minimum force for tipping is suggested to be 0.35N. [3,18-20] Therefore, for inclusivity, we selected the minimum threshold for clinical relevance to be 0.3N for forces and 5Nmm for moments.

The only teeth to measure clinically relevant forces and moments were teeth that directly anchored the class II elastics, upper canines and lower first molars. The exception was tooth 2.4 that measured slightly over the clinical threshold for Fy at -0.32N and -0.39N for Niti-heavy elastic (NitiH) and SS-heavy elastic (SSH) groups respectively.

3.3.2 Maxillary Canines

Table 3-2 provides force and moment measurements for the maxillary canines. Figure 3-5, 3-6, 3-7 and 3-8 graphically displays Fx, Fy, Fz and My for all maxillary teeth.

Variable	Tooth	NitiH Mean (SD)	SSH Mean (SD)	Mean Difference [95% C.I.]	NitiL Mean (SD)	SSL Mean (SD)	Mean Difference [95% C.I.]
Fx (N)	13	**1.24** (0.15)	1.12 (0.11)	0.12 (p<.001) [.06 , .18]	0.48 (0.05)	0.43 (0.07)	0.05 (p=.141) [-.01 , .11]
	23	1.5 (0.17)	1.56 (0.13)	0.06 (p=.150) [-.12 , .01]	0.56 (0.06)	0.54 (0.06)	0.01 (*p>.99*) [-.05 , .08]
Fy (N)	13	-0.43 (0.08)	**-0.78** (0.22)	*0.35 (p<.001)* *[-.44 , -.27]*	*-0.13** *(0.04)*	*-0.13** *(0.18)*	0.01 (*p>.99*) [-.08 , .09]
	23	-0.41 (0.07)	**-0.62** (0.13)	*0.21 (p<.001)* *[-.27 , -.11]*	*-0.11** *(0.02)*	*-0.19** *(0.16)*	*0.08 (p=.005)* *[.02 , .14]*
	24	-0.32 (0.04)	**-0.39** (0.14)	*0.07 (p=.005)* *[-.13 , -.02]*	*-0.15** *(0.02)*	*-0.13** *(0.13)*	*0.02 (p>.99)* *[-.03 , .08]*
Fz (N)	13	1.12 (0.15)	1.07 (0.10)	0.05 (p=.106) [-.01 , .10]	0.36 (0.04)	0.41 (0.06)	0.05 (p=.118) [-.10 , .01]
	23	**0.89** (0.11)	0.81 (0.08)	0.08 (p<.001) [.04 , .12]	0.30 (0.03)	*0.26** *(0.06)*	0.05 (p=.026) [.00 , .09]
Mx (Nmm)	13	*0.69* *(0.13)*	*1.17* *(0.16)*	0.48 (p<.001) [.55 , .41]	*0.09* *(0.06)*	*0.23* *(0.12)*	*0.13 (p<.001)* *[.06 , .20]*
	23	*0.07* *(0.10)*	*0.38* *(0.31)*	0.31 *(p<.001)* *[.21 , .42]*	*-0.01* *(0.11)*	*0.15* *(0.14)*	*0.16 (p=.05* *[.05 , .27])*
My (Nm)	13	-8.40 (1.04)	-8.44 (0.79)	0.04 (p>.99) [-.45 , .36]	*-2.72** *(0.30)*	-3.02* (0.45)	*0.31 (p=.262)* *[-.10 , .71]*
	23	-4.91 (0.64)	-4.73 (0.46)	0.17 (p=.331) [-.41 , .07]	*-1.59** *(0.17)*	*-1.41** *(0.24)*	*0.19 (p=235)* *[-.05 , .43]*
Mz (Nmm)	13	*-2.73* *(0.50)*	-5.77 (2.98)	3.05 *(p<.001)* [2.09 , 4.00]	-0.80 (0.24)	-0.95 (1.43)	*0.14 (p>.99)* *[-.81 to 1.09]*
	23	*-0.23* *(0.31)*	*-1.08* *(0.91)*	0.85 *(p<.001)* *[.49 , 1.21]*	0.29 (0.07)	-0.79 (0.81)	*1.09 (p<.001)* *[.73 , 1.45]*

Bold Text = Statistically larger (p<.05)
*Italics** = Below clinical significance

Table 3- 2: Mean values and mean differences for clinically significant findings from the maxillary arch. Clinical significance is 0.3N for force (Fx, Fy, Fz) and 5Nmm for moment (Mx, My, Mz).

Fx

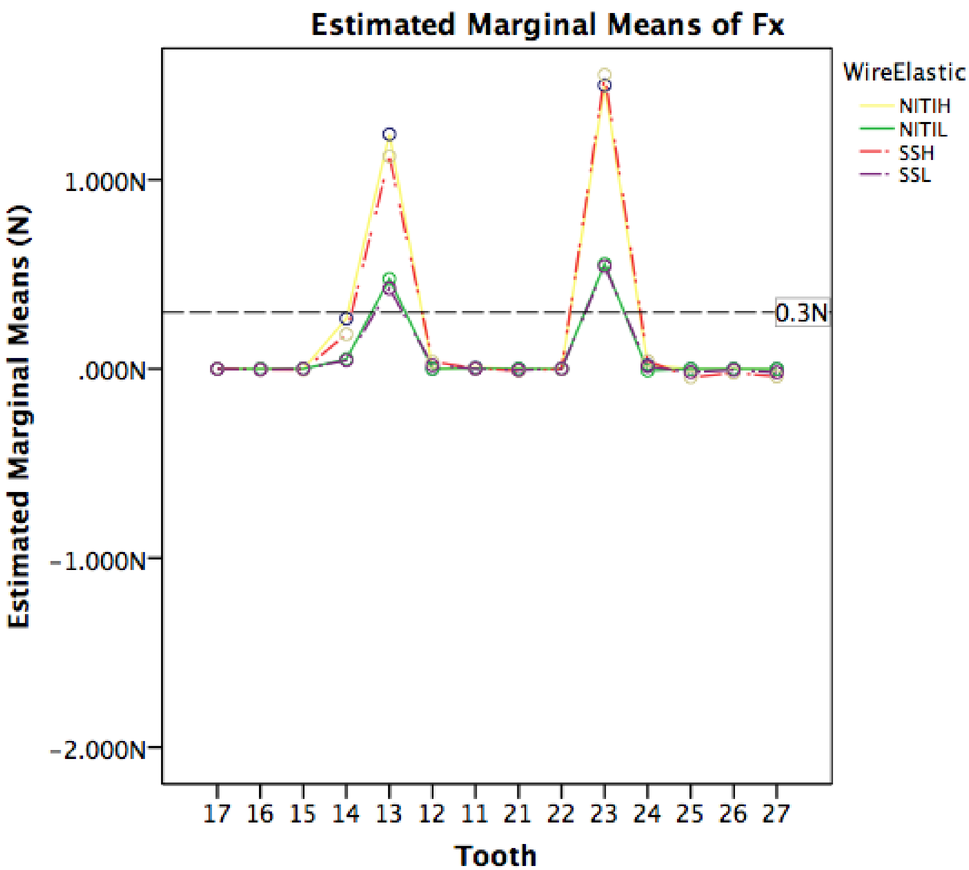

Figure 3- 5: Mean values of Fx on the maxillary arch for NitiL, NitiH, SSL and SSH test groups.

All measures for Fx at tooth 1.3 and tooth 2.3 were distalizing forces in the range of 1.55N to 1.12N for the 4.5oz/heavy elastic (HE) groups and 0.55N to 0.42N for the 2.0oz/light elastic (LE) groups. (Figure 3-3)

Within the HE groups, Niti produced a statistically significant larger distalizing force at the 1.3 compared to SS ($p<.001$), whereas at tooth 2.3, SS did not produce a significantly larger ($p=.150$) distalizing force.

The LE groups were not statistically different at 1.3 ($p=.141$) or 2.3 ($p=1.0$).

Fy

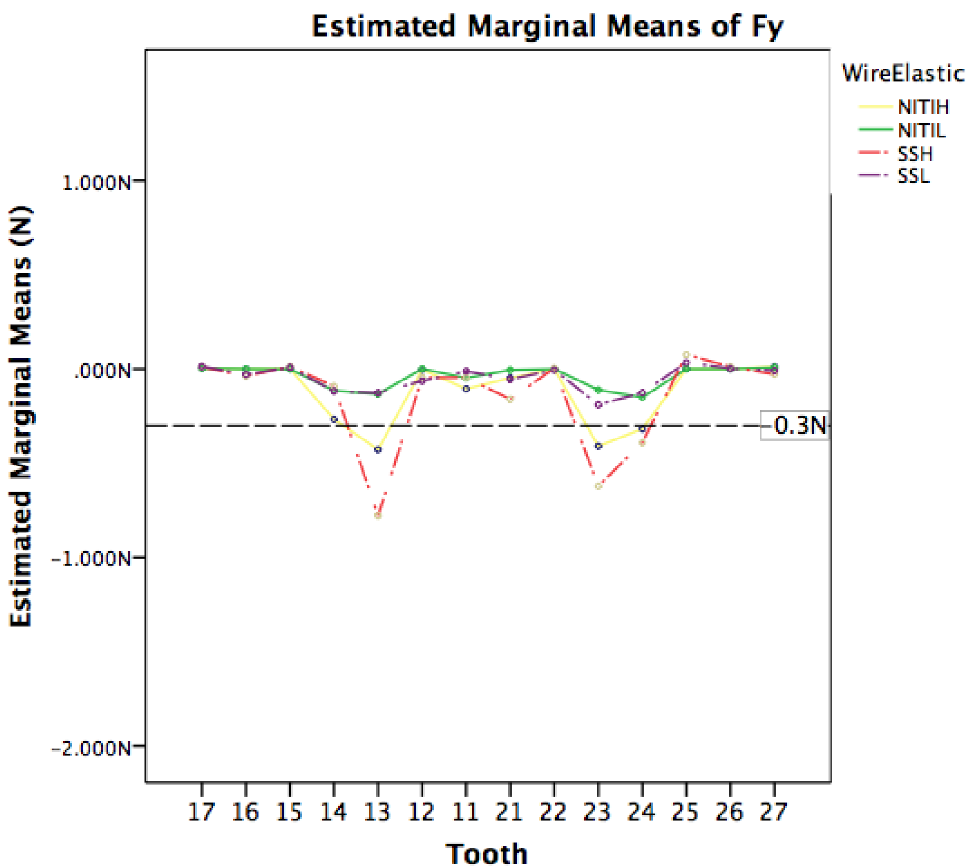

Figure 3- 6: Mean values of Fy on the maxillary arch for NitiL, NitiH, SSL and SSH test groups

All measures for Fy at 1.3, 2.3 and 2.4 were negative and in the lingual direction (Figure 3-4). When using HE, the SS archwire produced significantly larger forces compared to Niti at tooth 1.3 (p<.001)], tooth 2.3 (p<.001)] and tooth 2.4 (p=.005)]. There were no clinically significant outputs for Fy when using LE.

Fz

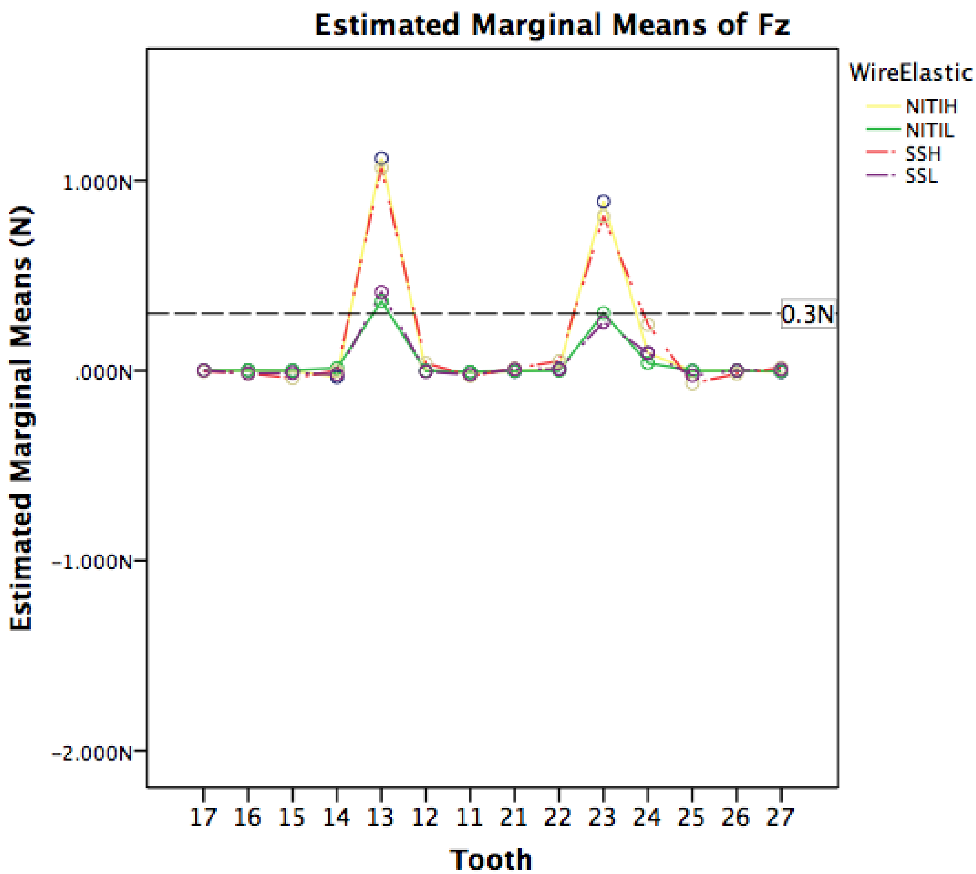

Figure 3- 7: Mean values of Fz on the maxillary arch for NitiL, NitiH, SSL and SSH test groups

Fz is the vertical force measured in the occluso-gingival direction. Occlusal is positive and gingival is negative. For all groups, Fz at 1.3 and 2.3 was positive and in the occlusal direction. (Figure 3-5) The mean difference [.08N] between Niti and SS was only statistically significant ($p<.001$) at tooth 2.3 with HE.

My

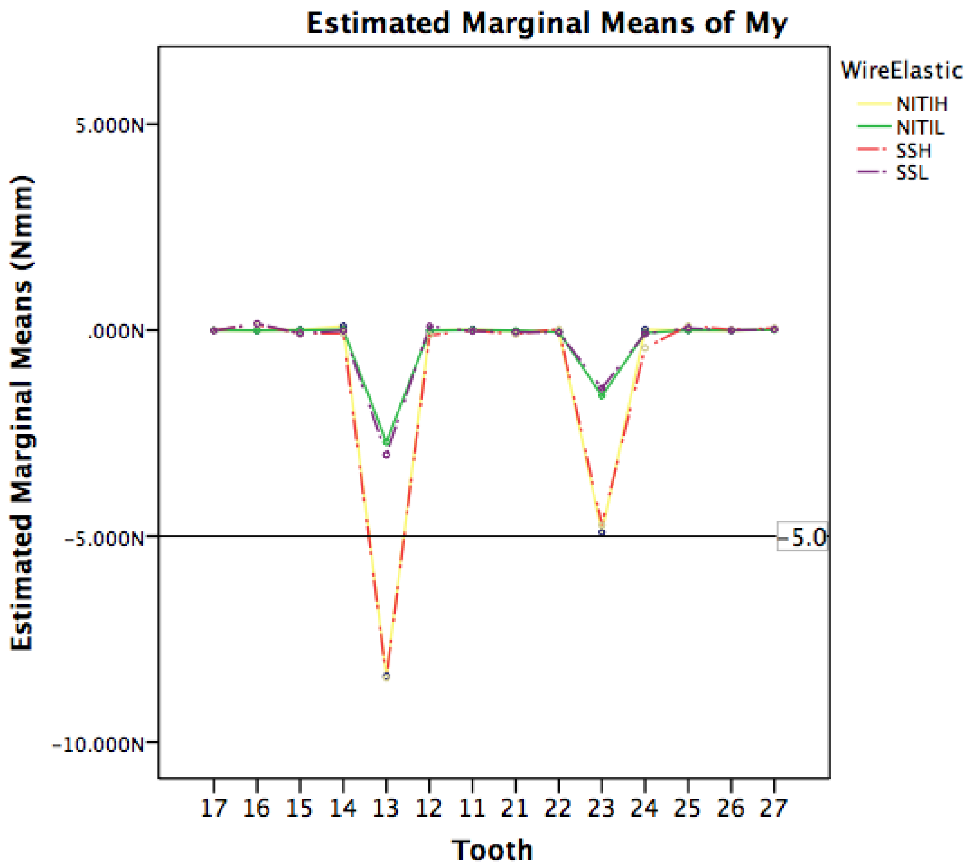

Figure 3- 8: Mean values of My on the maxillary arch for NitiL, NitiH, SSL and SSH test groups

My is the moment of mesial-distal tipping. Mesial crown tip is positive and distal crown tip is negative. For all groups, My at 1.3 and 2.3 was negative due to distal crown tipping. (Figure 3-6) Only the HE groups produced clinically significant moments above the 5Nmm threshold. My was significantly larger (p=0.049) with SS compare to Niti archwire, but not significant for tooth 2.3.

Table 3-3 provides force and moment measurements for the mandibular first molars.

Figure 3-9, 3-10, 3-11 and 3-12 graphically displays Fx, Fy, Fz and My for all mandibular teeth.

3.3.3 Mandibular First Molars

Variable	Tooth	NitiH Mean (SD)	SSH Mean (SD)	Mean Difference [95% C.I.]	NitiL Mean (SD)	SSL Mean (SD)	Mean Difference [95% C.I.]
Fx (N)	**46**	-1.58 (0.08)	-1.56 (0.14)	0.09 (*p>.99*) [-.07 to .03]	-0.54 (0.05)	-0.54 (0.04)	-0.01 (*p>.99*) [-.06 to .04]
	36	**-1.60** (0.08)	-1.53 (0.13)	-0.08 (p<.001) [-.12 to -.03]	-.55 (.04)	-0.52 (0.05)	-0.03 (p=.441) [-.08 to .02]
Fy (N)	**46**	-0.21 (0.01)	**-0.34** (0.04)	-0.14 (p<.001) [-.15 to -.12]	-0.07* (0.01)	-0.13* (0.02)	0.06 (p<0.001) [-.08 to -.05]
	36	-0.33 (0.06)	**-0.76** (0.11)	-0.43 (p<.001) [-.47 to -.39]	-0.12* (0.02)	-0.24* (0.05)	0.12 (p<0.001) [-.47 to -/39]
Fz (N)	**46**	**1.16** (0.06)	1.07 (0.11)	0.10 (p<0.001) [.06 to .14]	0.38 (0.04)	0.35 (0.04)	0.03 (p=.326) [-.01 to .07]
	36	1.09 (0.10)	1.07 (0.10)	0.03 (p=.838) [-.02 .07]	0.37 (0.04)	0.39 (0.06)	0.02 (p=.982) [-.02 to .07]
Mx (Nmm)	**46**	5.27 (0.37)	5.19 (0.51)	0.09 (*p>.99*) [-.15 to .32]	*1.72* *0(.47)*	*1.76* *(0.26)*	0.03 (*p>.99*) [-.27 to .20]
	36	*-0.88* *(0.24)*	*-0.34* *(0.15)*	0.53 (p<0.001) [.63 to .4.3]	*-.34* *(0.14)*	*-.31* *(0.16)*	0.04 (*p>.99*) [-.14 to .07)]
My (Nmm)	**46**	6.14 (0.32)	**6.44** (.60)	0.30 (p=.001) [.09 to .50]	2.09* (.19)	2.23* (0.20)	0.14 (p=.51) [-.426 to -3.84]
	36	**4.27** (0.26)	4.04 (0.35)	0.23 (p<.001) [.09 to .37]	1.39* (0.13)	1.31* (0.19)	0.08 (p=.732) [-.06 to .22]
Mz (Nmm)	**46**	*2.46* *(0.13)*	3.27 (0.33)	0.52 (p<0.001) [.63 to .41]	*1.04* *(0.09)*	*1.27* *(0.12)*	0.23 (p<0.001) [.34 to .12]
	36	*-0.19* *(0.12)*	*0.12* *(0.10)*	0.31 (p<0.001) [.37 to .26]	-0.05 (0.05)	0.05 (0.11)	0.11 (p<0.001) [.16 to .05]

Bold Text = Statistically larger (p<.05)
*Italics** = Below clinical significance

Table 3 - 3: Mean values and mean differences for clinically significant findings from the mandibular arch. Clinical significance is 0.3N for force (Fx, Fy, Fz) and 5Nmm for moment (Mx, My, Mz).

Fx

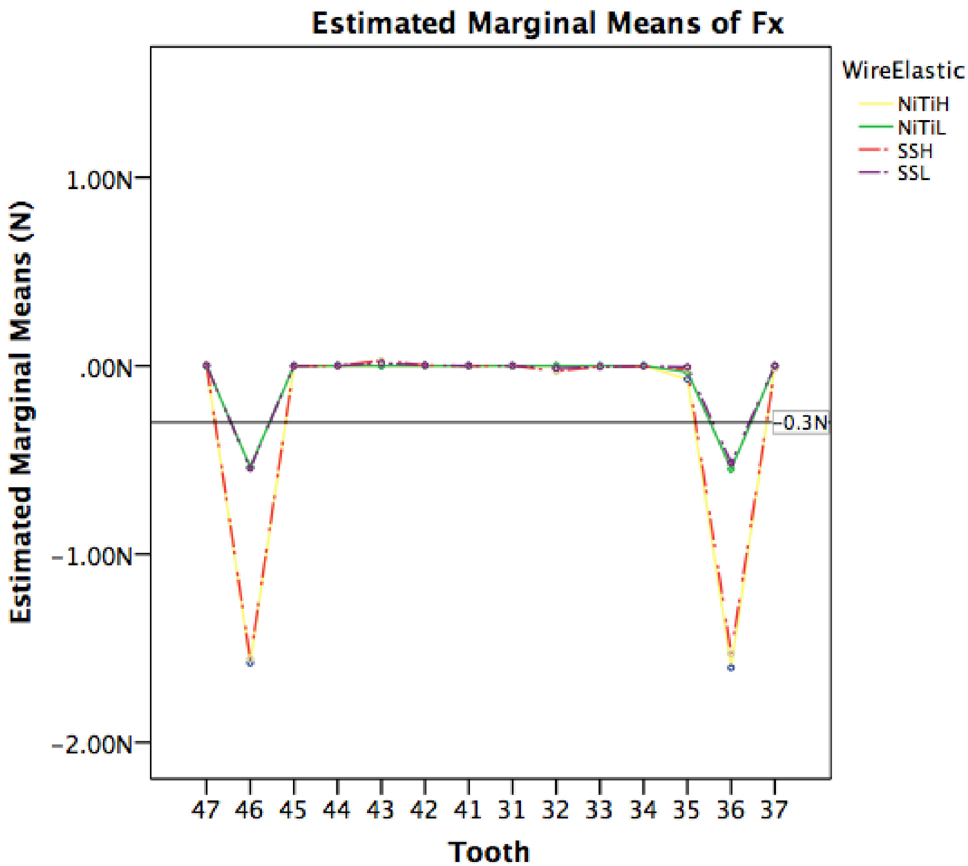

Figure 3- 9: Mean values of Fx on the mandibular arch for NitiL, NitiH, SSL and SSH test groups

Values for Fx were clinically significant for both HE and LE at 3.6 and 4.6 in the mesial direction. (Figure 3-7) Fx was only significantly larger at tooth 36 with Niti wire compared to SS wire ($p<0.001$).

Fy

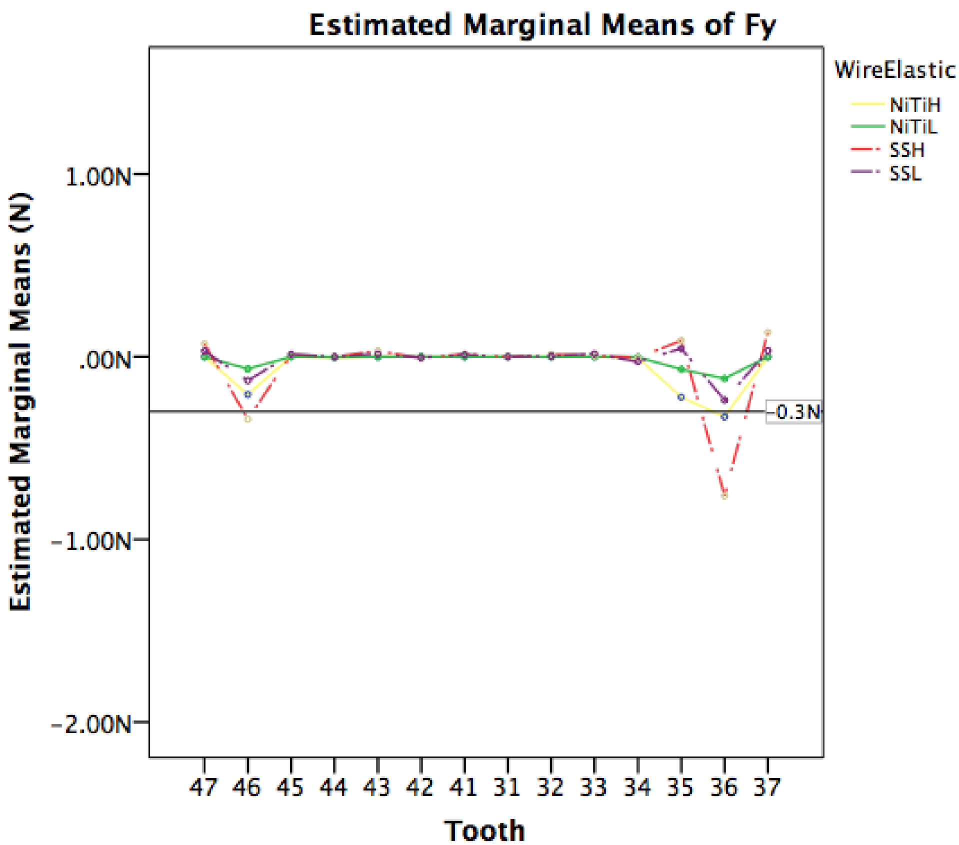

Figure 3- 10: Mean values of Fy on the mandibular arch for NitiL, NitiH, SSL and SSH test groups

The negative values of Fy on the mandibular dentition indicate a lingually directed force. The only clinically significant Fy outputs on the mandibular arch occurred at 3.6 and 4.6 when using HE. (Figure 3-8) Values for LE at 3.6 and 4.6 were larger with SS compared with Niti wire ($p<0.001$).

Fz

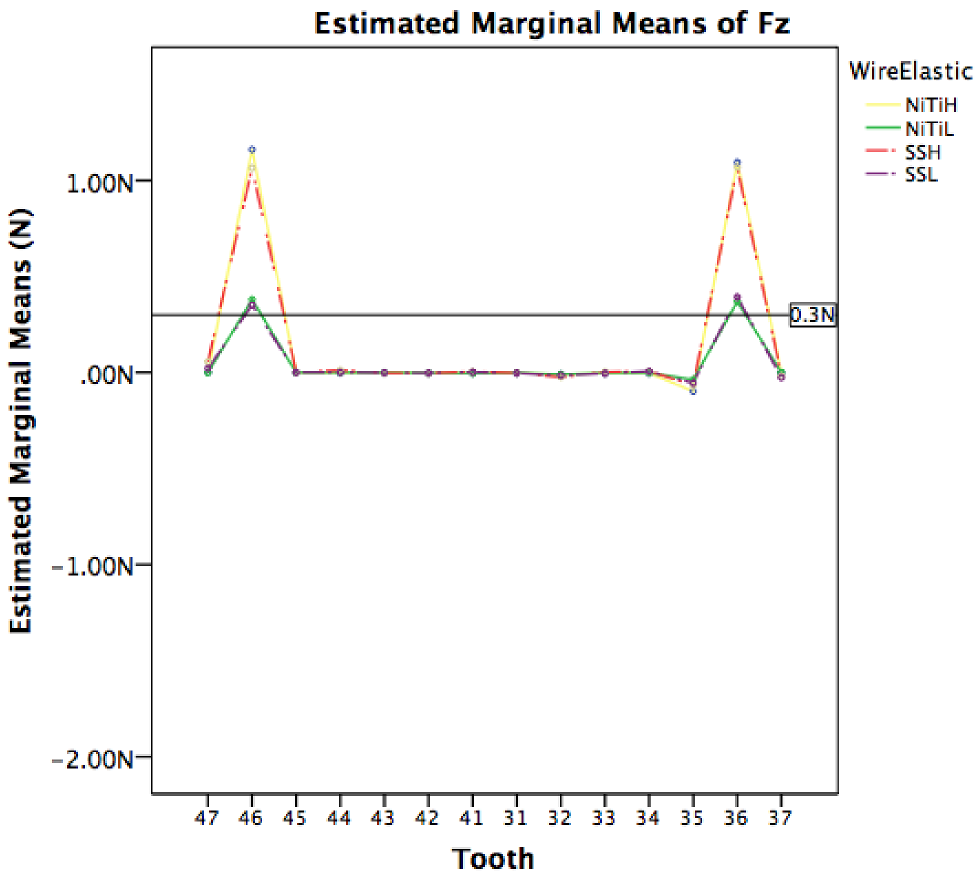

Figure 3- 11: Mean values of Fz on the mandibular arch for NitiL, NitiH, SSL and SSH test groups

Positive values for Fz at 36 and 46 indicate an occlusal direction of force for all groups. (Figure 3-9) Both HE and LE produced clinically significant forces at 3.6 and 4.6. Tooth 4.6 showed significantly larger Fz with Niti wire compared with SS wire ($p<0.001$), however significant difference was not identified for tooth 3.6 ($p=0.838$).

My

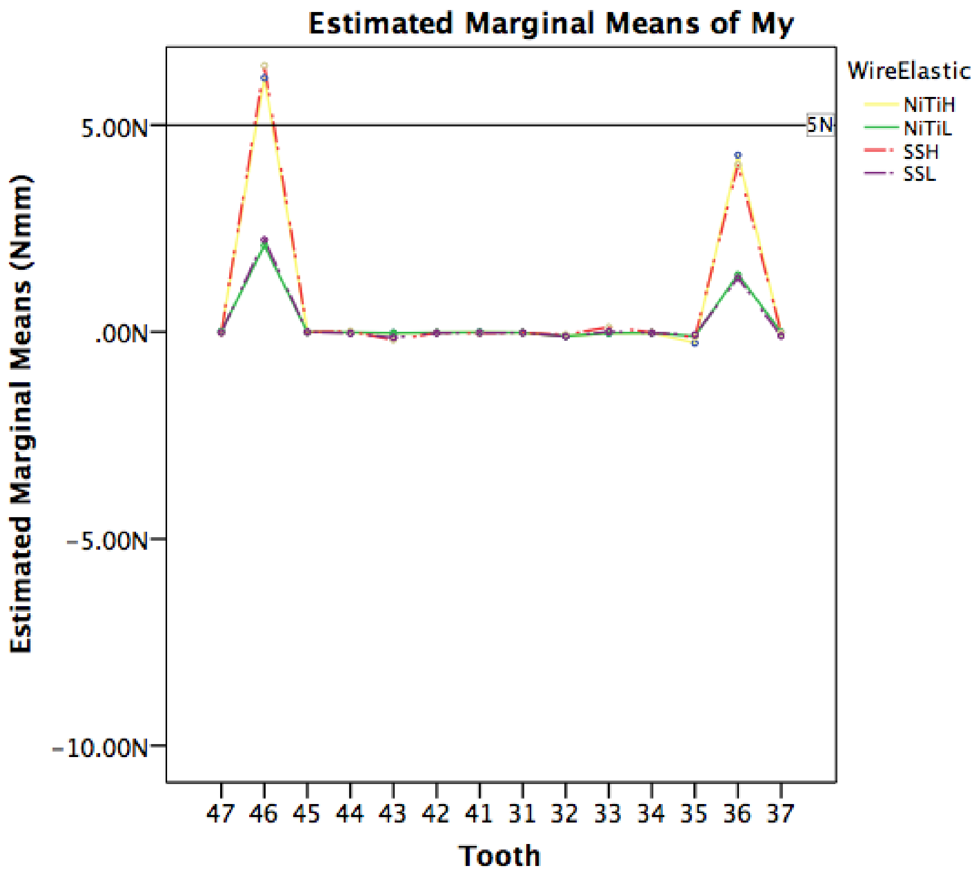

Figure 3- 12: Mean values of My on the mandibular arch for NitiL, NitiH, SSL and SSH test groups

Positive values for My at 3.6 and 4.6 indicate a mesial crown tipping moment for all groups. (Figure 3-10) Clinically significant moments were only observed at 4.6 when using HE with SS producing a statistically significant larger force than Niti (p=.001).

3.4 Discussion and Clinical Implications

It is well established that class II elastics are an effective tool used for the correction of class II malocclusions, however, evidence pertaining to an optimal protocol for the use of class II elastics is weak or non-existent.[2,17] There are no known clinical trials that attempt to directly compare any two protocols based on timing of elastic implementation, strength or size of elastics, location of elastic anchorage or types of archwires used. The best protocols we have are guidelines based solely on expert opinion. The current study is an attempt to provide the practitioner with quantitative data related to two possible class II elastic protocols. The specific protocols used for this study were selected in an attempt to study and compare the more extreme boundaries of class II elastic use. A 0.014″ Niti is often the smallest and lightest wire in an orthodontists' armamentarium, whereas a 0.019″x0.025″ SS is often the largest and most rigid. In the same fashion, 2oz elastics are often the lightest and 4.5oz are often the heaviest used during class II correction. As such, protocols using materials with properties intermediary to those used in this study will hypothetically produce results that lie within our data.

There were many trends in our data that are worthy of highlighting. Although the magnitudes varied slightly, the general trends observed at the upper canines and lower first molars were similar. The largest magnitude of force for all groups was the horizontal force along the archwire (Fx) in a distal direction for upper canines and mesial direction for lower first molars. This is reassuring because the goal of class II elastics is to correct an anterior-posterior discrepancy between the dental arches. Similar to Fx in magnitude was Fz, the vertical component of force in the occlusal or extrusive direction. This data confirms that the vertical component of force, which is often considered an unwanted side effect of class II elastics, is a reasonable concern and must be accounted for during treatment planning of patients presenting with minimal overjet and vertical growth tendencies. One such option is the use of a posterior bite block that may help control eruption of the molars while allowing the extrusive forces on the upper canines to express. This vertical force could also be beneficial in the correction of deep bites or when an increase in maxillary incisal display is desirable.

When heavy elastics were used, there was a trend for reduced extrusive effects of class II elastics in both the upper canines and lower first molars with SS archwires. However, this difference was only statistically significant on one side with a mean difference of 0.1N. 0.1N is well below our minimum level of force for clinical significance of 0.3N.

Both heavy and light Class II elastics resulted in clinically relevant lingual tipping forces (Fy) for NiTi as well as SS wire. However, the force was close to the clinically relevant threshold with light elastics and may not represent a clinical concern. Lingual tipping force (Fy) was significantly higher with SS wire when using heavy elastics. This effect may limit the ability of the archwire to expand the arch width during class II correction.

Mandibular molar mesial crown tipping (Fx) and maxillary distal crown tipping force (Fx) was clinically significant for heavy elastics, but not with light elastics. Based on these results, unwanted mesial crown tipping of the mandibular first molar and unwanted distal crown tipping of the maxillary canine can be avoided with light elastics.

When light elastics were used, SS and Niti archwire produced statistically similar results for each output variable. The lone exception being Fz at 2.3 for which Niti has weak statistical evidence ($p=.026$) for being larger than SS with a mean difference of only .05N. The meaning of this significant result at 2.3 is minimized by results at 1.3 which show a larger Fz (but not statistically significant) force for SS compared to Niti with the same mean difference of 0.05N. Also, despite the statistical significance, the mean difference of only 0.05N is not clinically significant. Therefore, we will assume that Niti and SS archwire produce similar forces for all output variables when using light elastics.

Unlike heavy elastics, light elastics did not produce clinically significant values for every output variable. LE's only produced clinically significant values at Fx and Fz which means that LE's may reduce lingual tipping (Fy) or mesial-distal tipping (My). The clinically significant values for Fx and Fz were approximately 1N less than the values produced by heavy elastics. Since the lowest effective force is desirable, using light elastics appears to be advantageous over heavy elastics, as it eliminates the lingual force and mesial-distal tipping moment while producing a minimal yet clinically effective force at Fz and most importantly Fx.

It is readily apparent when analysing the force and moment figures that there are asymmetries in the the data when comparing the same tooth on the left and right sides of the arch. If the model was setup perfectly symmetrical one would expect the two sides to be mirror images of each other. Since the data is asymmetric, we can assume that our model is slightly asymmetric. Perhaps the odontoform was not centered perfectly in relation to the opposing OSIM arch. This can change the angle at which the elastic is anchored which will change the direction of the applied force. Imperfect placement of the odontoform could also result in asymmetric distances between the anchor teeth, which could result in an asymmetry in the applied forces due to differential length of elastic stretch. Another possible explanation for the asymmetry in the data could be due to the location of the wire within the bracket slot when the OSIM is zeroed. Since the brackets are passive ligation, it is possible that the wire is sitting passively within the bracket slot but it is biased towards one of the internal walls of the bracket. When a force is applied, the bracket might engage the wire earlier compared to the contralateral tooth that has received the same applied force. The tooth that engages the wire first will produce a lower force reading as some of the force is being transferred to the wire.

To test the effects of odontoform position in relation to the OSIM, a sensitivity test was performed by moving the odontoform laterally to the left and to the right by 1mm and 2mm from center when using the SS archwire and heavy elastics. Appendix G contains the pairwise comparisons for the lateral sensitivity test where outputs for teeth 13 and 23 at 1mm and 2mm lateral deviations are compared to the center (0mm) position. Appendix H is a table of pairwise comparisons of the outputs of teeth 13 and 23 from the main study data. The asymmetries observed between 13 and 23 in the experimental data (Appendix H) are similar to the mean differences at 13 and 23 when there is a lateral deviation of 2mm (Appendix G). For example, the mean difference between teeth 13 and 23 at Fx was .43N for the experimental data. Whereas, the mean difference between center position and a 2mm deviation was .59N. This shows that a deviation in the position of the odontoform could at least partially explain the side to side asymmetries observed within a single arch. This test modified the position of the odontoform in one plane only. Realistically the position of the odontoform could be off from center in all 3 planes of space which would have an even greater impact on the symmetry of the data. However, the observed asymmetries in this tightly controlled *in vitro* experiment are minor compared to the dynamic oral environment where asymmetries in both form and function are the norm, not the exception.

In summary, when heavy elastics are used, both Nit and SS produce clinically significant forces for the desirable Fx vector and similar moments for My. However, SS minimizes the vertical Fz component while Niti minimizes the lingual horizontal component Fy. Therefore, the most appropriate choice of archwire to use with heavy elastics will depend largely on the treatment goals of each specific case. Archwire type has no effect on the measured outcomes for light elastics. This suggests that light elastics can be used on any archwire during treatment and have similar effects. light elastics minimizes Fy and My below clinical relevance while producing Fx and Fz forces that are only slightly above the clinical threshold for tooth movement thereby facilitating a more physiologic tooth movement which is believed to reduce root resorption and pain.[7]

3.5 Limitations of Study

As with any *in vitro* study, one must be mindful when applying the results to an *in vivo* model. This *in vitro* model lacks many important elements that constitute the natural human oral environment. Such elements include: the lubricating and elastic degrading effects of saliva; the forces created by the oral musculature; the continuously changing relationship between the dental arches due to movement of the mandible and the forces of occlusion, and most importantly, the movement of the teeth as a result of the applied orthodontic forces. This model represents a snapshot in time before orthodontic movement has occurred. Once tooth movement occurs, the system has changed and as a result the force systems will change. One would expect that as teeth begin to move and the bracket begins to engage and deflect the archwire, the type of archwire will have a greater effect on the propagation of forces throughout the arch. The more rigid, full dimension archwire will engage the bracket earlier in tooth movement and will disperse the forces from the class II elastics more readily to the adjacent teeth. The smaller, less rigid archwire will deflect much more easily and will transfer less force to the adjacent teeth as a tooth moves. This could be problematic if this movement is unwanted.

The malocclusion for this model is a well-aligned ½ cusp class II. This is a good representation of a clinical scenario where dimensional SS archwires would be used, but rarely are light Niti archwires used in a well-aligned dentition. Also, specific to this model are the brand and slot dimension of the brackets; the material type, dimension and arch form of the wires, and the size and strength of the elastics. It is not known how changing any of these variables would affect the result. However, our results suggest that archwire type and dimension have little effect when LE are used, so one could assume that any wire between an 0.014″ and 0.019″x0.025″ dimension with load defection curves that fall between Niti and SS would produce similar results in our test model.

The accuracy of the OSIM limits our ability to make precise conclusions or clinical recommendations. The error of the transducers for force is 1% at a range of +/- 25N. The error for moment is 1.75% at a range of +/-250Nmm. That is an error of +/- 0.025N for force and +/- 4.38Nmm for moment. The error in force measurement is less than 10% of the clinically relevant value for tooth movement. This is an adequate level of precision for the purposes of this study. The error in moment measurement is almost 90% of the clinically relevant value for tooth movement. As such, it may be wise to use the moment data to observe trends within the overall data opposed to detailed comparisons of the mean values.

A final noteworthy limitation is that the OSIM lacks interproximal contacts between pegs. Without interproximal contact, horizontal forces in the direction of the long axis of the archwire (Fx) are less likely to propagate throughout the arch. For this reason, values for Fx at the elastic anchor teeth could be inflated while values at neighboring teeth could be minimized.

3.6 Conclusions

An orthodontic simulator was used to simultaneously measure forces and moments at each individual tooth within a ½ cusp class II malocclusion model to quantitatively compare two class II elastic sizes and two archwire types. Within this model, both heavy and light elastics produced clinically sufficient horizontal forces along the archwire to move the teeth towards a class I relationship. SS archwire minimized the vertical extrusive effects of HE's. Archwire type had no effect when using light elastics which suggests that light class II elastics may be used on light archwire without consequence. However, this study describes the initial forces and moments and does not predict how the teeth will move once the initial tooth positions have changed.

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Chapter 4 – General Discussion

4.1 Final Discussion

Orthodontists strive to treat patients in the most efficient manner possible while maximizing functional, occlusal and esthetic goals and minimizing side effects, such as pain and root resorption. Although optimum force levels have yet to be determined, there is a well-established causal link between the magnitude of force and the rate of tooth movement, pain and root resorption. Oesterle *et al.* (2012) argues that a universal "sweet spot" for orthodontic forces may not exist due to the inherent anatomical and physiological differences that exist not only between individual patients, but also between individual teeth within a patient's mouth.[1] As such, Angle's suggestion that light forces should be used to facilitate tooth movement and minimize the potential for adverse side effects hold true 100+ years after its conception.[2]

Class II elastics are a commonly used treatment option for the correction of class II malocclusion.[3] Our systematic review of the literature concluded that class II elastics are an effective option for the correction of up to a ½ cusp class II malocclusion. However, there are no evidence based protocols for class II elastics that take into account the actual magnitude and direction of forces placed on the teeth.[1] The fabrication of an *in vitro* orthodontic simulator (OSIM) has allowed us to measure the initial 3D forces and moments experienced by teeth within a full dental arch simultaneously and in real-time while using four combinations of class II elastics and archwires.[4] It was found that both light (2oz) and heavy (4.5oz) elastics produced clinically significant forces to distalize and extrude the upper canines and to mesialize and extrude the lower first molars; however, the values for light elastics were approximately 1N less than heavy elastics. To minimize the potential side effects of heavy forces, this data may encourage the practitioner to opt for the lighter elastics. In regards to archwire, there were no statistical differences between archwire types (0.014 NiTi and 0.019 x 0.025 SS) when using light elastics. Since archwire appears to have no effect on the force systems generated by light elastics, the use of light elastics early in treatment while using light archwire can be rationalized. Pitts reasons that elastics should be started when patient compliance is greatest, which is early in treatment. [5] When using heavy elastics, the larger SS archwire statistically reduced the extrusive force on the upper canines and lower first molars. This should caution the practitioner to limit the use of heavier class II elastics while on light archwires, especially when the treatment goals do not include extrusion of the upper canines or lower first molars.

4.2 Recommendations and Future Research

To reduce the laborious task of manually zeroing the OSIM, a software program could be developed that would allow the OSIM to perform an automated self-zeroing procedure. If this procedure can be completed quickly, efficiently and accurately the time required for data collection would be reduced. An automated zeroing capability may also allow for the addition of tooth-to-tooth interproximal contacts, which may otherwise be impossible to zero manually. The addition of interproximal contacts to the OSIM would greatly increase the accuracy to which the OSIM model comports with reality. In the current OSIM model, a force applied to a single tooth in the X axis (Fx, along the long axis of the archwire) will not transfer any force to the adjacent teeth, except for a minor amount of friction from the archwire.

The current study measures only the initial force systems produced by an appliance. An interesting exercise would be to follow in the footsteps of Drescher *et al.* (1991) to use the data from the OSIM and input it into an FEM analysis to theorize how the teeth will move. [6] The teeth on the OSIM could then be moved accordingly and the force systems measured again.

Using this method, the correction of the malocclusion could be followed to completion. This would allow us to compare the treatment results and treatment efficiency of various appliances.

Finally, to reduce time spent moving data between spreadsheets and to minimize potential user errors, a program capable of populating a single spreadsheet with the mean outputs of all samples within a single group could be developed.

Future research related to this project could involve the study and quantification of alternative configurations of class II elastic use. For example, a triangle configuration (upper canines to lower second premolars and first molars) or a box configuration (upper canines and first premolars to lower second premolars and first molars) for class II elastics could be compared to the, upper canine to lower first molar, configuration that was used in this study. Various other class II correctors (Forsus, Twin Force, Wilson Distalizer, etc.) could be tested and quantified using the OSIM.

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Appendix A – Search Strategy for Systematic Review.

Database	Search Strategy	Total
PubMed	class[All Fields] AND (ii[All Fields] OR 2[All Fields]) AND (elastic[All Fields] OR elastics[All Fields] OR ("rubber"[MeSH Terms] OR "rubber"[All Fields]) OR ("elastomers"[MeSH Terms] OR "elastomers"[All Fields] OR "elastomer"[All Fields])) AND ("malocclusion"[MeSH Terms] OR "malocclusion"[All Fields]) OR ((elastic[All Fields] OR elastics[All Fields] OR ("rubber"[MeSH Terms] OR "rubber"[All Fields]) OR ("elastomers"[MeSH Terms] OR "elastomers"[All Fields] OR "elastomer"[All Fields])) AND (class[All Fields] AND (ii[All Fields] OR 2[All Fields]))) AND (("overbite"[MeSH Terms] OR "overbite"[All Fields] OR "overjet"[All Fields]) OR "angle class ii"[All Fields] OR "Malocclusion, Angle Class II"[Mesh])	152
Ovid/Embase	((class II.mp. OR Class 2.mp.) OR (overbite.mp. OR overjet.mp.)) AND (elastic*.mp OR exp latex/ OR rubber*.mp OR elastomer*.mp) AND malocclusion.mp.	158
SCOPUS	TITLE-ABS-KEY(class AND (ii OR 2) AND (elastic* OR rubber* OR elastomer*) AND (malocclusion OR overjet OR overbite))	217
Cochrane	class and 2 and elastic and malocclusion class and ii and elastic and malocclusion	21

Appendix B – Sample Size Calculation

The sample size was estimated based on pilot data. My for tooth 1.3 with SS archwire & light elastic (7 trials) as well as tooth 1.3 with SS archwire & heavy elastic (10 trials). The power was fixed at 90% and type I error rate was fixed at 5%. The My difference among 4 groups to be detected was set at least 0.2Nmm. The minimum sample size was 44 per group is estimated from the Table 3.4.1 on page 71 of the text book, Sample size calculations in clinical research.[1]

References

1. Chow S, Shao J, Wang H. Table 3.4.1. In: *Sample size calculations in clinical research.* CRC Press. Taylor & Francis Group; 2003:71.

Appendix C- Descriptive data for the maxillary arch for NitiH, NitiL, SSH and SSL groups for all measured outputs (Fx, Fy, Fz, Mx, My and Mz).

- Fx, Fy and Fz measured in Newton's (N)
- Mx, My and Mz measured in Newton-millimeters (Nmm)

WireElastic		N	Minimum	Maximum	Mean	Std. Deviation
NITIH	Fx17	44.00	.00	.00	.00	.00
	Fy17	44.00	.00	.01	.00	.00
	Fz17	44.00	-.01	.01	.00	.00
	Mx17	44.00	-.26	.24	.02	.15
	My17	44.00	-.07	.06	.00	.03
	Mz17	44.00	-.09	.12	.01	.06
	Fx16	44.00	.00	.00	.00	.00
	Fy16	44.00	.00	.00	.00	.00
	Fz16	44.00	-.01	.01	.00	.00
	Mx16	44.00	-.09	.19	.05	.08
	My16	44.00	-.07	.03	-.01	.02
	Mz16	44.00	-.07	.02	-.01	.02
	Fx15	44.00	.00	.00	.00	.00
	Fy15	44.00	-.03	.02	.00	.01
	Fz15	44.00	-.02	.01	.00	.01
	Mx15	44.00	-.92	.56	-.03	.30
	My15	44.00	-.02	.04	.01	.02
	Mz15	44.00	-.02	.08	.02	.03
	Fx14	44.00	.05	.48	.27	.08
	Fy14	44.00	-.42	-.09	-.27	.08
	Fz14	44.00	-.16	.09	-.03	.07
	Mx14	44.00	-.24	.49	.13	.22
	My14	44.00	-.13	.45	.10	.13
	Mz14	44.00	-.49	.79	.25	.32
	Fx13	44.00	.46	1.42	1.24	.15
	Fy13	44.00	-.57	-.13	-.43	.08
	Fz13	44.00	.35	1.28	1.12	.15
	Mx13	44.00	.12	.89	.69	.13
	My13	44.00	-9.49	-2.67	-8.40	1.04
	Mz13	44.00	-3.79	-.84	-2.73	.50
	Fx12	44.00	-.01	.01	.00	.00
	Fy12	44.00	-.04	.00	.00	.01
	Fz12	44.00	.00	.00	.00	.00
	Mx12	44.00	-.16	.14	-.06	.06
	My12	44.00	-.24	.13	-.01	.04
	Mz12	44.00	-.37	.23	.00	.07

Fx11	44.00	.00	.02	.01	.00
Fy11	44.00	-.15	.00	-.11	.03
Fz11	44.00	-.03	.01	-.01	.01
Mx11	44.00	-.98	.40	-.33	.32
My11	44.00	-.05	.07	.02	.03
Mz21	44.00	-.02	.29	.20	.07
Fx21	44.00	.00	.01	.00	.00
Fy21	44.00	-.08	.00	-.05	.02
Fz21	44.00	-.01	.00	.00	.00
Mx21	44.00	-.21	.11	-.06	.07
My21	44.00	-.05	.03	-.02	.01
Mz21	44.00	-.02	.10	.04	.03
Fx22	44.00	.00	.00	.00	.00
Fy22	44.00	.00	.00	.00	.00
Fz22	44.00	-.01	.03	.01	.01
Mx22	44.00	-.60	.28	-.15	.15
My22	44.00	-.15	.11	-.04	.04
Mz22	44.00	-.02	.05	.01	.02
Fx23	44.00	.58	1.75	1.50	.17
Fy23	44.00	-.50	-.12	-.41	.07
Fz23	44.00	.33	1.09	.89	.11
Mx23	44.00	-.19	.35	.07	.10
My23	44.00	-6.16	-1.71	-4.91	.64
Mz23	44.00	-1.07	.39	-.23	.31
Fx24	44.00	-.02	.14	.02	.03
Fy24	44.00	-.40	-.16	-.32	.04
Fz24	44.00	-.01	.16	.09	.04
Mx24	44.00	-.46	.14	-.06	.12
My24	44.00	-.18	.17	.02	.09
Mz24	44.00	-.71	-.23	-.59	.09
Fx25	44.00	.00	.00	.00	.00
Fy25	44.00	.00	.00	.00	.00
Fz25	44.00	-.01	.00	.00	.00
Mx25	44.00	-.33	.13	-.02	.09
My25	44.00	-.03	.02	.00	.01
Mz25	44.00	-.03	.02	.00	.01
Fx26	44.00	.00	.01	.00	.00
Fy26	44.00	-.01	.01	.00	.00
Fz26	44.00	-.01	.02	.00	.00
Mx26	44.00	-.31	.28	-.02	.16
My26	44.00	-.36	.21	-.01	.09
Mz26	44.00	-.34	.18	-.01	.08
Fx27	44.00	-.01	.00	.00	.00
Fy27	44.00	.00	.02	.01	.00
Fz27	44.00	-.01	.00	-.01	.00
Mx27	44.00	-.45	.50	-.02	.26
My27	44.00	-.20	.27	.03	.13

	Mz27	44.00	-.12	.22	.04	.09
NITIL	Fx17	44.00	.00	.00	.00	.00
	Fy17	44.00	.00	.01	.00	.00
	Fz17	44.00	-.01	.01	.00	.00
	Mx17	44.00	-.22	.25	.01	.16
	My17	44.00	-.06	.06	.00	.03
	Mz17	44.00	-.09	.09	.00	.06
	Fx16	44.00	.00	.00	.00	.00
	Fy16	44.00	.00	.00	.00	.00
	Fz16	44.00	-.01	.01	.00	.00
	Mx16	44.00	-.11	.36	.06	.09
	My16	44.00	-.04	.03	-.01	.02
	Mz16	44.00	-.04	.04	-.01	.02
	Fx15	44.00	.00	.00	.00	.00
	Fy15	44.00	-.02	.01	.00	.01
	Fz15	44.00	-.02	.01	.00	.00
	Mx15	44.00	-.74	.50	-.06	.28
	My15	44.00	-.07	.05	.00	.02
	Mz15	44.00	-.07	.12	.01	.03
	Fx14	44.00	-.01	.10	.05	.02
	Fy14	44.00	-.20	-.05	-.11	.04
	Fz14	44.00	-.02	.06	.01	.02
	Mx14	44.00	-.21	.22	-.04	.09
	My14	44.00	-.08	.12	.02	.05
	Mz14	44.00	-.33	.32	.00	.19
	Fx13	44.00	.38	.60	.48	.05
	Fy13	44.00	-.20	-.07	-.13	.04
	Fz13	44.00	.28	.44	.36	.04
	Mx13	44.00	-.03	.23	.09	.06
	My13	44.00	-3.52	-1.99	-2.72	.30
	Mz13	44.00	-1.30	-.40	-.80	.24
	Fx12	44.00	.00	.00	.00	.00
	Fy12	44.00	-.01	.01	.00	.00
	Fz12	44.00	.00	.00	.00	.00
	Mx12	44.00	-.19	.16	-.05	.08
	My12	44.00	-.05	.06	-.01	.02
	Mz12	44.00	-.04	.08	.00	.02
	Fx11	44.00	.00	.01	.00	.00
	Fy11	44.00	-.08	.00	-.05	.02
	Fz11	44.00	-.02	.01	-.01	.01
	Mx11	44.00	-.96	.52	-.25	.33
	My11	44.00	-.08	.08	.00	.04
	Mz21	44.00	-.07	.24	.09	.06
	Fx21	44.00	.00	.00	.00	.00
	Fy21	44.00	-.03	.02	-.01	.01
	Fz21	44.00	.00	.00	.00	.00
	Mx21	44.00	-.18	.10	-.07	.06
	My21	44.00	-.07	.02	-.01	.01
	Mz21	44.00	-.06	.05	.00	.02
	Fx22	44.00	.00	.00	.00	.00
	Fy22	44.00	.00	.00	.00	.00

	Fz22	44.00	-.01	.01	.00	.01
	Mx22	44.00	-.43	.21	-.18	.14
	My22	44.00	-.12	.08	-.05	.04
	Mz22	44.00	-.02	.05	.01	.02
	Fx23	44.00	.45	.67	.56	.06
	Fy23	44.00	-.16	-.04	-.11	.02
	Fz23	44.00	.24	.38	.30	.03
	Mx23	44.00	-.26	.25	-.01	.11
	My23	44.00	-1.92	-1.31	-1.59	.17
	Mz23	44.00	.17	.54	.29	.07
	Fx24	44.00	-.02	.01	-.01	.01
	Fy24	44.00	-.18	-.12	-.15	.02
	Fz24	44.00	.00	.07	.04	.02
	Mx24	44.00	-.29	.13	-.02	.10
	My24	44.00	-.15	.02	-.07	.03
	Mz24	44.00	-.39	-.24	-.33	.03
	Fx25	44.00	.00	.00	.00	.00
	Fy25	44.00	.00	.00	.00	.00
	Fz25	44.00	.00	.00	.00	.00
	Mx25	44.00	-.17	.12	-.02	.08
	My25	44.00	-.02	.02	.00	.01
	Mz25	44.00	-.03	.03	.00	.01
	Fx26	44.00	.00	.00	.00	.00
	Fy26	44.00	.00	.00	.00	.00
	Fz26	44.00	-.01	.01	.00	.00
	Mx26	44.00	-.22	.25	-.01	.14
	My26	44.00	-.11	.11	.00	.06
	Mz26	44.00	-.10	.10	.00	.05
	Fx27	44.00	-.01	.01	.00	.00
	Fy27	44.00	.00	.02	.01	.00
	Fz27	44.00	-.01	.01	.00	.00
	Mx27	44.00	-.41	.42	-.01	.26
	My27	44.00	-.21	.24	.01	.14
	Mz27	44.00	-.13	.19	.02	.09
SSH	Fx17	44.00	-.01	.01	.00	.00
	Fy17	44.00	-.03	.03	.01	.02
	Fz17	44.00	-.02	.01	.00	.01
	Mx17	44.00	-.15	.28	.05	.13
	My17	44.00	-.07	.09	.00	.04
	Mz17	44.00	-.15	.15	-.01	.08
	Fx16	44.00	-.01	.01	.00	.00
	Fy16	44.00	-.06	.00	-.04	.02
	Fz16	44.00	-.10	.01	-.01	.04
	Mx16	44.00	-3.95	.28	-.72	1.48
	My16	44.00	-.08	.76	.14	.25
	Mz16	44.00	-.14	.71	.08	.25
	Fx15	44.00	-.02	.07	.00	.02
	Fy15	44.00	-.03	.08	.01	.02
	Fz15	44.00	-.08	.02	-.04	.02
	Mx15	44.00	-.90	.46	-.07	.30
	My15	44.00	-.38	.01	-.08	.11

	Mz15	44.00	.00	.13	.05	.03
	Fx14	44.00	.02	.37	.18	.08
	Fy14	44.00	-.28	.43	-.09	.18
	Fz14	44.00	-.21	.19	.00	.08
	Mx14	44.00	-.24	.49	.23	.15
	My14	44.00	-.27	.19	-.08	.09
	Mz14	44.00	-.60	.38	.13	.24
	Fx13	44.00	.90	1.54	1.12	.11
	Fy13	44.00	-1.28	-.51	-.78	.22
	Fz13	44.00	.88	1.33	1.07	.10
	Mx13	44.00	.85	1.55	1.17	.16
	My13	44.00	-10.43	-7.09	-8.44	.79
	Mz13	44.00	-13.79	-3.19	-5.77	2.98
	Fx12	44.00	-.10	.20	.04	.07
	Fy12	44.00	-.13	.15	-.05	.07
	Fz12	44.00	-.07	.15	.04	.05
	Mx12	44.00	-.28	.38	-.10	.14
	My12	44.00	-.58	.45	-.12	.23
	Mz12	44.00	-2.14	2.12	.76	.83
	Fx11	44.00	-.01	.01	.00	.01
	Fy11	44.00	-.19	.04	-.05	.05
	Fz11	44.00	-.10	.04	-.03	.03
	Mx11	44.00	-.93	.55	-.25	.31
	My11	44.00	-.11	.14	-.01	.05
	Mz21	44.00	-.07	.41	.09	.11
	Fx21	44.00	-.06	.06	-.01	.03
	Fy21	44.00	-.34	.07	-.16	.08
	Fz21	44.00	-.06	.07	.01	.02
	Mx21	44.00	-.37	.26	-.11	.13
	My21	44.00	-.26	.08	-.10	.06
	Mz21	44.00	-1.79	2.31	.42	.86
	Fx22	44.00	-.02	.02	.00	.01
	Fy22	44.00	-.12	.11	.00	.04
	Fz22	44.00	-.01	.13	.05	.04
	Mx22	44.00	-.54	.19	-.15	.19
	My22	44.00	-.14	.19	.03	.08
	Mz22	44.00	-.06	.13	.03	.04
	Fx23	44.00	1.32	1.94	1.55	.13
	Fy23	44.00	-1.10	-.38	-.62	.13
	Fz23	44.00	.66	1.06	.81	.08
	Mx23	44.00	-.24	1.05	.38	.31
	My23	44.00	-5.86	-3.98	-4.73	.46
	Mz23	44.00	-3.39	.43	-1.08	.91
	Fx24	44.00	-.04	.08	.04	.03
	Fy24	44.00	-.67	-.03	-.39	.14
	Fz24	44.00	.07	.44	.24	.08
	Mx24	44.00	-.40	.24	-.08	.16
	My24	44.00	-.84	.25	-.43	.25
	Mz24	44.00	-2.68	.03	-.81	.63
	Fx25	44.00	-.16	.07	-.04	.05
	Fy25	44.00	-.07	.33	.08	.08

	Fz25	44.00	-.23	.02	-.07	.05
	Mx25	44.00	-.08	.51	.17	.13
	My25	44.00	-.54	.67	.11	.30
	Mz25	44.00	-1.60	.44	-.33	.50
	Fx26	44.00	-.13	.01	-.02	.04
	Fy26	44.00	-.01	.03	.01	.01
	Fz26	44.00	-.09	.03	-.02	.03
	Mx26	44.00	-.35	.33	-.02	.18
	My26	44.00	-.16	.18	.02	.08
	Mz26	44.00	-.19	.18	-.01	.09
	Fx27	44.00	-.14	.04	-.04	.05
	Fy27	44.00	-.08	.02	-.03	.03
	Fz27	44.00	-.03	.07	.01	.02
	Mx27	44.00	-.57	.47	-.04	.29
	My27	44.00	-.18	.35	.05	.13
	Mz27	44.00	-.20	.41	.10	.12
SSL	Fx17	44.00	-.01	.00	.00	.00
	Fy17	44.00	-.01	.03	.01	.01
	Fz17	44.00	.00	.01	.00	.00
	Mx17	44.00	-.19	.42	.05	.15
	My17	44.00	-.08	.03	-.01	.03
	Mz17	44.00	-.15	.11	-.02	.07
	Fx16	44.00	-.02	.00	.00	.00
	Fy16	44.00	-.05	-.01	-.03	.01
	Fz16	44.00	-.16	.02	-.02	.05
	Mx16	44.00	-6.51	.22	-.80	1.74
	My16	44.00	-.04	1.17	.16	.31
	Mz16	44.00	-.07	1.08	.11	.30
	Fx15	44.00	-.02	.01	.00	.01
	Fy15	44.00	-.01	.06	.01	.02
	Fz15	44.00	-.07	.03	-.01	.02
	Mx15	44.00	-.59	.39	-.10	.26
	My15	44.00	-.48	.04	-.08	.15
	Mz15	44.00	-.05	.11	.01	.04
	Fx14	44.00	.00	.10	.05	.02
	Fy14	44.00	-.22	.08	-.12	.10
	Fz14	44.00	-.07	.04	-.02	.02
	Mx14	44.00	-.23	.17	.02	.09
	My14	44.00	-.24	.24	-.01	.07
	Mz14	44.00	-.13	.50	.14	.09
	Fx13	44.00	.32	.59	.43	.07
	Fy13	44.00	-.51	.09	-.13	.18
	Fz13	44.00	.31	.54	.41	.06
	Mx13	44.00	.04	.54	.23	.12
	My13	44.00	-4.06	-2.35	-3.02	.44
	Mz13	44.00	-4.46	.55	-.95	1.43
	Fx12	44.00	-.28	.11	.02	.06
	Fy12	44.00	-.20	.20	-.06	.11
	Fz12	44.00	-.10	.06	-.01	.04

Mx12	44.00	-.59	.34	-.03	.15
My12	44.00	-.23	.41	.09	.15
Mz12	44.00	-1.05	3.99	-.21	.88
Fx11	44.00	-.01	.01	.00	.00
Fy11	44.00	-.11	.04	-.01	.03
Fz11	44.00	-.08	.02	-.02	.02
Mx11	44.00	-.72	.70	-.22	.32
My11	44.00	-.10	.07	-.02	.04
Mz21	44.00	-.23	.22	.02	.07
Fx21	44.00	-.10	.03	-.01	.02
Fy21	44.00	-.16	.03	-.06	.04
Fz21	44.00	-.01	.03	.01	.01
Mx21	44.00	-.33	1.18	-.07	.21
My21	44.00	-.11	.04	-.05	.03
Mz21	44.00	-.62	2.40	.16	.40
Fx22	44.00	-.01	.02	.00	.01
Fy22	44.00	-.10	.06	-.01	.03
Fz22	44.00	-.02	.06	.01	.02
Mx22	44.00	-.62	.12	-.23	.17
My22	44.00	-.20	.05	-.06	.06
Mz22	44.00	-.13	.13	.01	.05
Fx23	44.00	.41	.71	.54	.06
Fy23	44.00	-.49	.18	-.19	.16
Fz23	44.00	.08	.39	.26	.06
Mx23	44.00	-.12	.49	.15	.14
My23	44.00	-2.06	-.73	-1.40	.24
Mz23	44.00	-2.25	.63	-.79	.81
Fx24	44.00	-.02	.08	.01	.02
Fy24	44.00	-.47	.04	-.13	.13
Fz24	44.00	-.01	.25	.09	.06
Mx24	44.00	-.39	.14	-.08	.12
My24	44.00	-.51	.43	-.08	.16
Mz24	44.00	-1.84	.56	-.26	.48
Fx25	44.00	-.30	.08	-.02	.05
Fy25	44.00	-.07	.26	.03	.06
Fz25	44.00	-.17	.03	-.03	.04
Mx25	44.00	-.18	.45	.02	.12
My25	44.00	-.31	.59	.05	.21
Mz25	44.00	-1.21	.80	-.14	.37
Fx26	44.00	-.07	.02	-.01	.01
Fy26	44.00	-.02	.02	.00	.01
Fz26	44.00	-.04	.03	.00	.02
Mx26	44.00	-.24	.42	-.01	.16
My26	44.00	-.25	.16	.00	.08
Mz26	44.00	-.14	.09	-.01	.06
Fx27	44.00	-.19	.04	-.02	.03
Fy27	44.00	-.09	.04	-.01	.02
Fz27	44.00	-.02	.05	.01	.01

Mx27	44.00	-.43	.32	-.02	.24
My27	44.00	-.19	.40	.02	.11
Mz27	44.00	-.16	.36	.02	.09

Appendix D- Pairwise Comparisons for the Maxillary Teeth for NitiH, NitiL, SSH and SSL Groups for all Measured Outputs (Fx, Fy, Fz, Mx, My and Mz)

- Fx, Fy and Fz measured in Newton's (N)
- Mx, My and Mz measured in Newton-millimeters (Nmm)

Measure	Tooth	WireElastic	Wire Elastic	Mean Difference	Std. Error	Sig.	95% Confidence Interval for Difference Lower Bound	95% Confidence Interval for Difference Upper Bound
Fx	17	NITIH	NITIL	.00	.00	1.000	.00	.00
			SSH	.00	.00	.658	.00	.00
			SSL	.00	.00	1.000	.00	.00
		NITIL	NITIH	.00	.00	1.000	.00	.00
			SSH	.00	.00	.912	.00	.00
			SSL	.00	.00	1.000	.00	.00
		SSH	NITIH	.00	.00	.658	.00	.00
			NITIL	.00	.00	.912	.00	.00
			SSL	.00	.00	.566	.00	.00
		SSL	NITIH	.00	.00	1.000	.00	.00
			NITIL	.00	.00	1.000	.00	.00
			SSH	.00	.00	.566	.00	.00
	16	NITIH	NITIL	.00	.00	1.000	.00	.00
			SSH	.00	.00	.000	.00	.01
			SSL	.00	.00	.000	.00	.01
		NITIL	NITIH	.00	.00	1.000	.00	.00
			SSH	.00	.00	.000	.00	.01
			SSL	.00	.00	.000	.00	.01
		SSH	NITIH	.00	.00	.000	-.01	.00
			NITIL	.00	.00	.000	-.01	.00
			SSL	.00	.00	1.000	.00	.00
		SSL	NITIH	.00	.00	.000	-.01	.00
			NITIL	.00	.00	.000	-.01	.00
			SSH	.00	.00	1.000	.00	.00
	15	NITIH	NITIL	.00	.00	1.000	-.01	.00
			SSH	.00	.00	.095	.00	.01
			SSL	.00	.00	1.000	-.01	.00
		NITIL	NITIH	.00	.00	1.000	.00	.01
			SSH	.00	.00	.035	.00	.01
			SSL	.00	.00	1.000	.00	.00
		SSH	NITIH	.00	.00	.095	-.01	.00
			NITIL	.00	.00	.035	-.01	.00
			SSL	-.01	.00	.020	-.01	.00

	SSL	NITIH	.00	.00	1.000	.00	.01
		NITIL	.00	.00	1.000	.00	.00
		SSH	.01	.00	.020	.00	.01
14	NITIH	NITIL	.21	.01	.000	.18	.25
		SSH	.08	.01	.000	.05	.12
		SSL	.22	.01	.000	.19	.25
	NITIL	NITIH	-.21	.01	.000	-.25	-.18
		SSH	-.13	.01	.000	-.16	-.10
		SSL	.01	.01	1.000	-.03	.04
	SSH	NITIH	-.08	.01	.000	-.12	-.05
		NITIL	.13	.01	.000	.10	.16
		SSL	.14	.01	.000	.10	.17
	SSL	NITIH	-.22	.01	.000	-.25	-.19
		NITIL	-.01	.01	1.000	-.04	.03
		SSH	-.14	.01	.000	-.17	-.10
13	NITIH	NITIL	.76	.02	.000	.71	.82
		SSH	.12	.02	.000	.06	.18
		SSL	.81	.02	.000	.76	.87
	NITIL	NITIH	-.76	.02	.000	-.82	-.71
		SSH	-.65	.02	.000	-.71	-.59
		SSL	.05	.02	.141	-.01	.11
	SSH	NITIH	-.12	.02	.000	-.18	-.06
		NITIL	.65	.02	.000	.59	.71
		SSL	.70	.02	.000	.64	.76
	SSL	NITIH	-.81	.02	.000	-.87	-.76
		NITIL	-.05	.02	.141	-.11	.01
		SSH	-.70	.02	.000	-.76	-.64
12	NITIH	NITIL	.00	.01	1.000	-.03	.03
		SSH	-.04	.01	.001	-.06	-.01
		SSL	-.02	.01	.316	-.05	.01
	NITIL	NITIH	.00	.01	1.000	-.03	.03
		SSH	-.04	.01	.001	-.06	-.01
		SSL	-.02	.01	.282	-.05	.01
	SSH	NITIH	.04	.01	.001	.01	.06
		NITIL	.04	.01	.001	.01	.06
		SSL	.02	.01	.366	-.01	.04
	SSL	NITIH	.02	.01	.316	-.01	.05
		NITIL	.02	.01	.282	-.01	.05
		SSH	-.02	.01	.366	-.04	.01
11	NITIH	NITIL	.00	.00	.000	.00	.01
		SSH	.01	.00	.00	.00	.01
		SSL	.01	.00	.00	.00	.01
	NITIL	NITIH	.00	.00	.000	-.01	.00
		SSH	.00	.00	.738	.00	.00
		SSL	.00	.00	.061	.00	.00
	SSH	NITIH	-.01	.00	.000	-.01	.00
		NITIL	.00	.00	.738	.00	.00

		SSL	.00	.00	1.000	.00	.00
	SSL	NITIH	-.01	.00	.000	-.01	.00
		NITIL	.00	.00	.061	.00	5.86E-5
		SSH	.00	.00	1.000	.00	.00
21	NITIH	NITIL	.00	.00	1.000	-.01	.01
		SSH	.01	.00	.011	.00	.02
		SSL	.01	.00	.150	.00	.02
	NITIL	NITIH	.00	.00	1.000	-.01	.01
		SSH	.01	.00	.024	.00	.02
		SSL	.01	.00	.276	.00	.02
	SSH	NITIH	-.01	.00	.011	-.02	.00
		NITIL	-.01	.00	.024	-.02	.00
		SSL	.00	.00	1.000	-.01	.01
	SSL	NITIH	-.01	.00	.150	-.02	.00
		NITIL	-.01	.00	.276	-.02	.00
		SSH	.00	.00	1.000	-.01	.01
22	NITIH	NITIL	.00	.00	1.000	.00	.00
		SSH	.00	.00	1.000	.00	.00
		SSL	.00	.00	1.000	.00	.00
	NITIL	NITIH	.00	.00	1.000	.00	.00
		SSH	.00	.00	1.000	.00	.00
		SSL	.00	.00	1.000	.00	.00
	SSH	NITIH	.00	.00	1.000	.00	.00
		NITIL	.00	.00	1.000	.00	.00
		SSL	.00	.00	.241	.00	.00
	SSL	NITIH	.00	.00	1.000	.00	.00
		NITIL	.00	.00	1.000	.00	.00
		SSH	.00	.00	.241	.00	.00
23	NITIH	NITIL	.94	.02	.00	.88	1.01
		SSH	-.06	.02	.150	-.12	.01
		SSL	.96	.02	.000	.89	1.02
	NITIL	NITIH	-.94	.02	.000	-1.01	-.88
		SSH	-1.00	.02	.000	-1.06	-.93
		SSL	.01	.02	1.000	-.05	.08
	SSH	NITIH	.06	.02	.150	-.01	.12
		NITIL	1.00	.02	.000	.93	1.06
		SSL	1.01	.02	.000	.95	1.08
	SSL	NITIH	-.96	.02	.000	-1.02	-.89
		NITIL	-.01	.02	1.000	-.08	.05
		SSH	-1.01	.02	.000	-1.08	-.95
24	NITIH	NITIL	.03	.01	.000	.02	.04
		SSH	-.02	.01	.000	-.04	-.01
		SSL	.01	.01	1.000	-.01	.02
	NITIL	NITIH	-.03	.01	.000	-.04	-.02
		SSH	-.05	.01	.000	-.07	-.04
		SSL	-.02	.01	.000	-.04	-.01
	SSH	NITIH	.02	.01	.000	.01	.04

			NITIL	.05	.01	000	.04	.07
			SSL	.03	.01	.000	.01	.04
		SSL	NITIH	-.01	.01	1.000	-.02	.01
			NITIL	.02	.01	.000	.01	.04
			SSH	-.03	.01	.000	-.04	-.01
	25	NITIH	NITIL	.00	.01	1.000	-.02	.02
			SSH	.04	.01	.000	.03	.06
			SSL	.02	.01	.108	.00	.04
		NITIL	NITIH	.00	.01	1.000	-.02	.02
			SSH	.04	.01	.000	.03	.06
			SSL	.02	.01	.109	.00	.04
		SSH	NITIH	-.04	.01	.000	-.06	-.03
			NITIL	-.04	.01	.00	-.06	-.03
			SSL	-.03	.01	.002	-.05	-.01
		SSL	NITIH	-.02	.01	.108	-.04	.00
			NITIL	-.02	.01	.109	-.04	.00
			SSH	.03	.01	.002	.01	.05
	26	NITIH	NITIL	.00	.00	1.000	-.01	.01
			SSH	.02	.00	.000	.01	.03
			SSL	.01	.00	.983	-.01	.02
		NITIL	NITIH	.00	.00	1.000	-.01	.01
			SSH	.02	.00	.000	.01	.03
			SSL	.01	.00	1.000	-.01	.02
		SSH	NITIH	-.02	.00	.000	-.03	-.01
			NITIL	-.02	.00	.000	-.03	-.01
			SSL	-.02	.00	.002	-.03	.00
		SSL	NITIH	-.01	.00	.983	-.02	.01
			NITIL	-.01	.00	1.000	-.02	.01
			SSH	.02	.00	.002	.00	.03
	27	NITIH	NITIL	.00	.01	1.000	-.02	.02
			SSH	.04	.01	.000	.02	.06
			SSL	.02	.01	.041	.00	.04
		NITIL	NITIH	.00	.01	1.000	-.02	.02
			SSH	.04	.01	.000	.02	.06
			SSL	.02	.01	.032	.00	.04
		SSH	NITIH	-.04	.01	.000	-.06	-.02
			NITIL	-.04	.01	.000	-.06	-.02
			SSL	-.02	.01	.008	-.04	.00
		SSL	NITIH	-.02	.01	.041	-.04	.00
			NITIL	-.02	.01	.032	-.04	.00
			SSH	.02	.01	.008	.00	.04
Fy	17	NITIH	NITIL	.00	.00	1.000	-.01	.01
			SSH	-.01	.00	.011	-.01	.00
			SSL	-.01	.00	.000	-.02	.00
		NITIL	NITIH	.00	.00	1.000	-.01	.01
			SSH	-.01	.00	.003	-.01	.00
			SSL	-.01	.00	.000	-.02	.00
		SSH	NITIH	.01	.00	.011	.00	.01

		NITIL	.01	.00	.003	.00	.01
		SSL	.00	.00	1.000	-.01	.00
	SSL	NITIH	.01	.00	.000	.00	.02
		NITIL	.01	.00	.000	.00	.02
		SSH	.00	.00	1.000	.00	.01
16	NITIH	NITIL	.00	.00	1.000	-.01	.01
		SSH	.04	.00	.000	.03	.04
		SSL	.03	.00	.000	.03	.04
	NITIL	NITIH	.00	.00	1.000	-.01	.01
		SSH	.04	.00	.000	.03	.04
		SSL	.03	.00	.000	.03	.04
	SSH	NITIH	-.04	.00	4.526E-45	-.04	-.03
		NITIL	-.04	.00	4.008E-45	-.04	-.03
		SSL	-.01	.00	.000	-.01	.00
	SSL	NITIH	-.03	.00	6.866E-34	-.04	-.03
		NITIL	-.03	.00	6.029E-34	-.04	-.03
		SSH	.01	.00	.000	.00	.01
15	NITIH	NITIL	.00	.00	1.000	-.01	.01
		SSH	-.01	.00	.003	-.02	.00
		SSL	-.01	.00	.172	-.02	.00
	NITIL	NITIH	.00	.00	1.000	-.01	.01
		SSH	-.01	.00	.001	-.02	.00
		SSL	-.01	.00	.060	-.02	.00
	SSH	NITIH	.01	.00	.003	.00	.02
		NITIL	.01	.00	.001	.00	.02
		SSL	.00	.00	1.000	.00	.01
	SSL	NITIH	.01	.00	.172	.00	.02
		NITIL	.01	.00	.060	.00	.02
		SSH	.00	.00	1.000	-.01	.00
14	NITIH	NITIL	-.15	.02	.000	-.22	-.09
		SSH	-.18	.02	.000	-.24	-.11
		SSL	-.15	.02	.000	-.21	-.08
	NITIL	NITIH	.15	.02	.000	.09	.22
		SSH	-.02	.02	1.000	-.09	.04
		SSL	.00	.02	1.000	-.06	.07
	SSH	NITIH	.18	.02	.000	.11	.24
		NITIL	.02	.02	1.000	-.04	.09
		SSL	.03	.02	1.000	-.04	.09
	SSL	NITIH	.15	.02	.000	.08	.21
		NITIL	.00	.02	1.000	-.07	.06
		SSH	-.03	.02	1.000	-.09	.04
13	NITIH	NITIL	-.29	.03	.000	-.38	-.21
		SSH	.35	.03	.000	.27	.44
		SSL	-.30	.03	.000	-.39	-.22
	NITIL	NITIH	.29	.03	.000	.21	.38
		SSH	.65	.03	.000	.56	.73
		SSL	-.01	.03	1.000	-.09	.08
	SSH	NITIH	-.35	.03	.000	-.44	-.27

		NITIL	-.65	.03	.000	-.73	-.56
		SSL	-.65	.03	.000	-.74	-.57
	SSL	NITIH	.30	.03	.000	.22	.39
		NITIL	.01	.03	1.000	-.08	.09
		SSH	.65	.03	.000	.57	.74
12	NITIH	NITIL	.00	.01	1.000	-.04	.03
		SSH	.04	.01	.011	.01	.08
		SSL	.06	.01	.000	.02	.10
	NITIL	NITIH	.00	.01	1.000	-.03	.04
		SSH	.05	.01	.004	.01	.08
		SSL	.06	.01	.000	.03	.10
	SSH	NITIH	-.04	.01	.011	-.08	-.01
		NITIL	-.05	.01	.004	-.08	-.01
		SSL	.02	.01	1.000	-.02	.05
	SSL	NITIH	-.06	.01	.000	-.10	-.02
		NITIL	-.06	.01	.000	-.10	-.03
		SSH	-.02	.01	1.000	-.05	.02
11	NITIH	NITIL	-.06	.01	.000	-.08	-.04
		SSH	-.06	.01	.000	-.08	-.04
		SSL	-.09	.01	.000	-.11	-.07
	NITIL	NITIH	.06	.01	.000	.04	.08
		SSH	.00	.01	1.000	-.02	.02
		SSL	-.04	.01	.000	-.06	-.02
	SSH	NITIH	.06	.01	.000	.04	.08
		NITIL	.00	.01	1.000	-.02	.02
		SSL	-.03	.01	.000	-.05	-.01
	SSL	NITIH	.09	.01	.000	.07	.11
		NITIL	.04	.01	.000	.02	.06
		SSH	.03	.01	.000	.01	.05
21	NITIH	NITIL	-.04	.01	.000	-.07	-.02
		SSH	.11	.01	.000	.09	.14
		SSL	.01	.01	1.000	-.02	.03
	NITIL	NITIH	.04	.01	.000	.02	.07
		SSH	.15	.01	.000	.13	.18
		SSL	.05	.01	.000	.02	.08
	SSH	NITIH	-.11	.01	.000	-.14	-.09
		NITIL	-.15	.01	.000	-.18	-.13
		SSL	-.11	.01	.000	-.13	-.08
	SSL	NITIH	-.01	.01	1.000	-.03	.02
		NITIL	-.05	.01	.000	-.08	-.02
		SSH	.11	.01	.000	.08	.13
22	NITIH	NITIL	.00	.01	1.000	-.02	.02
		SSH	-.01	.01	1.000	-.02	.01
		SSL	.00	.01	1.000	-.01	.02
	NITIL	NITIH	.00	.01	1.000	-.02	.02
		SSH	.00	.01	1.000	-.02	.01
		SSL	.00	.01	1.000	-.01	.02
	SSH	NITIH	.01	.01	1.000	-.01	.02
		NITIL	.00	.01	1.000	-.01	.02
		SSL	.01	.01	.654	-.01	.02
	SSL	NITIH	.00	.01	1.000	-.02	.01

		NITIL	.00	.01	1.000	-.02	.01
		SSH	-.01	.01	.654	-.02	.01
23	NITIH	NITIL	-.30	.02	.000	-.36	-.24
		SSH	.21	.02	.000	.15	.27
		SSL	-.22	.02	.000	-.28	-.16
	NITIL	NITIH	.30	.02	.000	.24	.36
		SSH	.51	.02	.000	.45	.57
		SSL	.08	.02	.005	.02	.14
	SSH	NITIH	-.21	.02	.000	-.27	-.15
		NITIL	-.51	.02	.000	-.57	-.45
		SSL	-.43	.02	.000	-.49	-.37
	SSL	NITIH	.22	.02	.000	.16	.28
		NITIL	-.08	.02	.005	-.14	-.02
		SSH	.43	.02	.000	.37	.49
24	NITIH	NITIL	-.17	.02	.000	-.22	-.11
		SSH	.07	.02	.005	.02	.13
		SSL	-.19	.02	.000	-.25	-.14
	NITIL	NITIH	.17	.02	.000	.11	.22
		SSH	.24	.02	.000	.18	.30
		SSL	-.02	.02	1.000	-.08	.03
	SSH	NITIH	-.07	.02	.005	-.13	-.02
		NITIL	-.24	.02	.000	-.30	-.18
		SSL	-.26	.02	.000	-.32	-.21
	SSL	NITIH	.19	.02	.000	.14	.25
		NITIL	.02	.02	1.000	-.03	.08
		SSH	.26	.02	.000	.21	.32
25	NITIH	NITIL	.00	.01	1.000	-.03	.03
		SSH	-.08	.01	.000	-.11	-.05
		SSL	-.03	.01	.015	-.06	.00
	NITIL	NITIH	.00	.01	1.000	-.03	.03
		SSH	-.08	.01	.000	-.11	-.05
		SSL	-.03	.01	.015	-.06	.00
	SSH	NITIH	.08	.01	.000	.05	.11
		NITIL	.08	.01	.000	.05	.11
		SSL	.04	.01	.001	.01	.07
	SSL	NITIH	.03	.01	.015	.00	.06
		NITIL	.03	.01	.015	.00	.06
		SSH	-.04	.01	.001	-.07	-.01
26	NITIH	NITIL	.00	.00	1.000	.00	.00
		SSH	-.01	.00	.000	-.01	-.01
		SSL	.00	.00	.450	-.01	.00
	NITIL	NITIH	.00	.00	1.000	.00	.00
		SSH	-.01	.00	.000	-.01	-.01
		SSL	.00	.00	.782	-.01	.00
	SSH	NITIH	.01	.00	.000	.01	.01
		NITIL	.01	.00	.000	.01	.01
		SSL	.01	.00	.000	.00	.01
	SSL	NITIH	.00	.00	.450	.00	.01
		NITIL	.00	.00	.782	.00	.01
		SSH	-.01	.00	.000	-.01	.00
27	NITIH	NITIL	.00	.00	1.000	.00	.01

			SSH	.04	.00	.000	.03	.05
			SSL	.02	.00	.000	.01	.03
		NITIL	NITIH	.00	.00	1.000	-.01	.00
			SSH	.04	.00	.000	.03	.04
			SSL	.02	.00	.000	.01	.02
		SSH	NITIH	-.04	.00	.000	-.05	-.03
			NITIL	-.04	.00	.000	-.04	-.03
			SSL	-.02	.00	.000	-.03	-.01
		SSL	NITIH	-.02	.00	.000	-.03	-.01
			NITIL	-.02	.00	.000	-.02	-.01
			SSH	.02	.00	.000	.01	.03
Fz	17	NITIH	NITIL	.00	.00	1.000	.00	.00
			SSH	.00	.00	.001	.00	.01
			SSL	.00	.00	.235	.00	.00
		NITIL	NITIH	.00	.00	1.000	.00	.00
			SSH	.00	.00	.000	.00	.01
			SSL	.00	.00	1.000	.00	.00
		SSH	NITIH	.00	.00	.001	-.01	.00
			NITIL	.00	.00	.000	-.01	.00
			SSL	.00	.00	.000	-.01	.00
		SSL	NITIH	.00	.00	.235	.00	.00
			NITIL	.00	.00	1.000	.00	.00
			SSH	.00	.00	.000	.00	.01
	16	NITIH	NITIL	.00	.01	1.000	-.02	.02
			SSH	.02	.01	.117	.00	.03
			SSL	.02	.01	.084	.00	.03
		NITIL	NITIH	.00	.01	1.000	-.02	.02
			SSH	.02	.01	.087	.00	.03
			SSL	.02	.01	.062	.00	.04
		SSH	NITIH	-.02	.01	.117	-.03	.00
			NITIL	-.02	.01	.087	-.03	.00
			SSL	.00	.01	1.000	-.02	.02
		SSL	NITIH	-.02	.01	.084	-.03	.00
			NITIL	-.02	.01	.062	-.04	.00
			SSH	.00	.01	1.000	-.02	.02
	15	NITIH	NITIL	.00	.00	1.000	-.01	.01
			SSH	.04	.00	.000	.03	.05
			SSL	.01	.00	.012	.00	.02
		NITIL	NITIH	.00	.00	1.000	-.01	.01
			SSH	.04	.00	.000	.03	.05
			SSL	.01	.00	.002	.00	.02
		SSH	NITIH	-.04	.00	.000	-.05	-.03
			NITIL	-.04	.00	.000	-.05	-.03
			SSL	-.03	.00	.000	-.04	-.02
		SSL	NITIH	-.01	.00	.012	-.02	.00
			NITIL	-.01	.00	.002	-.02	.00
			SSH	.03	.00	.000	.02	.04
	14	NITIH	NITIL	-.05	.01	.001	-.08	-.02
			SSH	-.03	.01	.033	-.06	.00
			SSL	-.01	.01	1.000	-.05	.02
		NITIL	NITIH	.05	.01	.001	.02	.08

		SSH	.01	.01	1.000	-.02	.05
		SSL	.03	.01	.033	.00	.07
	SSH	NITIH	.03	.01	.033	.00	.06
		NITIL	-.01	.01	1.000	-.05	.02
		SSL	.02	.01	.644	-.01	.05
	SSL	NITIH	.01	.01	1.000	-.02	.05
		NITIL	-.03	.01	.033	-.07	.00
		SSH	-.02	.01	.644	-.05	.01
13	NITIH	NITIL	.75	.02	.000	.70	.81
		SSH	.05	.02	.106	-.01	.10
		SSL	.70	.02	.000	.65	.76
	NITIL	NITIH	-.75	.02	.000	-.81	-.70
		SSH	-.70	.02	.000	-.76	-.65
		SSL	-.05	.02	.118	-.10	.01
	SSH	NITIH	-.05	.02	.106	-.10	.01
		NITIL	.70	.02	.000	.65	.76
		SSL	.65	.02	.000	.60	.71
	SSL	NITIH	-.70	.02	.000	-.76	-.65
		NITIL	.05	.02	.118	-.01	.10
		SSH	-.65	.02	.000	-.71	-.60
12	NITIH	NITIL	.00	.01	1.000	-.02	.02
		SSH	-.04	.01	.000	-.06	-.02
		SSL	.00	.01	1.000	-.01	.02
	NITIL	NITIH	.00	.01	1.000	-.02	.02
		SSH	-.04	.01	.000	-.06	-.02
		SSL	.00	.01	1.000	-.02	.02
	SSH	NITIH	.04	.01	.000	.02	.06
		NITIL	.04	.01	.000	.02	.06
		SSL	.04	.01	.000	.03	.06
	SSL	NITIH	.00	.01	1.000	-.02	.01
		NITIL	.00	.01	1.000	-.02	.02
		SSH	-.04	.01	.000	-.06	-.03
11	NITIH	NITIL	.00	.00	1.000	-.01	.01
		SSH	.02	.00	.000	.01	.03
		SSL	.01	.00	.009	.00	.03
	NITIL	NITIH	.00	.00	1.000	-.01	.01
		SSH	.02	.00	.000	.01	.03
		SSL	.01	.00	.005	.00	.03
	SSH	NITIH	-.02	.00	.000	-.03	-.01
		NITIL	-.02	.00	.000	-.03	-.01
		SSL	-.01	.00	.637	-.02	.00
	SSL	NITIH	-.01	.00	.009	-.03	.00
		NITIL	-.01	.00	.005	-.03	.00
		SSH	.01	.00	.637	.00	.02
21	NITIH	NITIL	.00	.00	1.000	-.01	.01
		SSH	-.02	.00	.000	-.02	-.01
		SSL	-.01	.00	.001	-.02	.00
	NITIL	NITIH	.00	.00	1.000	-.01	.01
		SSH	-.01	.00	.000	-.02	-.01
		SSL	-.01	.00	.010	-.02	.00
	SSH	NITIH	.02	.00	.000	.01	.02

		NITIL	.01	.00	.000	.01	.02
		SSL	.00	.00	.712	.00	.01
	SSL	NITIH	.01	.00	.001	.00	.02
		NITIL	.01	.00	.010	.00	.02
		SSH	.00	.00	.712	-.01	.00
22	NITIH	NITIL	.01	.00	.093	.00	.02
		SSH	-.04	.00	.000	-.05	-.03
		SSL	.00	.00	1.000	-.01	.02
	NITIL	NITIH	-.01	.00	.093	-.02	.00
		SSH	-.05	.00	.000	-.06	-.04
		SSL	-.01	.00	.692	-.02	.00
	SSH	NITIH	.04	.00	.000	.03	.05
		NITIL	.05	.00	.000	.04	.06
		SSL	.04	.00	.000	.03	.06
	SSL	NITIH	.00	.00	1.000	-.02	.01
		NITIL	.01	.00	.692	.00	.02
		SSH	-.04	.00	.000	-.06	-.03
23	NITIH	NITIL	.59	.02	.000	.54	.63
		SSH	.08	.02	.000	.03	.12
		SSL	.63	.02	.000	.59	.68
	NITIL	NITIH	-.59	.02	.000	-.63	-.54
		SSH	-.51	.02	.000	-.55	-.47
		SSL	.05	.02	.026	.00	.09
	SSH	NITIH	-.08	.02	.000	-.12	-.03
		NITIL	.51	.02	.000	.47	.55
		SSL	.56	.02	.000	.51	.60
	SSL	NITIH	-.63	.02	.000	-.68	-.59
		NITIL	-.05	.02	.026	-.09	.00
		SSH	-.56	.02	.000	-.60	-.51
24	NITIH	NITIL	.05	.01	.000	.02	.08
		SSH	-.15	.01	.000	-.18	-.12
		SSL	.00	.01	1.000	-.03	.03
	NITIL	NITIH	-.05	.01	.000	-.08	-.02
		SSH	-.20	.01	.000	-.23	-.17
		SSL	-.05	.01	.000	-.08	-.02
	SSH	NITIH	.15	.01	.000	.12	.18
		NITIL	.20	.01	.000	.17	.23
		SSL	.15	.01	.000	.12	.18
	SSL	NITIH	.00	.01	1.000	-.03	.03
		NITIL	.05	.01	.000	.02	.08
		SSH	-.15	.01	.000	-.18	-.12
25	NITIH	NITIL	.00	.01	1.000	-.02	.02
		SSH	.07	.01	.000	.05	.08
		SSL	.02	.01	.002	.01	.04
	NITIL	NITIH	.00	.01	1.000	-.02	.02
		SSH	.07	.01	.000	.05	.08
		SSL	.02	.01	.001	.01	.04
	SSH	NITIH	-.07	.01	.000	-.08	-.05
		NITIL	-.07	.01	.000	-.08	-.05
		SSL	-.04	.01	.000	-.06	-.02
	SSL	NITIH	-.02	.01	.002	-.04	-.01

			NITIL	-.02	.01	.001	-.04	-.01
			SSH	.04	.01	.000	.02	.06
	26	NITIH	NITIL	.00	.00	1.000	-.01	.01
			SSH	.02	.00	.000	.01	.03
			SSL	.00	.00	1.000	-.01	.01
		NITIL	NITIH	.00	.00	1.000	-.01	.01
			SSH	.02	.00	.000	.01	.03
			SSL	.00	.00	1.000	-.01	.01
		SSH	NITIH	-.02	.00	.000	-.03	-.01
			NITIL	-.02	.00	.000	-.03	-.01
			SSL	-.02	.00	.000	-.03	-.01
		SSL	NITIH	.00	.00	1.000	-.01	.01
			NITIL	.00	.00	1.000	-.01	.01
			SSH	.02	.00	.000	.01	.03
	27	NITIH	NITIL	.00	.00	1.000	-.01	.00
			SSH	-.02	.00	.000	-.03	-.01
			SSL	-.01	.00	.000	-.02	.00
		NITIL	NITIH	.00	.00	1.000	.00	.01
			SSH	-.02	.00	.000	-.03	-.01
			SSL	-.01	.00	.012	-.02	.00
		SSH	NITIH	.02	.00	.000	.01	.03
			NITIL	.02	.00	.000	.01	.03
			SSL	.01	.00	.031	.00	.02
		SSL	NITIH	.01	.00	.000	.00	.02
			NITIL	.01	.00	.012	.00	.02
			SSH	-.01	.00	.031	-.02	.00
Mx	17	NITIH	NITIL	.02	.03	1.000	-.07	.10
			SSH	-.02	.03	1.000	-.11	.06
			SSL	-.03	.03	1.000	-.11	.05
		NITIL	NITIH	-.02	.03	1.000	-.10	.07
			SSH	-.04	.03	1.000	-.12	.04
			SSL	-.05	.03	.849	-.13	.04
		SSH	NITIH	.02	.03	1.000	-.06	.11
			NITIL	.04	.03	1.000	-.04	.12
			SSL	-.01	.03	1.000	-.09	.08
		SSL	NITIH	.03	.03	1.000	-.05	.11
			NITIL	.05	.03	.849	-.04	.13
			SSH	.01	.03	1.000	-.08	.09
	16	NITIH	NITIL	-.01	.24	1.000	-.66	.64
			SSH	.77	.24	.011	.12	1.42
			SSL	.84	.24	.004	.19	1.49
		NITIL	NITIH	.01	.24	1.000	-.64	.66
			SSH	.78	.24	.010	.13	1.43
			SSL	.85	.24	.004	.20	1.50
		SSH	NITIH	-.77	.24	.011	-1.42	-.12
			NITIL	-.78	.24	.010	-1.43	-.13
			SSL	.07	.24	1.000	-.58	.72
		SSL	NITIH	-.84	.24	.004	-1.49	-.19
			NITIL	-.85	.24	.004	-1.50	-.20
			SSH	-.07	.24	1.000	-.72	.58
	15	NITIH	NITIL	.03	.06	1.000	-.13	.20

		SSH	.04	.06	1.000	-.12	.21
		SSL	.07	.06	1.000	-.09	.24
	NITIL	NITIH	-.03	.06	1.000	-.20	.13
		SSH	.01	.06	1.000	-.15	.17
		SSL	.04	.06	1.000	-.13	.20
	SSH	NITIH	-.04	.06	1.000	-.21	.12
		NITIL	-.01	.06	1.000	-.17	.15
		SSL	.03	.06	1.000	-.14	.19
	SSL	NITIH	-.07	.06	1.000	-.24	.09
		NITIL	-.04	.06	1.000	-.20	.13
		SSH	-.03	.06	1.000	-.19	.14
14	NITIH	NITIL	.18	.03	.000	.09	.26
		SSH	-.10	.03	.009	-.18	-.02
		SSL	.12	.03	.001	.03	.20
	NITIL	NITIH	-.18	.03	.000	-.26	-.09
		SSH	-.28	.03	.000	-.36	-.19
		SSL	-.06	.03	.336	-.14	.02
	SSH	NITIH	.10	.03	.009	.02	.18
		NITIL	.28	.03	.000	.19	.36
		SSL	.22	.03	.000	.13	.30
	SSL	NITIH	-.12	.03	.001	-.20	-.03
		NITIL	.06	.03	.336	-.02	.14
		SSH	-.22	.03	.000	-.30	-.13
13	NITIH	NITIL	.60	.03	.000	.53	.67
		SSH	-.48	.03	.000	-.55	-.41
		SSL	.46	.03	.000	.39	.53
	NITIL	NITIH	-.60	.03	.000	-.67	-.53
		SSH	-1.08	.03	.000	-1.15	-1.01
		SSL	-.13	.03	.000	-.20	-.06
	SSH	NITIH	.48	.03	.000	.41	.55
		NITIL	1.08	.03	.000	1.01	1.15
		SSL	.95	.03	.000	.88	1.02
	SSL	NITIH	-.46	.03	.000	-.53	-.39
		NITIL	.13	.03	.000	.06	.20
		SSH	-.95	.03	.000	-1.02	-.88
12	NITIH	NITIL	.00	.02	1.000	-.07	.06
		SSH	.05	.02	.381	-.02	.11
		SSL	-.03	.02	1.000	-.09	.04
	NITIL	NITIH	.00	.02	1.000	-.06	.07
		SSH	.05	.02	.243	-.01	.11
		SSL	-.02	.02	1.000	-.09	.04
	SSH	NITIH	-.05	.02	.381	-.11	.02
		NITIL	-.05	.02	.243	-.11	.01
		SSL	-.07	.02	.015	-.14	-.01
	SSL	NITIH	.03	.02	1.000	-.04	.09
		NITIL	.02	.02	1.000	-.04	.09
		SSH	.07	.02	.015	.01	.14
11	NITIH	NITIL	-.08	.07	1.000	-.26	.10
		SSH	-.08	.07	1.000	-.26	.10
		SSL	-.11	.07	.589	-.30	.07
	NITIL	NITIH	.08	.07	1.000	-.10	.26

			SSH	.00	.07	1.000	-.18	.18
			SSL	-.04	.07	1.000	-.22	.15
		SSH	NITIH	.08	.07	1.000	-.10	.26
			NITIL	.00	.07	1.000	-.18	.18
			SSL	-.04	.07	1.000	-.22	.15
		SSL	NITIH	.11	.07	.589	-.07	.30
			NITIL	.04	.07	1.000	-.15	.22
			SSH	.04	.07	1.000	-.15	.22
	21	NITIH	NITIL	.01	.03	1.000	-.06	.08
			SSH	.05	.03	.563	-.03	.12
			SSL	.01	.03	1.000	-.07	.08
		NITIL	NITIH	-.01	.03	1.000	-.08	.06
			SSH	.04	.03	1.000	-.04	.11
			SSL	.00	.03	1.000	-.08	.07
		SSH	NITIH	-.05	.03	.563	-.12	.03
			NITIL	-.04	.03	1.000	-.11	.04
			SSL	-.04	.03	.906	-.11	.03
		SSL	NITIH	-.01	.03	1.000	-.08	.07
			NITIL	.00	.03	1.000	-.07	.08
			SSH	.04	.03	.906	-.03	.11
	22	NITIH	NITIL	.02	.04	1.000	-.07	.12
			SSH	.00	.04	1.000	-.10	.09
			SSL	.07	.04	.239	-.02	.17
		NITIL	NITIH	-.02	.04	1.000	-.12	.07
			SSH	-.03	.04	1.000	-.12	.07
			SSL	.05	.04	.976	-.05	.15
		SSH	NITIH	.00	.04	1.000	-.09	.10
			NITIL	.03	.04	1.000	-.07	.12
			SSL	.08	.04	.182	-.02	.17
		SSL	NITIH	-.07	.04	.239	-.17	.02
			NITIL	-.05	.04	.976	-.15	.05
			SSH	-.08	.04	.182	-.17	.02
	23	NITIH	NITIL	.07	.04	.412	-.03	.18
			SSH	-.31	.04	.000	-.42	-.21
			SSL	-.09	.04	.172	-.19	.02
		NITIL	NITIH	-.07	.04	.412	-.18	.03
			SSH	-.39	.04	.000	-.49	-.28
			SSL	-.16	.04	.000	-.27	-.05
		SSH	NITIH	.31	.04	.000	.21	.42
			NITIL	.39	.04	.000	.28	.49
			SSL	.23	.04	.000	.12	.33
		SSL	NITIH	.09	.04	.172	-.02	.19
			NITIL	.16	.04	.000	.05	.27
			SSH	-.23	.04	.000	-.33	-.12
	24	NITIH	NITIL	-.04	.03	.765	-.11	.03
			SSH	.02	.03	1.000	-.05	.09
			SSL	.02	.03	1.000	-.05	.09
		NITIL	NITIH	.04	.03	.765	-.03	.11
			SSH	.06	.03	.184	-.01	.13
			SSL	.06	.03	.118	-.01	.13
		SSH	NITIH	-.02	.03	1.000	-.09	.05

			NITIL	-.06	.03	.184	-.13	.01
			SSL	.00	.03	1.000	-.07	.08
		SSL	NITIH	-.02	.03	1.000	-.09	.05
			NITIL	-.06	.03	.118	-.13	.01
			SSH	.00	.03	1.000	-.08	.07
	25	NITIH	NITIL	.00	.02	1.000	-.06	.06
			SSH	-.20	.02	.000	-.26	-.14
			SSL	-.05	.02	.292	-.11	.02
		NITIL	NITIH	.00	.02	1.000	-.06	.06
			SSH	-.20	.02	.000	-.26	-.14
			SSL	-.05	.02	.291	-.11	.02
		SSH	NITIH	.20	.02	.000	.14	.26
			NITIL	.20	.02	.000	.14	.26
			SSL	.15	.02	.000	.09	.21
		SSL	NITIH	.05	.02	.292	-.02	.11
			NITIL	.05	.02	.291	-.02	.11
			SSH	-.15	.02	.000	-.21	-.09
	26	NITIH	NITIL	-.01	.03	1.000	-.10	.08
			SSH	.00	.03	1.000	-.10	.09
			SSL	-.01	.03	1.000	-.10	.08
		NITIL	NITIH	.01	.03	1.000	-.08	.10
			SSH	.01	.03	1.000	-.08	.10
			SSL	.00	.03	1.000	-.09	.09
		SSH	NITIH	.00	.03	1.000	-.09	.10
			NITIL	-.01	.03	1.000	-.10	.08
			SSL	-.01	.03	1.000	-.10	.08
		SSL	NITIH	.01	.03	1.000	-.08	.10
			NITIL	.00	.03	1.000	-.09	.09
			SSH	.01	.03	1.000	-.08	.10
	27	NITIH	NITIL	-.01	.06	1.000	-.16	.14
			SSH	.02	.06	1.000	-.13	.17
			SSL	.00	.06	1.000	-.15	.15
		NITIL	NITIH	.01	.06	1.000	-.14	.16
			SSH	.03	.06	1.000	-.12	.18
			SSL	.01	.06	1.000	-.14	.16
		SSH	NITIH	-.02	.06	1.000	-.17	.13
			NITIL	-.03	.06	1.000	-.18	.12
			SSL	-.02	.06	1.000	-.17	.13
		SSL	NITIH	.00	.06	1.000	-.15	.15
			NITIL	-.01	.06	1.000	-.16	.14
			SSH	.02	.06	1.000	-.13	.17
My	17	NITIH	NITIL	.00	.01	1.000	-.02	.02
			SSH	.00	.01	1.000	-.02	.02
			SSL	.01	.01	1.000	-.01	.03
		NITIL	NITIH	.00	.01	1.000	-.02	.02
			SSH	.00	.01	1.000	-.02	.02
			SSL	.01	.01	1.000	-.01	.03
		SSH	NITIH	.00	.01	1.000	-.02	.02
			NITIL	.00	.01	1.000	-.02	.02
			SSL	.01	.01	1.000	-.01	.03
		SSL	NITIH	-.01	.01	1.000	-.03	.01

		NITIL	-.01	.01	1.000	-.03	.01
		SSH	-.01	.01	1.000	-.03	.01
16	NITIH	NITIL	.00	.04	1.000	-.12	.11
		SSH	-.15	.04	.004	-.26	-.03
		SSL	-.17	.04	.000	-.28	-.06
	NITIL	NITIH	.00	.04	1.000	-.11	.12
		SSH	-.14	.04	.006	-.26	-.03
		SSL	-.17	.04	.001	-.28	-.05
	SSH	NITIH	.15	.04	.004	.03	.26
		NITIL	.14	.04	.006	.03	.26
		SSL	-.02	.04	1.000	-.14	.09
	SSL	NITIH	.17	.04	.000	.06	.28
		NITIL	.17	.04	.001	.05	.28
		SSH	.02	.04	1.000	-.09	.14
15	NITIH	NITIL	.01	.02	1.000	-.04	.06
		SSH	.09	.02	.000	.04	.14
		SSL	.09	.02	.000	.04	.14
	NITIL	NITIH	-.01	.02	1.000	-.06	.04
		SSH	.08	.02	.000	.03	.13
		SSL	.08	.02	.001	.03	.13
	SSH	NITIH	-.09	.02	.000	-.14	-.04
		NITIL	-.08	.02	.000	-.13	-.03
		SSL	.00	.02	1.000	-.05	.05
	SSL	NITIH	-.09	.02	.000	-.14	-.04
		NITIL	-.08	.02	.001	-.13	-.03
		SSH	.00	.02	1.000	-.05	.05
14	NITIH	NITIL	.08	.02	.000	.03	.14
		SSH	.18	.02	.000	.13	.23
		SSL	.11	.02	.000	.06	.16
	NITIL	NITIH	-.08	.02	.000	-.14	-.03
		SSH	.09	.02	.000	.04	.15
		SSL	.03	.02	1.000	-.03	.08
	SSH	NITIH	-.18	.02	.000	-.23	-.13
		NITIL	-.09	.02	.000	-.15	-.04
		SSL	-.07	.02	.005	-.12	-.02
	SSL	NITIH	-.11	.02	.000	-.16	-.06
		NITIL	-.03	.02	1.000	-.08	.03
		SSH	.07	.02	.005	.02	.12
13	NITIH	NITIL	-5.68	.15	.000	-6.08	-5.28
		SSH	.04	.15	1.000	-.36	.44
		SSL	-5.38	.15	.000	-5.78	-4.97
	NITIL	NITIH	5.68	.15	.000	5.28	6.08
		SSH	5.72	.15	.000	5.32	6.13
		SSL	.31	.15	.262	-.10	.71
	SSH	NITIH	-.04	.15	1.000	-.44	.36
		NITIL	-5.72	.15	.000	-6.13	-5.32
		SSL	-5.42	.15	.000	-5.82	-5.02
	SSL	NITIH	5.38	.15	.000	4.97	5.78
		NITIL	-.31	.15	.262	-.71	.10
		SSH	5.42	.15	.000	5.02	5.82
12	NITIH	NITIL	.00	.03	1.000	-.08	.07

		SSH	.11	.03	.001	.03	.19
		SSL	-.11	.03	.002	-.19	-.03
	NITIL	NITIH	.00	.03	1.000	-.07	.08
		SSH	.12	.03	.001	.04	.19
		SSL	-.10	.03	.004	-.18	-.02
	SSH	NITIH	-.11	.03	.001	-.19	-.03
		NITIL	-.12	.03	.001	-.19	-.04
		SSL	-.22	.03	.000	-.30	-.14
	SSL	NITIH	.11	.03	.002	.03	.19
		NITIL	.10	.03	.004	.02	.18
		SSH	.22	.03	.000	.14	.30
11	NITIH	NITIL	.02	.01	.149	.00	.04
		SSH	.03	.01	.002	.01	.05
		SSL	.05	.01	.000	.02	.07
	NITIL	NITIH	-.02	.01	.149	-.04	.00
		SSH	.01	.01	.912	-.01	.04
		SSL	.03	.01	.009	.00	.05
	SSH	NITIH	-.03	.01	.002	-.05	-.01
		NITIL	-.01	.01	.912	-.04	.01
		SSL	.02	.01	.448	-.01	.04
	SSL	NITIH	-.05	.01	.000	-.07	-.02
		NITIL	-.03	.01	.009	-.05	.00
		SSH	-.02	.01	.448	-.04	.01
21	NITIH	NITIL	-.01	.01	.381	-.03	.01
		SSH	.07	.01	.000	.05	.09
		SSL	.02	.01	.034	.00	.04
	NITIL	NITIH	.01	.01	.381	-.01	.03
		SSH	.09	.01	.000	.07	.11
		SSL	.04	.01	.000	.02	.06
	SSH	NITIH	-.07	.01	.000	-.09	-.05
		NITIL	-.09	.01	.000	-.11	-.07
		SSL	-.05	.01	.000	-.07	-.03
	SSL	NITIH	-.02	.01	.034	-.04	.00
		NITIL	-.04	.01	.000	-.06	-.02
		SSH	.05	.01	.000	.03	.07
22	NITIH	NITIL	.01	.01	1.000	-.03	.04
		SSH	-.07	.01	.000	-.10	-.03
		SSL	.02	.01	.683	-.01	.05
	NITIL	NITIH	-.01	.01	1.000	-.04	.03
		SSH	-.07	.01	.000	-.11	-.04
		SSL	.01	.01	1.000	-.02	.05
	SSH	NITIH	.07	.01	.000	.03	.10
		NITIL	.07	.01	.000	.04	.11
		SSL	.09	.01	.000	.05	.12
	SSL	NITIH	-.02	.01	.683	-.05	.01
		NITIL	-.01	.01	1.000	-.05	.02
		SSH	-.09	.01	.000	-.12	-.05
23	NITIH	NITIL	-3.32	.09	.000	-3.56	-3.08
		SSH	-.17	.09	.331	-.41	.07
		SSL	-3.50	.09	.000	-3.74	-3.26
	NITIL	NITIH	3.32	.09	.000	3.08	3.56

		SSH	3.14	.09	.000	2.90	3.38
		SSL	-.19	.09	.235	-.43	.05
	SSH	NITIH	.17	.09	.331	-.07	.41
		NITIL	-3.14	.09	.000	-3.38	-2.90
		SSL	-3.33	.09	.000	-3.57	-3.09
	SSL	NITIH	3.50	.09	.000	3.26	3.74
		NITIL	.19	.09	.235	-.05	.43
		SSH	3.33	.09	.000	3.09	3.57
24	NITIH	NITIL	.09	.03	.059	.00	.18
		SSH	.45	.03	.000	.36	.54
		SSL	.11	.03	.012	.02	.20
	NITIL	NITIH	-.09	.03	.059	-.18	.00
		SSH	.37	.03	.000	.28	.46
		SSL	.02	.03	1.000	-.07	.11
	SSH	NITIH	-.45	.03	.000	-.54	-.36
		NITIL	-.37	.03	.000	-.46	-.28
		SSL	-.35	.03	.000	-.44	-.26
	SSL	NITIH	-.11	.03	.012	-.20	-.02
		NITIL	-.02	.03	1.000	-.11	.07
		SSH	.35	.03	.000	.26	.44
25	NITIH	NITIL	.00	.04	1.000	-.11	.10
		SSH	-.11	.04	.032	-.21	-.01
		SSL	-.05	.04	1.000	-.16	.05
	NITIL	NITIH	.00	.04	1.000	-.10	.11
		SSH	-.11	.04	.036	-.21	.00
		SSL	-.05	.04	1.000	-.16	.05
	SSH	NITIH	.11	.04	.032	.01	.21
		NITIL	.11	.04	.036	.00	.21
		SSL	.06	.04	.910	-.05	.16
	SSL	NITIH	.05	.04	1.000	-.05	.16
		NITIL	.05	.04	1.000	-.05	.16
		SSH	-.06	.04	.910	-.16	.05
26	NITIH	NITIL	-.01	.02	1.000	-.06	.03
		SSH	-.03	.02	.629	-.07	.02
		SSL	-.01	.02	1.000	-.05	.03
	NITIL	NITIH	.01	.02	1.000	-.03	.06
		SSH	-.02	.02	1.000	-.06	.03
		SSL	.00	.02	1.000	-.04	.05
	SSH	NITIH	.03	.02	.629	-.02	.07
		NITIL	.02	.02	1.000	-.03	.06
		SSL	.02	.02	1.000	-.03	.06
	SSL	NITIH	.01	.02	1.000	-.03	.05
		NITIL	.00	.02	1.000	-.05	.04
		SSH	-.02	.02	1.000	-.06	.03
27	NITIH	NITIL	.02	.03	1.000	-.05	.09
		SSH	-.02	.03	1.000	-.10	.05
		SSL	.01	.03	1.000	-.07	.08
	NITIL	NITIH	-.02	.03	1.000	-.09	.05
		SSH	-.04	.03	.754	-.11	.03
		SSL	-.01	.03	1.000	-.09	.06
	SSH	NITIH	.02	.03	1.000	-.05	.10

			NITIL	.04	.03	.754	-.03	.11
			SSL	.03	.03	1.000	-.04	.10
		SSL	NITIH	-.01	.03	1.000	-.08	.07
			NITIL	.01	.03	1.000	-.06	.09
			SSH	-.03	.03	1.000	-.10	.04
Mz	17	NITIH	NITIL	.01	.01	1.000	-.03	.05
			SSH	.02	.01	1.000	-.02	.06
			SSL	.03	.01	.468	-.01	.07
		NITIL	NITIH	-.01	.01	1.000	-.05	.03
			SSH	.01	.01	1.000	-.03	.05
			SSL	.02	.01	1.000	-.02	.06
		SSH	NITIH	-.02	.01	1.000	-.06	.02
			NITIL	-.01	.01	1.000	-.05	.03
			SSL	.01	.01	1.000	-.03	.05
		SSL	NITIH	-.03	.01	.468	-.07	.01
			NITIL	-.02	.01	1.000	-.06	.02
			SSH	-.01	.01	1.000	-.05	.03
	16	NITIH	NITIL	.00	.04	1.000	-.12	.11
			SSH	-.10	.04	.133	-.21	.01
			SSL	-.12	.04	.018	-.23	-.01
		NITIL	NITIH	.00	.04	1.000	-.11	.12
			SSH	-.09	.04	.178	-.20	.02
			SSL	-.12	.04	.026	-.23	-.01
		SSH	NITIH	.10	.04	.133	-.01	.21
			NITIL	.09	.04	.178	-.02	.20
			SSL	-.03	.04	1.000	-.14	.08
		SSL	NITIH	.12	.04	.018	.01	.23
			NITIL	.12	.04	.026	.01	.23
			SSH	.03	.04	1.000	-.08	.14
	15	NITIH	NITIL	.01	.01	.637	-.01	.03
			SSH	-.03	.01	.002	-.05	-.01
			SSL	.01	.01	1.000	-.01	.02
		NITIL	NITIH	-.01	.01	.637	-.03	.01
			SSH	-.04	.01	.000	-.06	-.02
			SSL	-.01	.01	1.000	-.03	.01
		SSH	NITIH	.03	.01	.002	.01	.05
			NITIL	.04	.01	.000	.02	.06
			SSL	.03	.01	.000	.01	.05
		SSL	NITIH	-.01	.01	1.000	-.02	.01
			NITIL	.01	.01	1.000	-.01	.03
			SSH	-.03	.01	.000	-.05	-.01
	14	NITIH	NITIL	.25	.05	.000	.12	.38
			SSH	.12	.05	.067	.00	.25
			SSL	.11	.05	.152	-.02	.24
		NITIL	NITIH	-.25	.05	.000	-.38	-.12
			SSH	-.12	.05	.071	-.25	.01
			SSL	-.14	.05	.029	-.27	-.01
		SSH	NITIH	-.12	.05	.067	-.25	.00

		NITIL	.12	.05	.071	-.01	.25
		SSL	-.02	.05	1.000	-.14	.11
	SSL	NITIH	-.11	.05	.152	-.24	.02
		NITIL	.14	.05	.029	.01	.27
		SSH	.02	.05	1.000	-.11	.14
13	NITIH	NITIL	-1.92	.36	.000	-2.88	-.97
		SSH	3.05	.36	.000	2.09	4.00
		SSL	-1.78	.36	.000	-2.73	-.83
	NITIL	NITIH	1.92	.36	.000	.97	2.88
		SSH	4.97	.36	.000	4.02	5.92
		SSL	.14	.36	1.000	-.81	1.09
	SSH	NITIH	-3.05	.36	.000	-4.00	-2.09
		NITIL	-4.97	.36	.000	-5.92	-4.02
		SSL	-4.83	.36	.000	-5.78	-3.88
	SSL	NITIH	1.78	.36	.000	.83	2.73
		NITIL	-.14	.36	1.000	-1.09	.81
		SSH	4.83	.36	.000	3.88	5.78
12	NITIH	NITIL	.00	.13	1.000	-.34	.35
		SSH	-.76	.13	.000	-1.10	-.41
		SSL	.21	.13	.648	-.14	.55
	NITIL	NITIH	.00	.13	1.000	-.35	.34
		SSH	-.76	.13	.000	-1.10	-.41
		SSL	.21	.13	.664	-.14	.55
	SSH	NITIH	.76	.13	.000	.41	1.10
		NITIL	.76	.13	.000	.41	1.10
		SSL	.97	.13	.000	.62	1.31
	SSL	NITIH	-.21	.13	.648	-.55	.14
		NITIL	-.21	.13	.664	-.55	.14
		SSH	-.97	.13	.000	-1.31	-.62
11	NITIH	NITIL	.11	.02	.000	.07	.16
		SSH	.11	.02	.000	.07	.16
		SSL	.18	.02	.000	.13	.22
	NITIL	NITIH	-.11	.02	.000	-.16	-.07
		SSH	.00	.02	1.000	-.04	.05
		SSL	.07	.02	.000	.02	.11
	SSH	NITIH	-.11	.02	.000	-.16	-.07
		NITIL	.00	.02	1.000	-.05	.04
		SSL	.07	.02	.001	.02	.11
	SSL	NITIH	-.18	.02	.000	-.22	-.13
		NITIL	-.07	.02	.000	-.11	-.02
		SSH	-.07	.02	.001	-.11	-.02
21	NITIH	NITIL	.04	.10	1.000	-.23	.31
		SSH	-.38	.10	.002	-.65	-.11
		SSL	-.12	.10	1.000	-.39	.15
	NITIL	NITIH	-.04	.10	1.000	-.31	.23
		SSH	-.42	.10	.000	-.69	-.15
		SSL	-.16	.10	.654	-.43	.11
	SSH	NITIH	.38	.10	.002	.11	.65

		NITIL	.42	.10	.000	.15	.69
		SSL	.25	.10	.080	-.02	.52
	SSL	NITIH	.12	.10	1.000	-.15	.39
		NITIL	.16	.10	.654	-.11	.43
		SSH	-.25	.10	.080	-.52	.02
22	NITIH	NITIL	.00	.01	1.000	-.02	.02
		SSH	-.02	.01	.204	-.04	.00
		SSL	.00	.01	1.000	-.02	.02
	NITIL	NITIH	.00	.01	1.000	-.02	.02
		SSH	-.02	.01	.084	-.04	.00
		SSL	.00	.01	1.000	-.02	.02
	SSH	NITIH	.02	.01	.204	.00	.04
		NITIL	.02	.01	.084	.00	.04
		SSL	.01	.01	.361	-.01	.03
	SSL	NITIH	.00	.01	1.000	-.02	.02
		NITIL	.00	.01	1.000	-.02	.02
		SSH	-.01	.01	.361	-.03	.01
23	NITIH	NITIL	-.52	.13	.001	-.88	-.17
		SSH	.85	.13	.000	.49	1.21
		SSL	.56	.13	.000	.21	.92
	NITIL	NITIH	.52	.13	.001	.17	.88
		SSH	1.37	.13	.000	1.02	1.73
		SSL	1.09	.13	.000	.73	1.45
	SSH	NITIH	-.85	.13	.000	-1.21	-.49
		NITIL	-1.37	.13	.000	-1.73	-1.02
		SSL	-.28	.13	.209	-.64	.07
	SSL	NITIH	-.56	.13	.000	-.92	-.21
		NITIL	-1.09	.13	.000	-1.45	-.73
		SSH	.28	.13	.209	-.07	.64
24	NITIH	NITIL	-.26	.08	.016	-.48	-.03
		SSH	.22	.08	.063	-.01	.45
		SSL	-.33	.08	.001	-.55	-.10
	NITIL	NITIH	.26	.08	.016	.03	.48
		SSH	.48	.08	.000	.25	.70
		SSL	-.07	.08	1.000	-.29	.16
	SSH	NITIH	-.22	.08	.063	-.45	.01
		NITIL	-.48	.08	.000	-.70	-.25
		SSL	-.55	.08	.000	-.77	-.32
	SSL	NITIH	.33	.08	.001	.10	.55
		NITIL	.07	.08	1.000	-.16	.29
		SSH	.55	.08	.000	.32	.77
25	NITIH	NITIL	.00	.07	1.000	-.18	.18
		SSH	.33	.07	.000	.15	.51
		SSL	.14	.07	.191	-.03	.32
	NITIL	NITIH	.00	.07	1.000	-.18	.18
		SSH	.33	.07	.000	.15	.51
		SSL	.15	.07	.179	-.03	.32
	SSH	NITIH	-.33	.07	.000	-.51	-.15

			NITIL	-.33	.07	.000	-.51	-.15
			SSL	-.18	.07	.036	-.36	-.01
		SSL	NITIH	-.14	.07	.191	-.32	.03
			NITIL	-.15	.07	.179	-.32	.03
			SSH	.18	.07	.036	.01	.36
	26	NITIH	NITIL	-.01	.02	1.000	-.05	.03
			SSH	-.01	.02	1.000	-.05	.04
			SSL	.00	.02	1.000	-.04	.04
		NITIL	NITIH	.01	.02	1.000	-.03	.05
			SSH	.01	.02	1.000	-.03	.05
			SSL	.01	.02	1.000	-.03	.05
		SSH	NITIH	.01	.02	1.000	-.04	.05
			NITIL	-.01	.02	1.000	-.05	.03
			SSL	.01	.02	1.000	-.04	.05
		SSL	NITIH	.00	.02	1.000	-.04	.04
			NITIL	-.01	.02	1.000	-.05	.03
			SSH	-.01	.02	1.000	-.05	.04
	27	NITIH	NITIL	.02	.02	1.000	-.04	.08
			SSH	-.07	.02	.014	-.12	-.01
			SSL	.01	.02	1.000	-.05	.07
		NITIL	NITIH	-.02	.02	1.000	-.08	.04
			SSH	-.08	.02	.001	-.14	-.03
			SSL	-.01	.02	1.000	-.06	.05
		SSH	NITIH	.07	.02	.014	.01	.12
			NITIL	.08	.02	.001	.03	.14
			SSL	.08	.02	.002	.02	.13
		SSL	NITIH	-.01	.02	1.000	-.07	.05
			NITIL	.01	.02	1.000	-.05	.06
			SSH	-.08	.02	.002	-.13	-.02

Appendix E- Descriptive Data for the Mandibular Arch for NitiH, NitiL, SSH and SSL Groups for all Measured Outputs (Fx, Fy, Fz, Mx, My and Mz).

- Fx, Fy and Fz measured in Newton's (N)
- Mx, My and Mz measured in Newton-millimeters (Nmm)

WireElastic		N	Minimum	Maximum	Mean	Std. Deviation
NiTiH	Fx47	44.00	.00	.00	.00	.00
	Fy47	44.00	-.01	.00	.00	.00
	Fz47	44.00	.00	.00	.00	.00
	Mx47	44.00	-.20	.19	-.03	.11
	My47	44.00	-.04	.04	.00	.02
	Mz47	44.00	-.09	.09	.00	.05
	Fx46	44.00	-1.75	-1.42	-1.58	.08
	Fy46	44.00	-.23	-.18	-.21	.01
	Fz46	44.00	1.04	1.29	1.16	.06
	Mx46	44.00	4.66	6.63	5.27	.37
	My46	44.00	5.44	6.90	6.14	.32
	Mz46	44.00	2.45	3.04	2.76	.13
	Fx45	44.00	.00	.00	.00	.00
	Fy45	44.00	-.03	.02	.00	.01
	Fz45	44.00	-.01	.00	.00	.00
	Mx45	44.00	-.99	.50	-.02	.31
	My45	44.00	-.02	.02	.00	.01
	Mz45	44.00	-.13	.09	.00	.04
	Fx44	44.00	-.01	.00	.00	.00
	Fy44	44.00	-.02	.00	-.01	.00
	Fz44	44.00	-.02	.00	.00	.00
	Mx44	44.00	-1.19	.24	-.09	.20
	My44	44.00	-.10	.10	-.02	.05
	Mz44	44.00	-.06	.49	.02	.08
	Fx43	44.00	.00	.00	.00	.00
	Fy43	44.00	.00	.00	.00	.00
	Fz43	44.00	-.01	.00	.00	.00
	Mx43	44.00	-.17	.11	-.07	.06
	My43	44.00	-.06	.04	-.02	.02
	Mz43	44.00	-.05	.06	.00	.02
	Fx42	44.00	.00	.00	.00	.00
	Fy42	44.00	.00	.00	.00	.00
	Fz42	44.00	-.01	.00	.00	.00
	Mx42	44.00	-.29	.05	-.13	.07
	My42	44.00	-.07	.03	-.02	.02

Mz42	44.00	-.03	.04	-.01	.02
Fx41	44.00	.00	.00	.00	.00
Fy41	44.00	.00	.00	.00	.00
Fz41	44.00	-.02	.02	.00	.01
Mx41	44.00	-.63	.76	-.14	.32
My41	44.00	-.06	.04	-.01	.03
Mz41	44.00	-.12	.06	-.02	.03
Fx31	44.00	.00	.00	.00	.00
Fy31	44.00	-.01	.00	.00	.00
Fz31	44.00	-.01	.00	.00	.00
Mx31	44.00	-.58	.06	-.14	.10
My31	44.00	-.13	.02	-.02	.02
Mz31	44.00	-.17	.05	-.01	.03
Fx32	44.00	.00	.00	.00	.00
Fy32	44.00	-.01	.00	.00	.00
Fz32	44.00	-.02	.00	-.01	.01
Mx32	44.00	-.87	.16	-.40	.24
My32	44.00	-.25	.04	-.10	.06
Mz32	44.00	-.07	.03	.01	.02
Fx33	44.00	.00	.00	.00	.00
Fy33	44.00	.00	.00	.00	.00
Fz33	44.00	-.01	.00	.00	.00
Mx33	44.00	-.27	.15	-.09	.10
My33	44.00	-.10	.05	-.03	.04
Mz33	44.00	-.02	.04	.00	.02
Fx34	44.00	.00	.00	.00	.00
Fy34	44.00	-.02	.00	-.01	.01
Fz34	44.00	-.01	.00	.00	.00
Mx34	44.00	-.33	.16	-.10	.12
My34	44.00	-.08	.04	-.02	.03
Mz34	44.00	-.05	.05	-.01	.02
Fx35	44.00	-.18	.03	-.07	.04
Fy35	44.00	-.39	-.08	-.22	.08
Fz35	44.00	-.31	.07	-.10	.11
Mx35	44.00	.36	.89	.64	.14
My35	44.00	-.46	-.10	-.27	.08
Mz35	44.00	-.15	.29	.04	.13
Fx36	44.00	-1.75	-1.43	-1.60	.08
Fy36	44.00	-.44	-.22	-.33	.06
Fz36	44.00	.90	1.30	1.09	.10
Mx36	44.00	-1.37	-.20	-.88	.24
My36	44.00	3.77	4.82	4.27	.26
Mz36	44.00	-.40	.03	-.19	.12
Fx37	44.00	.00	.00	.00	.00
Fy37	44.00	-.01	.00	.00	.00
Fz37	44.00	-.01	.00	.00	.00

	Mx37	44.00	-.37	.26	-.01	.20
	My37	44.00	-.14	.17	.00	.08
	Mz37	44.00	-.11	.12	.00	.05
NiTiL	Fx47	44.00	.00	.00	.00	.00
	Fy47	44.00	.00	.00	.00	.00
	Fz47	44.00	.00	.00	.00	.00
	Mx47	44.00	-.25	.19	.01	.11
	My47	44.00	-.05	.08	.01	.02
	Mz47	44.00	-.10	.07	.01	.04
	Fx46	44.00	-.67	-.43	-.54	.05
	Fy46	44.00	-.08	-.06	-.07	.01
	Fz46	44.00	.31	.49	.38	.04
	Mx46	44.00	-.45	2.77	1.72	.47
	My46	44.00	1.67	2.53	2.09	.19
	Mz46	44.00	.80	1.22	1.04	.09
	Fx45	44.00	.00	.00	.00	.00
	Fy45	44.00	-.02	.02	.00	.01
	Fz45	44.00	-.01	.00	.00	.00
	Mx45	44.00	-.77	.42	-.02	.29
	My45	44.00	-.03	.01	.00	.01
	Mz45	44.00	-.09	.07	.00	.04
	Fx44	44.00	.00	.00	.00	.00
	Fy44	44.00	-.01	.01	.00	.00
	Fz44	44.00	-.01	.02	.00	.00
	Mx44	44.00	-.25	1.25	-.01	.23
	My44	44.00	-.08	.17	-.01	.04
	Mz44	44.00	-.30	.05	.00	.05
	Fx43	44.00	.00	.00	.00	.00
	Fy43	44.00	.00	.00	.00	.00
	Fz43	44.00	.00	.00	.00	.00
	Mx43	44.00	-.21	.06	-.06	.06
	My43	44.00	-.08	.02	-.02	.02
	Mz43	44.00	-.04	.03	-.01	.02
	Fx42	44.00	.00	.00	.00	.00
	Fy42	44.00	.00	.00	.00	.00
	Fz42	44.00	-.01	.00	.00	.00
	Mx42	44.00	-.24	.06	-.11	.07
	My42	44.00	-.07	.01	-.01	.02
	Mz42	44.00	-.06	.02	-.01	.02
	Fx41	44.00	.00	.00	.00	.00
	Fy41	44.00	.00	.00	.00	.00
	Fz41	44.00	-.02	.02	.00	.01
	Mx41	44.00	-.71	.56	-.20	.28
	My41	44.00	-.07	.04	-.01	.02
	Mz41	44.00	-.08	.08	-.01	.03
	Fx31	44.00	.00	.00	.00	.00

	Fy31	44.00	.00	.00	.00	.00
	Fz31	44.00	-.01	.00	.00	.00
	Mx31	44.00	-.27	.03	-.12	.07
	My31	44.00	-.05	.03	-.02	.01
	Mz31	44.00	-.06	.06	-.01	.02
	Fx32	44.00	.00	.00	.00	.00
	Fy32	44.00	.00	.00	.00	.00
	Fz32	44.00	-.02	.00	-.01	.01
	Mx32	44.00	-.82	.11	-.40	.22
	My32	44.00	-.20	.04	-.10	.06
	Mz32	44.00	-.04	.03	.00	.02
	Fx33	44.00	.00	.00	.00	.00
	Fy33	44.00	.00	.00	.00	.00
	Fz33	44.00	-.01	.00	.00	.00
	Mx33	44.00	-.31	.07	-.08	.10
	My33	44.00	-.13	.05	-.02	.04
	Mz33	44.00	-.04	.05	.01	.02
	Fx34	44.00	.00	.00	.00	.00
	Fy34	44.00	-.01	.00	.00	.00
	Fz34	44.00	-.01	.00	.00	.00
	Mx34	44.00	-.35	.10	-.08	.11
	My34	44.00	-.08	.03	-.02	.02
	Mz34	44.00	-.03	.03	.00	.01
	Fx35	44.00	-.07	.00	-.03	.01
	Fy35	44.00	-.11	-.02	-.07	.03
	Fz35	44.00	-.08	.03	-.04	.03
	Mx35	44.00	-.01	.44	.22	.10
	My35	44.00	-.15	-.03	-.10	.03
	Mz35	44.00	-.06	.11	.00	.04
	Fx36	44.00	-.66	-.45	-.55	.04
	Fy36	44.00	-.17	-.09	-.12	.02
	Fz36	44.00	.30	.48	.37	.04
	Mx36	44.00	-.68	-.08	-.34	.14
	My36	44.00	1.14	1.71	1.39	.13
	Mz36	44.00	-.17	.06	-.05	.05
	Fx37	44.00	.00	.00	.00	.00
	Fy37	44.00	-.01	.00	.00	.00
	Fz37	44.00	-.01	.00	.00	.00
	Mx37	44.00	-.42	.25	.03	.18
	My37	44.00	-.18	.15	-.01	.07
	Mz37	44.00	-.16	.09	.00	.05
SSH	Fx47	44.00	.00	.02	.01	.00
	Fy47	44.00	.00	.10	.07	.02
	Fz47	44.00	.00	.13	.06	.04
	Mx47	44.00	-.14	.30	.08	.13
	My47	44.00	-.18	.22	-.02	.11
	Mz47	44.00	-.26	.00	-.11	.06

Fx46	44.00	-1.79	-.83	-1.56	.14
Fy46	44.00	-.41	-.17	-.34	.04
Fz46	44.00	.55	1.24	1.07	.11
Mx46	44.00	2.73	6.07	5.19	.51
My46	44.00	3.50	7.39	6.44	.60
Mz46	44.00	1.68	3.82	3.27	.33
Fx45	44.00	.00	.00	.00	.00
Fy45	44.00	-.02	.05	.01	.02
Fz45	44.00	.00	.01	.00	.00
Mx45	44.00	-.72	.70	-.05	.33
My45	44.00	-.03	.03	-.01	.01
Mz45	44.00	-.13	.05	-.02	.04
Fx44	44.00	.00	.00	.00	.00
Fy44	44.00	.00	.00	.00	.00
Fz44	44.00	-.01	.04	.01	.01
Mx44	44.00	-.23	.04	-.09	.06
My44	44.00	-.06	.10	.02	.05
Mz44	44.00	-.03	.11	.01	.02
Fx43	44.00	-.01	.08	.03	.02
Fy43	44.00	.00	.07	.03	.01
Fz43	44.00	-.02	.01	.00	.01
Mx43	44.00	-.30	-.03	-.16	.06
My43	44.00	-.36	-.05	-.20	.07
Mz43	44.00	-.05	.68	.48	.12
Fx42	44.00	.00	.02	.00	.00
Fy42	44.00	-.03	.02	-.01	.01
Fz42	44.00	-.02	.00	.00	.00
Mx42	44.00	-.37	.04	-.12	.07
My42	44.00	-.15	.02	-.02	.03
Mz42	44.00	-.12	.05	-.01	.02
Fx41	44.00	.00	.01	.00	.00
Fy41	44.00	-.01	.05	.02	.01
Fz41	44.00	-.03	.04	.00	.01
Mx41	44.00	-1.03	.91	-.16	.38
My41	44.00	-.09	.02	-.03	.03
Mz41	44.00	-.11	.05	-.01	.03
Fx31	44.00	.00	.00	.00	.00
Fy31	44.00	-.06	.05	.00	.02
Fz31	44.00	-.01	.00	.00	.00
Mx31	44.00	-.25	-.01	-.14	.05
My31	44.00	-.05	.01	-.02	.01
Mz31	44.00	-.10	.07	-.01	.03
Fx32	44.00	-.08	.00	-.03	.02
Fy32	44.00	-.03	.07	.01	.02
Fz32	44.00	-.04	-.01	-.02	.01
Mx32	44.00	-1.01	.01	-.46	.19
My32	44.00	-.24	.11	-.06	.07

	Mz32	44.00	-.17	.67	.19	.17
	Fx33	44.00	-.02	.03	.00	.01
	Fy33	44.00	-.11	.07	.01	.03
	Fz33	44.00	-.03	.06	.00	.02
	Mx33	44.00	-.33	-.02	-.13	.07
	My33	44.00	-.10	.31	.12	.12
	Mz33	44.00	-.28	.23	.04	.09
	Fx34	44.00	-.03	.01	.00	.01
	Fy34	44.00	-.05	.17	-.01	.04
	Fz34	44.00	-.09	.04	.01	.02
	Mx34	44.00	-.31	.10	-.10	.09
	My34	44.00	-.13	.09	-.01	.04
	Mz34	44.00	-.09	.24	.00	.06
	Fx35	44.00	-.07	.02	-.02	.02
	Fy35	44.00	-.31	.22	.09	.08
	Fz35	44.00	-.20	.03	-.07	.05
	Mx35	44.00	-.05	.77	.23	.13
	My35	44.00	-.37	.14	-.13	.14
	Mz35	44.00	.08	1.54	1.07	.25
	Fx36	44.00	-1.74	-.88	-1.53	.13
	Fy36	44.00	-.97	-.26	-.76	.11
	Fz36	44.00	.60	1.21	1.07	.10
	Mx36	44.00	-.64	-.02	-.34	.15
	My36	44.00	2.37	4.66	4.04	.35
	Mz36	44.00	-.33	.30	.12	.10
	Fx37	44.00	-.07	.02	-.01	.02
	Fy37	44.00	.00	.22	.13	.03
	Fz37	44.00	-.08	.03	-.02	.03
	Mx37	44.00	-.34	.33	.11	.17
	My37	44.00	-.37	.39	-.02	.19
	Mz37	44.00	-.67	-.08	-.40	.11
SSL	Fx47	44.00	.00	.01	.00	.00
	Fy47	44.00	.01	.05	.03	.01
	Fz47	44.00	-.01	.08	.02	.02
	Mx47	44.00	-.23	.17	.00	.11
	My47	44.00	-.11	.11	-.02	.04
	Mz47	44.00	-.23	-.02	-.13	.06
	Fx46	44.00	-.64	-.47	-.54	.04
	Fy46	44.00	-.17	-.09	-.13	.02
	Fz46	44.00	.27	.43	.35	.04
	Mx46	44.00	1.20	2.26	1.76	.26
	My46	44.00	1.91	2.73	2.23	.20
	Mz46	44.00	1.04	1.58	1.27	.12
	Fx45	44.00	.00	.00	.00	.00
	Fy45	44.00	-.02	.05	.01	.02
	Fz45	44.00	.00	.01	.00	.00
	Mx45	44.00	-.83	.73	-.05	.36

My45	44.00	-.04	.02	.00	.01
Mz45	44.00	-.10	.10	-.03	.05
Fx44	44.00	.00	.00	.00	.00
Fy44	44.00	.00	.00	.00	.00
Fz44	44.00	-.02	.02	.00	.01
Mx44	44.00	-.69	.04	-.11	.11
My44	44.00	-.26	.06	-.03	.05
Mz44	44.00	-.08	.05	-.01	.03
Fx43	44.00	.00	.03	.01	.01
Fy43	44.00	-.02	.03	.02	.01
Fz43	44.00	-.01	.01	.00	.01
Mx43	44.00	-.24	-.01	-.13	.07
My43	44.00	-.31	-.01	-.14	.07
Mz43	44.00	.12	.33	.24	.05
Fx42	44.00	.00	.01	.00	.00
Fy42	44.00	-.02	.02	-.01	.01
Fz42	44.00	-.01	.00	.00	.00
Mx42	44.00	-.32	.01	-.13	.07
My42	44.00	-.09	.08	-.02	.03
Mz42	44.00	-.09	.08	-.02	.03
Fx41	44.00	-.01	.01	.00	.00
Fy41	44.00	-.01	.03	.01	.01
Fz41	44.00	-.02	.03	.00	.01
Mx41	44.00	-.72	.64	-.08	.33
My41	44.00	-.08	.03	-.02	.02
Mz41	44.00	-.08	.14	-.01	.04
Fx31	44.00	.00	.00	.00	.00
Fy31	44.00	-.01	.02	.00	.01
Fz31	44.00	-.01	.00	.00	.00
Mx31	44.00	-.26	.02	-.15	.06
My31	44.00	-.06	.01	-.02	.01
Mz31	44.00	-.06	.02	-.01	.02
Fx32	44.00	-.04	.00	-.01	.01
Fy32	44.00	-.03	.04	.00	.02
Fz32	44.00	-.03	.00	-.01	.01
Mx32	44.00	-.79	.09	-.46	.19
My32	44.00	-.22	.06	-.11	.07
Mz32	44.00	-.16	.19	.05	.09
Fx33	44.00	-.03	.01	-.01	.01
Fy33	44.00	-.03	.09	.02	.03
Fz33	44.00	-.03	.01	.00	.01
Mx33	44.00	-.30	.10	-.13	.09
My33	44.00	-.11	.23	.01	.08
Mz33	44.00	-.10	.26	.05	.08
Fx34	44.00	-.01	.01	.00	.01
Fy34	44.00	-.07	.09	-.03	.03

Fz34	44.00	-.04	.04	.01	.02
Mx34	44.00	-.32	.13	-.14	.11
My34	44.00	-.10	.09	-.02	.04
Mz34	44.00	-.10	.16	-.03	.04
Fx35	44.00	-.04	.01	-.01	.01
Fy35	44.00	-.03	.13	.05	.04
Fz35	44.00	-.12	.02	-.05	.04
Mx35	44.00	-.24	.21	.01	.11
My35	44.00	-.30	.15	-.07	.09
Mz35	44.00	-.01	.73	.23	.14
Fx36	44.00	-.64	-.41	-.52	.05
Fy36	44.00	-.32	-.12	-.24	.05
Fz36	44.00	.27	.51	.39	.06
Mx36	44.00	-.70	.00	-.31	.16
My36	44.00	.99	1.74	1.31	.19
Mz36	44.00	-.12	.34	.05	.11
Fx37	44.00	-.03	.02	.00	.01
Fy37	44.00	.00	.07	.03	.02
Fz37	44.00	-.09	.03	-.03	.03
Mx37	44.00	-.37	.34	-.03	.19
My37	44.00	-.47	.20	-.10	.16
Mz37	44.00	-.31	.07	-.10	.08

Appendix F- Pairwise Comparisons for the Mandibular Teeth for NitiH, NitiL, SSH and SSL Groups for all Measured Outputs (Fx, Fy, Fz, Mx, My and Mz).

- Fx, Fy and Fz measured in Newton's (N)
- Mx, My and Mz measured in Newton-millimeters (Nmm)

Pairwise Comparisons

Measure	Tooth	Wire Elastic	Wire Elastic	Mean Difference	Std. Error	Sig.	95% Confidence Interval for Difference Lower Bound	95% Confidence Interval for Difference Upper Bound
Fx	47	NiTiH	NiTiL	.00	.00	1.000	.00	.00
			SSH	-.01	.00	.000	-.01	.00
			SSL	.00	.00	.001	.00	.00
		NiTiL	NiTiH	.00	.00	1.000	.00	.00
			SSH	-.01	.00	.000	-.01	.00
			SSL	.00	.00	.000	.00	.00
		SSH	NiTiH	.01	.00	.000	.00	.01
			NiTiL	.01	.00	.000	.00	.01
			SSL	.00	.00	.000	.00	.00
		SSL	NiTiH	.00	.00	.001	.00	.00
			NiTiL	.00	.00	.000	.00	.00
			SSH	.00	.00	.000	.00	.00
	46	NiTiH	NiTiL	-1.04	.02	.000	-1.09	-.99
			SSH	-.02	.02	1.000	-.07	.03
			SSL	-1.03	.02	.000	-1.08	-.98
		NiTiL	NiTiH	1.04	.02	.000	.99	1.09
			SSH	1.02	.02	.000	.97	1.07
			SSL	.01	.02	1.000	-.04	.06
		SSH	NiTiH	.02	.02	1.000	-.03	.07
			NiTiL	-1.02	.02	.000	-1.07	-.97
			SSL	-1.01	.02	.000	-1.06	-.96
		SSL	NiTiH	1.03	.02	.000	.98	1.08
			NiTiL	-.01	.02	1.000	-.06	.04
			SSH	1.01	.02	.000	.96	1.06
	45	NiTiH	NiTiL	.00	.00	1.000	.00	.00
			SSH	.00	.00	.485	.00	.00
			SSL	.00	.00	.573	.00	.00
		NiTiL	NiTiH	.00	.00	1.000	.00	.00
			SSH	.00	.00	.634	.00	.00
			SSL	.00	.00	.743	.00	.00
		SSH	NiTiH	.00	.00	.485	.00	.00

		NiTiL	.00	.00	.634	.00	.00
		SSL	.00	.00	1.000	.00	.00
	SSL	NiTiH	.00	.00	.573	.00	.00
		NiTiL	.00	.00	.743	.00	.00
		SSH	.00	.00	1.000	.00	.00
44	NiTiH	NiTiL	.00	.00	1.000	.00	.00
		SSH	.00	.00	1.000	.00	.00
		SSL	.00	.00	.813	.00	.00
	NiTiL	NiTiH	.00	.00	1.000	.00	.00
		SSH	.00	.00	.477	.00	.00
		SSL	.00	.00	1.000	.00	.00
	SSH	NiTiH	.00	.00	1.000	.00	.00
		NiTiL	.00	.00	.477	.00	.00
		SSL	.00	.00	.106	.00	.00
	SSL	NiTiH	.00	.00	.813	.00	.00
		NiTiL	.00	.00	1.000	.00	.00
		SSH	.00	.00	.106	.00	.00
43	NiTiH	NiTiL	.00	.00	1.000	-.01	.01
		SSH	-.03	.00	.000	-.03	-.02
		SSL	-.01	.00	.000	-.02	-.01
	NiTiL	NiTiH	.00	.00	1.000	-.01	.01
		SSH	-.03	.00	.000	-.03	-.02
		SSL	-.01	.00	.000	-.02	-.01
	SSH	NiTiH	.03	.00	.000	.02	.03
		NiTiL	.03	.00	.000	.02	.03
		SSL	.01	.00	.000	.01	.02
	SSL	NiTiH	.01	.00	.000	.01	.02
		NiTiL	.01	.00	.000	.01	.02
		SSH	-.01	.00	.000	-.02	-.01
42	NiTiH	NiTiL	.00	.00	1.000	.00	.00
		SSH	.00	.00	.000	.00	.00
		SSL	.00	.00	.000	.00	.00
	NiTiL	NiTiH	.00	.00	1.000	.00	.00
		SSH	.00	.00	.000	.00	.00
		SSL	.00	.00	.000	.00	.00
	SSH	NiTiH	.00	.00	.000	.00	.00
		NiTiL	.00	.00	.000	.00	.00
		SSL	.00	.00	1.000	.00	.00
	SSL	NiTiH	.00	.00	.000	.00	.00
		NiTiL	.00	.00	.000	.00	.00
		SSH	.00	.00	1.000	.00	.00
41	NiTiH	NiTiL	.00	.00	1.000	.00	.00
		SSH	.00	.00	1.000	.00	.00
		SSL	.00	.00	1.000	.00	.00
	NiTiL	NiTiH	.00	.00	1.000	.00	.00
		SSH	.00	.00	1.000	.00	.00
		SSL	.00	.00	1.000	.00	.00

	SSH	NiTiH	.00	.00	1.000	.00	.00
		NiTiL	.00	.00	1.000	.00	.00
		SSL	.00	.00	1.000	.00	.00
	SSL	NiTiH	.00	.00	1.000	.00	.00
		NiTiL	.00	.00	1.000	.00	.00
		SSH	.00	.00	1.000	.00	.00
31	NiTiH	NiTiL	.00	.00	1.000	.00	.00
		SSH	.00	.00	1.000	.00	.00
		SSL	.00	.00	1.000	.00	.00
	NiTiL	NiTiH	.00	.00	1.000	.00	.00
		SSH	.00	.00	1.000	.00	.00
		SSL	.00	.00	1.000	.00	.00
	SSH	NiTiH	.00	.00	1.000	.00	.00
		NiTiL	.00	.00	1.000	.00	.00
		SSL	.00	.00	1.000	.00	.00
	SSL	NiTiH	.00	.00	1.000	.00	.00
		NiTiL	.00	.00	1.000	.00	.00
		SSH	.00	.00	1.000	.00	.00
32	NiTiH	NiTiL	.00	.00	1.000	-.01	.01
		SSH	.03	.00	.000	.02	.04
		SSL	.01	.00	.000	.01	.02
	NiTiL	NiTiH	.00	.00	1.000	-.01	.01
		SSH	.03	.00	.000	.02	.04
		SSL	.01	.00	.000	.01	.02
	SSH	NiTiH	-.03	.00	.000	-.04	-.02
		NiTiL	-.03	.00	.000	-.04	-.02
		SSL	-.02	.00	.000	-.02	-.01
	SSL	NiTiH	-.01	.00	.000	-.02	-.01
		NiTiL	-.01	.00	.000	-.02	-.01
		SSH	.02	.00	.000	.01	.02
33	NiTiH	NiTiL	.00	.00	1.000	.00	.00
		SSH	.00	.00	.022	.00	.01
		SSL	.01	.00	.002	.00	.01
	NiTiL	NiTiH	.00	.00	1.000	.00	.00
		SSH	.00	.00	.024	.00	.01
		SSL	.01	.00	.002	.00	.01
	SSH	NiTiH	.00	.00	.022	-.01	.00
		NiTiL	.00	.00	.024	-.01	.00
		SSL	.00	.00	1.000	.00	.00
	SSL	NiTiH	-.01	.00	.002	-.01	.00
		NiTiL	-.01	.00	.002	-.01	.00
		SSH	.00	.00	1.000	.00	.00
34	NiTiH	NiTiL	.00	.00	1.000	.00	.00
		SSH	.00	.00	.002	.00	.01
		SSL	.00	.00	.705	.00	.00
	NiTiL	NiTiH	.00	.00	1.000	.00	.00
		SSH	.00	.00	.002	.00	.01

			SSL	.00	.00	.572	.00	.00
		SSH	NiTiH	.00	.00	.002	-.01	.00
			NiTiL	.00	.00	.002	-.01	.00
			SSL	.00	.00	.262	.00	.00
		SSL	NiTiH	.00	.00	.705	.00	.00
			NiTiL	.00	.00	.572	.00	.00
			SSH	.00	.00	.262	.00	.00
	35	NiTiH	NiTiL	-.04	.01	.000	-.05	-.02
			SSH	-.05	.01	.000	-.07	-.04
			SSL	-.06	.01	.000	-.08	-.05
		NiTiL	NiTiH	.04	.01	.000	.02	.05
			SSH	-.01	.01	.025	-.03	.00
			SSL	-.03	.01	.000	-.04	-.01
		SSH	NiTiH	.05	.01	.000	.04	.07
			NiTiL	.01	.01	.025	.00	.03
			SSL	-.01	.01	.079	-.03	.00
		SSL	NiTiH	.06	.01	.000	.05	.08
			NiTiL	.03	.01	.000	.01	.04
			SSH	.01	.01	.079	.00	.03
	36	NiTiH	NiTiL	-1.05	.02	.000	-1.10	-1.01
			SSH	-.07	.02	.000	-.12	-.03
			SSL	-1.09	.02	.000	-1.14	-1.04
		NiTiL	NiTiH	1.05	.02	.000	1.01	1.10
			SSH	.98	.02	.000	.93	1.03
			SSL	-.03	.02	.441	-.08	.02
		SSH	NiTiH	.07	.02	.000	.03	.12
			NiTiL	-.98	.02	.000	-1.03	-.93
			SSL	-1.01	.02	.000	-1.06	-.96
		SSL	NiTiH	1.09	.02	.000	1.04	1.14
			NiTiL	.03	.02	.441	-.02	.08
			SSH	1.01	.02	.000	.96	1.06
	37	NiTiH	NiTiL	.00	.00	1.000	-.01	.01
			SSH	.01	.00	.000	.01	.02
			SSL	.00	.00	1.000	-.01	.01
		NiTiL	NiTiH	.00	.00	1.000	-.01	.01
			SSH	.01	.00	.000	.01	.02
			SSL	.00	.00	1.000	-.01	.01
		SSH	NiTiH	-.01	.00	.000	-.02	-.01
			NiTiL	-.01	.00	.000	-.02	-.01
			SSL	-.01	.00	.000	-.02	-.01
		SSL	NiTiH	.00	.00	1.000	-.01	.01
			NiTiL	.00	.00	1.000	-.01	.01
			SSH	.01	.00	.000	.01	.02
Fy	47	NiTiH	NiTiL	.00	.00	1.000	-.01	.00
			SSH	-.07	.00	.000	-.08	-.07
			SSL	-.03	.00	.000	-.04	-.03
		NiTiL	NiTiH	.00	.00	1.000	.00	.01
			SSH	-.07	.00	.000	-.08	-.07

		SSL	-.03	.00	.000	-.04	-.03
	SSH	NiTiH	.07	.00	.000	.07	.08
		NiTiL	.07	.00	.000	.07	.08
		SSL	.04	.00	.000	.04	.05
	SSL	NiTiH	.03	.00	.000	.03	.04
		NiTiL	.03	.00	.000	.03	.04
		SSH	-.04	.00	.000	-.05	-.04
46	NiTiH	NiTiL	-.14	.01	.000	-.15	-.13
		SSH	.14	.01	.000	.12	.15
		SSL	-.08	.01	.000	-.09	-.06
	NiTiL	NiTiH	.14	.01	.000	.13	.15
		SSH	.28	.01	.000	.26	.29
		SSL	.06	.01	.000	.05	.08
	SSH	NiTiH	-.14	.01	.000	-.15	-.12
		NiTiL	-.28	.01	.000	-.29	-.26
		SSL	-.21	.01	.000	-.22	-.20
	SSL	NiTiH	.08	.01	.000	.06	.09
		NiTiL	-.06	.01	.000	-.08	-.05
		SSH	.21	.01	.000	.20	.22
45	NiTiH	NiTiL	.00	.00	1.000	-.01	.01
		SSH	-.01	.00	.002	-.02	.00
		SSL	-.01	.00	.000	-.02	-.01
	NiTiL	NiTiH	.00	.00	1.000	-.01	.01
		SSH	-.01	.00	.001	-.02	.00
		SSL	-.01	.00	.000	-.02	-.01
	SSH	NiTiH	.01	.00	.002	.00	.02
		NiTiL	.01	.00	.001	.00	.02
		SSL	.00	.00	1.000	-.01	.01
	SSL	NiTiH	.01	.00	.000	.01	.02
		NiTiL	.01	.00	.000	.01	.02
		SSH	.00	.00	1.000	-.01	.01
44	NiTiH	NiTiL	.00	.00	.000	-.01	.00
		SSH	-.01	.00	.000	-.01	-.01
		SSL	-.01	.00	.000	-.01	.00
	NiTiL	NiTiH	.00	.00	.000	.00	.01
		SSH	.00	.00	.000	.00	.00
		SSL	.00	.00	.001	.00	.00
	SSH	NiTiH	.01	.00	.000	.01	.01
		NiTiL	.00	.00	.000	.00	.00
		SSL	.00	.00	1.000	.00	.00
	SSL	NiTiH	.01	.00	.000	.00	.01
		NiTiL	.00	.00	.001	.00	.00
		SSH	.00	.00	1.000	.00	.00
43	NiTiH	NiTiL	.00	.00	1.000	-.01	.01
		SSH	-.03	.00	.000	-.04	-.03
		SSL	-.02	.00	.000	-.02	-.01
	NiTiL	NiTiH	.00	.00	1.000	-.01	.01
		SSH	-.03	.00	.000	-.04	-.03
		SSL	-.02	.00	.000	-.02	-.01
	SSH	NiTiH	.03	.00	.000	.03	.04
		NiTiL	.03	.00	.000	.03	.04

		SSL	.02	.00	.000	.01	.02
	SSL	NiTiH	.02	.00	.000	.01	.02
		NiTiL	.02	.00	.000	.01	.02
		SSH	-.02	.00	.000	-.02	-.01
42	NiTiH	NiTiL	.00	.00	1.000	.00	.00
		SSH	.01	.00	.000	.00	.01
		SSL	.01	.00	.006	.00	.01
	NiTiL	NiTiH	.00	.00	1.000	.00	.00
		SSH	.01	.00	.000	.00	.01
		SSL	.01	.00	.005	.00	.01
	SSH	NiTiH	-.01	.00	.000	-.01	.00
		NiTiL	-.01	.00	.000	-.01	.00
		SSL	.00	.00	1.000	-.01	.00
	SSL	NiTiH	-.01	.00	.006	-.01	.00
		NiTiL	-.01	.00	.005	-.01	.00
		SSH	.00	.00	1.000	.00	.01
41	NiTiH	NiTiL	.00	.00	1.000	.00	.00
		SSH	-.02	.00	.000	-.02	-.01
		SSL	-.01	.00	.000	-.02	-.01
	NiTiL	NiTiH	.00	.00	1.000	.00	.00
		SSH	-.02	.00	.000	-.02	-.01
		SSL	-.01	.00	.000	-.02	-.01
	SSH	NiTiH	.02	.00	.000	.01	.02
		NiTiL	.02	.00	.000	.01	.02
		SSL	.00	.00	.068	.00	.01
	SSL	NiTiH	.01	.00	.000	.01	.02
		NiTiL	.01	.00	.000	.01	.02
		SSH	.00	.00	.068	-.01	.00
31	NiTiH	NiTiL	.00	.00	1.000	-.01	.01
		SSH	.00	.00	1.000	-.01	.01
		SSL	.00	.00	1.000	-.01	.00
	NiTiL	NiTiH	.00	.00	1.000	-.01	.01
		SSH	.00	.00	1.000	-.01	.01
		SSL	.00	.00	1.000	-.01	.00
	SSH	NiTiH	.00	.00	1.000	-.01	.01
		NiTiL	.00	.00	1.000	-.01	.01
		SSL	.00	.00	1.000	-.01	.00
	SSL	NiTiH	.00	.00	1.000	.00	.01
		NiTiL	.00	.00	1.000	.00	.01
		SSH	.00	.00	1.000	.00	.01
32	NiTiH	NiTiL	.00	.00	1.000	-.01	.01
		SSH	-.01	.00	.000	-.02	-.01
		SSL	-.01	.00	.530	-.01	.00
	NiTiL	NiTiH	.00	.00	1.000	-.01	.01
		SSH	-.01	.00	.000	-.02	-.01
		SSL	.00	.00	.698	-.01	.00
	SSH	NiTiH	.01	.00	.000	.01	.02
		NiTiL	.01	.00	.000	.01	.02
		SSL	.01	.00	.020	.00	.02
	SSL	NiTiH	.01	.00	.530	.00	.01
		NiTiL	.00	.00	.698	.00	.01

		SSH	-.01	.00	.020	-.02	.00
33	NiTiH	NiTiL	.00	.00	1.000	-.01	.01
		SSH	-.01	.00	.874	-.02	.01
		SSL	-.02	.00	.003	-.03	.00
	NiTiL	NiTiH	.00	.00	1.000	-.01	.01
		SSH	-.01	.00	.892	-.02	.01
		SSL	-.02	.00	.003	-.03	.00
	SSH	NiTiH	.01	.00	.874	-.01	.02
		NiTiL	.01	.00	.892	-.01	.02
		SSL	-.01	.00	.247	-.02	.00
	SSL	NiTiH	.02	.00	.003	.00	.03
		NiTiL	.02	.00	.003	.00	.03
		SSH	.01	.00	.247	.00	.02
34	NiTiH	NiTiL	.00	.01	1.000	-.02	.01
		SSH	.00	.01	1.000	-.01	.01
		SSL	.02	.01	.000	.01	.04
	NiTiL	NiTiH	.00	.01	1.000	-.01	.02
		SSH	.00	.01	1.000	-.01	.02
		SSL	.03	.01	.000	.01	.04
	SSH	NiTiH	.00	.01	1.000	-.01	.01
		NiTiL	.00	.01	1.000	-.02	.01
		SSL	.02	.01	.000	.01	.03
	SSL	NiTiH	-.02	.01	.000	-.04	-.01
		NiTiL	-.03	.01	.000	-.04	-.01
		SSH	-.02	.01	.000	-.03	-.01
35	NiTiH	NiTiL	-.15	.01	.000	-.19	-.12
		SSH	-.31	.01	.000	-.35	-.27
		SSL	-.27	.01	.000	-.30	-.23
	NiTiL	NiTiH	.15	.01	.000	.12	.19
		SSH	-.16	.01	.000	-.19	-.12
		SSL	-.11	.01	.000	-.15	-.08
	SSH	NiTiH	.31	.01	.000	.27	.35
		NiTiL	.16	.01	.000	.12	.19
		SSL	.04	.01	.011	.01	.08
	SSL	NiTiH	.27	.01	.000	.23	.30
		NiTiL	.11	.01	.000	.08	.15
		SSH	-.04	.01	.011	-.08	-.01
36	NiTiH	NiTiL	-.21	.01	.000	-.25	-.17
		SSH	.43	.01	.000	.39	.47
		SSL	-.09	.01	.000	-.13	-.05
	NiTiL	NiTiH	.21	.01	.000	.17	.25
		SSH	.64	.01	.000	.60	.68
		SSL	.12	.01	.000	.08	.16
	SSH	NiTiH	-.43	.01	.000	-.47	-.39
		NiTiL	-.64	.01	.000	-.68	-.60
		SSL	-.52	.01	.000	-.56	-.48
	SSL	NiTiH	.09	.01	.000	.05	.13
		NiTiL	-.12	.01	.000	-.16	-.08
		SSH	.52	.01	.000	.48	.56
37	NiTiH	NiTiL	.00	.00	1.000	-.01	.01
		SSH	-.13	.00	.000	-.14	-.13

			SSL	-.03	.00	.000	-.04	-.02
		NiTiL	NiTiH	.00	.00	1.000	-.01	.01
			SSH	-.13	.00	.000	-.14	-.12
			SSL	-.03	.00	.000	-.04	-.02
		SSH	NiTiH	.13	.00	.000	.13	.14
			NiTiL	.13	.00	.000	.12	.14
			SSL	.10	.00	.000	.09	.11
		SSL	NiTiH	.03	.00	.000	.02	.04
			NiTiL	.03	.00	.000	.02	.04
			SSH	-.10	.00	.000	-.11	-.09
Fz	47	NiTiH	NiTiL	.00	.00	1.000	-.01	.01
			SSH	-.06	.00	.000	-.07	-.05
			SSL	-.02	.00	.000	-.03	-.01
		NiTiL	NiTiH	.00	.00	1.000	-.01	.01
			SSH	-.06	.00	.000	-.07	-.05
			SSL	-.02	.00	.000	-.03	-.01
		SSH	NiTiH	.06	.00	.000	.05	.07
			NiTiL	.06	.00	.000	.05	.07
			SSL	.04	.00	.000	.02	.05
		SSL	NiTiH	.02	.00	.000	.01	.03
			NiTiL	.02	.00	.000	.01	.03
			SSH	-.04	.00	.000	-.05	-.02
	46	NiTiH	NiTiL	.78	.01	.000	.74	.82
			SSH	.10	.01	.000	.06	.14
			SSL	.81	.01	.000	.77	.85
		NiTiL	NiTiH	-.78	.01	.000	-.82	-.74
			SSH	-.69	.01	.000	-.72	-.65
			SSL	.03	.01	.326	-.01	.07
		SSH	NiTiH	-.10	.01	.000	-.14	-.06
			NiTiL	.69	.01	.000	.65	.72
			SSL	.71	.01	.000	.67	.75
		SSL	NiTiH	-.81	.01	.000	-.85	-.77
			NiTiL	-.03	.01	.326	-.07	.01
			SSH	-.71	.01	.000	-.75	-.67
	45	NiTiH	NiTiL	.00	.00	.584	.00	.00
			SSH	.00	.00	.001	.00	.00
			SSL	.00	.00	.003	.00	.00
		NiTiL	NiTiH	.00	.00	.584	.00	.00
			SSH	.00	.00	.143	.00	.00
			SSL	.00	.00	.366	.00	.00
		SSH	NiTiH	.00	.00	.001	.00	.00
			NiTiL	.00	.00	.143	.00	.00
			SSL	.00	.00	1.000	.00	.00
		SSL	NiTiH	.00	.00	.003	.00	.00
			NiTiL	.00	.00	.366	.00	.00
			SSH	.00	.00	1.000	.00	.00
	44	NiTiH	NiTiL	.00	.00	1.000	-.01	.00
			SSH	-.01	.00	.000	-.02	-.01
			SSL	.00	.00	.394	-.01	.00
		NiTiL	NiTiH	.00	.00	1.000	.00	.01
			SSH	-.01	.00	.000	-.02	-.01

		SSL	.00	.00	1.000	-.01	.00
	SSH	NiTiH	.01	.00	.000	.01	.02
		NiTiL	.01	.00	.000	.01	.02
		SSL	.01	.00	.000	.01	.01
	SSL	NiTiH	.00	.00	.394	.00	.01
		NiTiL	.00	.00	1.000	.00	.01
		SSH	-.01	.00	.000	-.01	-.01
43	NiTiH	NiTiL	.00	.00	1.000	.00	.00
		SSH	.00	.00	1.000	.00	.00
		SSL	.00	.00	1.000	.00	.00
	NiTiL	NiTiH	.00	.00	1.000	.00	.00
		SSH	.00	.00	.832	.00	.01
		SSL	.00	.00	1.000	.00	.00
	SSH	NiTiH	.00	.00	1.000	.00	.00
		NiTiL	.00	.00	.832	-.01	.00
		SSL	.00	.00	.802	-.01	.00
	SSL	NiTiH	.00	.00	1.000	.00	.00
		NiTiL	.00	.00	1.000	.00	.00
		SSH	.00	.00	.802	.00	.01
42	NiTiH	NiTiL	.00	.00	1.000	.00	.00
		SSH	.00	.00	1.000	.00	.00
		SSL	.00	.00	1.000	.00	.00
	NiTiL	NiTiH	.00	.00	1.000	.00	.00
		SSH	.00	.00	.245	.00	.00
		SSL	.00	.00	1.000	.00	.00
	SSH	NiTiH	.00	.00	1.000	.00	.00
		NiTiL	.00	.00	.245	.00	.00
		SSL	.00	.00	.550	.00	.00
	SSL	NiTiH	.00	.00	1.000	.00	.00
		NiTiL	.00	.00	1.000	.00	.00
		SSH	.00	.00	.550	.00	.00
41	NiTiH	NiTiL	.00	.00	1.000	.00	.01
		SSH	-.01	.00	.003	-.01	.00
		SSL	-.01	.00	.073	-.01	.00
	NiTiL	NiTiH	.00	.00	1.000	-.01	.00
		SSH	-.01	.00	.000	-.01	.00
		SSL	-.01	.00	.006	-.01	.00
	SSH	NiTiH	.01	.00	.003	.00	.01
		NiTiL	.01	.00	.000	.00	.01
		SSL	.00	.00	1.000	.00	.01
	SSL	NiTiH	.01	.00	.073	.00	.01
		NiTiL	.01	.00	.006	.00	.01
		SSH	.00	.00	1.000	-.01	.00
31	NiTiH	NiTiL	.00	.00	.742	.00	.00
		SSH	.00	.00	1.000	.00	.00
		SSL	.00	.00	1.000	.00	.00
	NiTiL	NiTiH	.00	.00	.742	.00	.00
		SSH	.00	.00	1.000	.00	.00
		SSL	.00	.00	.184	.00	.00
	SSH	NiTiH	.00	.00	1.000	.00	.00
		NiTiL	.00	.00	1.000	.00	.00

		SSL	.00	.00	1.000	.00	.00
	SSL	NiTiH	.00	.00	1.000	.00	.00
		NiTiL	.00	.00	.184	.00	.00
		SSH	.00	.00	1.000	.00	.00
32	NiTiH	NiTiL	.00	.00	1.000	.00	.00
		SSH	.01	.00	.000	.01	.02
		SSL	.01	.00	.000	.00	.01
	NiTiL	NiTiH	.00	.00	1.000	.00	.00
		SSH	.01	.00	.000	.01	.02
		SSL	.01	.00	.000	.00	.01
	SSH	NiTiH	-.01	.00	.000	-.02	-.01
		NiTiL	-.01	.00	.000	-.02	-.01
		SSL	-.01	.00	.000	-.01	-.01
	SSL	NiTiH	-.01	.00	.000	-.01	.00
		NiTiL	-.01	.00	.000	-.01	.00
		SSH	.01	.00	.000	.01	.01
33	NiTiH	NiTiL	.00	.00	1.000	-.01	.00
		SSH	-.01	.00	.022	-.01	.00
		SSL	.00	.00	1.000	.00	.01
	NiTiL	NiTiH	.00	.00	1.000	.00	.01
		SSH	-.01	.00	.071	-.01	.00
		SSL	.00	.00	1.000	.00	.01
	SSH	NiTiH	.01	.00	.022	.00	.01
		NiTiL	.01	.00	.071	.00	.01
		SSL	.01	.00	.003	.00	.01
	SSL	NiTiH	.00	.00	1.000	-.01	.00
		NiTiL	.00	.00	1.000	-.01	.00
		SSH	-.01	.00	.003	-.01	.00
34	NiTiH	NiTiL	.00	.00	1.000	-.01	.01
		SSH	-.01	.00	.003	-.02	.00
		SSL	-.01	.00	.004	-.02	.00
	NiTiL	NiTiH	.00	.00	1.000	-.01	.01
		SSH	-.01	.00	.022	-.02	.00
		SSL	-.01	.00	.032	-.02	.00
	SSH	NiTiH	.01	.00	.003	.00	.02
		NiTiL	.01	.00	.022	.00	.02
		SSL	.00	.00	1.000	-.01	.01
	SSL	NiTiH	.01	.00	.004	.00	.02
		NiTiL	.01	.00	.032	.00	.02
		SSH	.00	.00	1.000	-.01	.01
35	NiTiH	NiTiL	-.06	.01	.000	-.10	-.02
		SSH	-.03	.01	.150	-.07	.01
		SSL	-.04	.01	.015	-.08	-.01
	NiTiL	NiTiH	.06	.01	.000	.02	.10
		SSH	.03	.01	.225	-.01	.07
		SSL	.02	.01	1.000	-.02	.05
	SSH	NiTiH	.03	.01	.150	-.01	.07
		NiTiL	-.03	.01	.225	-.07	.01
		SSL	-.01	.01	1.000	-.05	.03
	SSL	NiTiH	.04	.01	.015	.01	.08
		NiTiL	-.02	.01	1.000	-.05	.02

			SSH	.01	.01	1.000	-.03	.05
	36	NiTiH	NiTiL	.72	.02	.000	.68	.77
			SSH	.02	.02	.838	-.02	.07
			SSL	.70	.02	.000	.66	.75
		NiTiL	NiTiH	-.72	.02	.000	-.77	-.68
			SSH	-.70	.02	.000	-.74	-.65
			SSL	-.02	.02	.982	-.07	.02
		SSH	NiTiH	-.02	.02	.838	-.07	.02
			NiTiL	.70	.02	.000	.65	.74
			SSL	.68	.02	.000	.63	.72
		SSL	NiTiH	-.70	.02	.000	-.75	-.66
			NiTiL	.02	.02	.982	-.02	.07
			SSH	-.68	.02	.000	-.72	-.63
	37	NiTiH	NiTiL	.00	.00	1.000	-.01	.01
			SSH	.02	.00	.004	.00	.03
			SSL	.02	.00	.000	.01	.04
		NiTiL	NiTiH	.00	.00	1.000	-.01	.01
			SSH	.02	.00	.001	.01	.03
			SSL	.03	.00	.000	.01	.04
		SSH	NiTiH	-.02	.00	.004	-.03	.00
			NiTiL	-.02	.00	.001	-.03	-.01
			SSL	.01	.00	.465	.00	.02
		SSL	NiTiH	-.02	.00	.000	-.04	-.01
			NiTiL	-.03	.00	.000	-.04	-.01
			SSH	-.01	.00	.465	-.02	.00
Mx	47	NiTiH	NiTiL	-.03	.02	.899	-.10	.03
			SSH	-.10	.02	.000	-.17	-.04
			SSL	-.03	.02	1.000	-.09	.03
		NiTiL	NiTiH	.03	.02	.899	-.03	.10
			SSH	-.07	.02	.028	-.13	.00
			SSL	.00	.02	1.000	-.06	.07
		SSH	NiTiH	.10	.02	.000	.04	.17
			NiTiL	.07	.02	.028	.00	.13
			SSL	.07	.02	.016	.01	.14
		SSL	NiTiH	.03	.02	1.000	-.03	.09
			NiTiL	.00	.02	1.000	-.07	.06
			SSH	-.07	.02	.016	-.14	-.01
	46	NiTiH	NiTiL	3.55	.09	.000	3.31	3.78
			SSH	.08	.09	1.000	-.15	.32
			SSL	3.51	.09	.000	3.28	3.75
		NiTiL	NiTiH	-3.55	.09	.000	-3.78	-3.31
			SSH	-3.46	.09	.000	-3.70	-3.23
			SSL	-.03	.09	1.000	-.27	.20
		SSH	NiTiH	-.08	.09	1.000	-.32	.15
			NiTiL	3.46	.09	.000	3.23	3.70
			SSL	3.43	.09	.000	3.19	3.67
		SSL	NiTiH	-3.51	.09	.000	-3.75	-3.28
			NiTiL	.03	.09	1.000	-.20	.27
			SSH	-3.43	.09	.000	-3.67	-3.19
	45	NiTiH	NiTiL	.00	.07	1.000	-.18	.18
			SSH	.02	.07	1.000	-.16	.21

		SSL	.03	.07	1.000	-.16	.21
	NiTiL	NiTiH	.00	.07	1.000	-.18	.18
		SSH	.03	.07	1.000	-.16	.21
		SSL	.03	.07	1.000	-.15	.21
	SSH	NiTiH	-.02	.07	1.000	-.21	.16
		NiTiL	-.03	.07	1.000	-.21	.16
		SSL	.00	.07	1.000	-.18	.18
	SSL	NiTiH	-.03	.07	1.000	-.21	.16
		NiTiL	-.03	.07	1.000	-.21	.15
		SSH	.00	.07	1.000	-.18	.18
44	NiTiH	NiTiL	-.08	.04	.153	-.17	.01
		SSH	.00	.04	1.000	-.10	.09
		SSL	.02	.04	1.000	-.07	.12
	NiTiL	NiTiH	.08	.04	.153	-.01	.17
		SSH	.08	.04	.176	-.02	.17
		SSL	.10	.04	.022	.01	.20
	SSH	NiTiH	.00	.04	1.000	-.09	.10
		NiTiL	-.08	.04	.176	-.17	.02
		SSL	.03	.04	1.000	-.07	.12
	SSL	NiTiH	-.02	.04	1.000	-.12	.07
		NiTiL	-.10	.04	.022	-.20	-.01
		SSH	-.03	.04	1.000	-.12	.07
43	NiTiH	NiTiL	-.01	.01	1.000	-.05	.02
		SSH	.09	.01	.000	.05	.12
		SSL	.06	.01	.000	.02	.09
	NiTiL	NiTiH	.01	.01	1.000	-.02	.05
		SSH	.10	.01	.000	.07	.14
		SSL	.07	.01	.000	.03	.10
	SSH	NiTiH	-.09	.01	.000	-.12	-.05
		NiTiL	-.10	.01	.000	-.14	-.07
		SSL	-.03	.01	.060	-.07	.00
	SSL	NiTiH	-.06	.01	.000	-.09	-.02
		NiTiL	-.07	.01	.000	-.10	-.03
		SSH	.03	.01	.060	.00	.07
42	NiTiH	NiTiL	-.02	.01	1.000	-.06	.02
		SSH	-.01	.01	1.000	-.04	.03
		SSL	.00	.01	1.000	-.03	.04
	NiTiL	NiTiH	.02	.01	1.000	-.02	.06
		SSH	.01	.01	1.000	-.03	.05
		SSL	.02	.01	.774	-.02	.06
	SSH	NiTiH	.01	.01	1.000	-.03	.04
		NiTiL	-.01	.01	1.000	-.05	.03
		SSL	.01	.01	1.000	-.03	.05
	SSL	NiTiH	.00	.01	1.000	-.04	.03
		NiTiL	-.02	.01	.774	-.06	.02
		SSH	-.01	.01	1.000	-.05	.03
41	NiTiH	NiTiL	.06	.07	1.000	-.12	.25
		SSH	.02	.07	1.000	-.16	.21
		SSL	-.06	.07	1.000	-.25	.13
	NiTiL	NiTiH	-.06	.07	1.000	-.25	.12
		SSH	-.04	.07	1.000	-.23	.15

		SSL	-.12	.07	.489	-.31	.06
	SSH	NiTiH	-.02	.07	1.000	-.21	.16
		NiTiL	.04	.07	1.000	-.15	.23
		SSL	-.08	.07	1.000	-.27	.10
	SSL	NiTiH	.06	.07	1.000	-.13	.25
		NiTiL	.12	.07	.489	-.06	.31
		SSH	.08	.07	1.000	-.10	.27
31	NiTiH	NiTiL	-.02	.02	1.000	-.06	.02
		SSH	.00	.02	1.000	-.04	.04
		SSL	.01	.02	1.000	-.03	.05
	NiTiL	NiTiH	.02	.02	1.000	-.02	.06
		SSH	.02	.02	1.000	-.02	.06
		SSL	.03	.02	.422	-.01	.07
	SSH	NiTiH	.00	.02	1.000	-.04	.04
		NiTiL	-.02	.02	1.000	-.06	.02
		SSL	.01	.02	1.000	-.03	.05
	SSL	NiTiH	-.01	.02	1.000	-.05	.03
		NiTiL	-.03	.02	.422	-.07	.01
		SSH	-.01	.02	1.000	-.05	.03
32	NiTiH	NiTiL	.00	.05	1.000	-.12	.12
		SSH	.06	.05	1.000	-.06	.18
		SSL	.06	.05	1.000	-.06	.18
	NiTiL	NiTiH	.00	.05	1.000	-.12	.12
		SSH	.06	.05	.995	-.06	.18
		SSL	.06	.05	1.000	-.06	.18
	SSH	NiTiH	-.06	.05	1.000	-.18	.06
		NiTiL	-.06	.05	.995	-.18	.06
		SSL	.00	.05	1.000	-.12	.12
	SSL	NiTiH	-.06	.05	1.000	-.18	.06
		NiTiL	-.06	.05	1.000	-.18	.06
		SSH	.00	.05	1.000	-.12	.12
33	NiTiH	NiTiL	-.01	.02	1.000	-.06	.04
		SSH	.04	.02	.184	-.01	.09
		SSL	.04	.02	.202	-.01	.09
	NiTiL	NiTiH	.01	.02	1.000	-.04	.06
		SSH	.05	.02	.045	.00	.10
		SSL	.05	.02	.051	.00	.10
	SSH	NiTiH	-.04	.02	.184	-.09	.01
		NiTiL	-.05	.02	.045	-.10	.00
		SSL	.00	.02	1.000	-.05	.05
	SSL	NiTiH	-.04	.02	.202	-.09	.01
		NiTiL	-.05	.02	.051	-.10	.00
		SSH	.00	.02	1.000	-.05	.05
34	NiTiH	NiTiL	-.01	.02	1.000	-.08	.05
		SSH	.00	.02	1.000	-.06	.07
		SSL	.04	.02	.620	-.02	.10
	NiTiL	NiTiH	.01	.02	1.000	-.05	.08
		SSH	.02	.02	1.000	-.04	.08
		SSL	.05	.02	.144	-.01	.11
	SSH	NiTiH	.00	.02	1.000	-.07	.06
		NiTiL	-.02	.02	1.000	-.08	.04

			SSL	.03	.02	.861	-.03	.10
		SSL	NiTiH	-.04	.02	.620	-.10	.02
			NiTiL	-.05	.02	.144	-.11	.01
			SSH	-.03	.02	.861	-.10	.03
	35	NiTiH	NiTiL	.42	.03	.000	.35	.49
			SSH	.42	.03	.000	.35	.49
			SSL	.63	.03	.000	.57	.70
		NiTiL	NiTiH	-.42	.03	.000	-.49	-.35
			SSH	.00	.03	1.000	-.07	.06
			SSL	.21	.03	.000	.14	.28
		SSH	NiTiH	-.42	.03	.000	-.49	-.35
			NiTiL	.00	.03	1.000	-.06	.07
			SSL	.22	.03	.000	.15	.29
		SSL	NiTiH	-.63	.03	.000	-.70	-.57
			NiTiL	-.21	.03	.000	-.28	-.14
			SSH	-.22	.03	.000	-.29	-.15
	36	NiTiH	NiTiL	-.53	.04	.000	-.63	-.43
			SSH	-.53	.04	.000	-.63	-.43
			SSL	-.57	.04	.000	-.67	-.47
		NiTiL	NiTiH	.53	.04	.000	.43	.63
			SSH	.00	.04	1.000	-.10	.10
			SSL	-.03	.04	1.000	-.14	.07
		SSH	NiTiH	.53	.04	.000	.43	.63
			NiTiL	.00	.04	1.000	-.10	.10
			SSL	-.03	.04	1.000	-.13	.07
		SSL	NiTiH	.57	.04	.000	.47	.67
			NiTiL	.03	.04	1.000	-.07	.14
			SSH	.03	.04	1.000	-.07	.13
	37	NiTiH	NiTiL	-.04	.04	1.000	-.15	.06
			SSH	-.13	.04	.008	-.23	-.02
			SSL	.01	.04	1.000	-.09	.12
		NiTiL	NiTiH	.04	.04	1.000	-.06	.15
			SSH	-.09	.04	.173	-.19	.02
			SSL	.05	.04	1.000	-.05	.16
		SSH	NiTiH	.13	.04	.008	.02	.23
			NiTiL	.09	.04	.173	-.02	.19
			SSL	.14	.04	.003	.03	.24
		SSL	NiTiH	-.01	.04	1.000	-.12	.09
			NiTiL	-.05	.04	1.000	-.16	.05
			SSH	-.14	.04	.003	-.24	-.03
My	47	NiTiH	NiTiL	.00	.01	1.000	-.04	.03
			SSH	.02	.01	.379	-.01	.06
			SSL	.02	.01	.905	-.02	.05
		NiTiL	NiTiH	.00	.01	1.000	-.03	.04
			SSH	.03	.01	.167	-.01	.06
			SSL	.02	.01	.450	-.01	.06
		SSH	NiTiH	-.02	.01	.379	-.06	.01
			NiTiL	-.03	.01	.167	-.06	.01
			SSL	-.01	.01	1.000	-.04	.03
		SSL	NiTiH	-.02	.01	.905	-.05	.02
			NiTiL	-.02	.01	.450	-.06	.01

		SSH	.01	.01	1.000	-.03	.04
46	NiTiH	NiTiL	4.05	.08	.000	3.84	4.25
		SSH	-.30	.08	.001	-.50	-.09
		SSL	3.91	.08	.000	3.71	4.12
	NiTiL	NiTiH	-4.05	.08	.000	-4.25	-3.84
		SSH	-4.34	.08	.000	-4.55	-4.14
		SSL	-.13	.08	.508	-.34	.07
	SSH	NiTiH	.30	.08	.001	.09	.50
		NiTiL	4.34	.08	.000	4.14	4.55
		SSL	4.21	.08	.000	4.00	4.42
	SSL	NiTiH	-3.91	.08	.000	-4.12	-3.71
		NiTiL	.13	.08	.508	-.07	.34
		SSH	-4.21	.08	.000	-4.42	-4.00
45	NiTiH	NiTiL	.00	.00	1.000	-.01	.01
		SSH	.00	.00	1.000	.00	.01
		SSL	.00	.00	1.000	.00	.01
	NiTiL	NiTiH	.00	.00	1.000	-.01	.01
		SSH	.00	.00	1.000	.00	.01
		SSL	.00	.00	1.000	.00	.01
	SSH	NiTiH	.00	.00	1.000	-.01	.00
		NiTiL	.00	.00	1.000	-.01	.00
		SSL	.00	.00	1.000	-.01	.00
	SSL	NiTiH	.00	.00	1.000	-.01	.00
		NiTiL	.00	.00	1.000	-.01	.00
		SSH	.00	.00	1.000	.00	.01
44	NiTiH	NiTiL	-.01	.01	1.000	-.03	.02
		SSH	-.03	.01	.004	-.06	-.01
		SSL	.01	.01	1.000	-.01	.04
	NiTiL	NiTiH	.01	.01	1.000	-.02	.03
		SSH	-.03	.01	.037	-.05	.00
		SSL	.02	.01	.305	-.01	.05
	SSH	NiTiH	.03	.01	.004	.01	.06
		NiTiL	.03	.01	.037	.00	.05
		SSL	.05	.01	.000	.02	.07
	SSL	NiTiH	-.01	.01	1.000	-.04	.01
		NiTiL	-.02	.01	.305	-.05	.01
		SSH	-.05	.01	.000	-.07	-.02
43	NiTiH	NiTiL	.00	.01	1.000	-.03	.03
		SSH	.17	.01	.000	.14	.20
		SSL	.11	.01	.000	.08	.14
	NiTiL	NiTiH	.00	.01	1.000	-.03	.03
		SSH	.17	.01	.000	.14	.20
		SSL	.11	.01	.000	.08	.14
	SSH	NiTiH	-.17	.01	.000	-.20	-.14
		NiTiL	-.17	.01	.000	-.20	-.14
		SSL	-.06	.01	.000	-.09	-.03
	SSL	NiTiH	-.11	.01	.000	-.14	-.08
		NiTiL	-.11	.01	.000	-.14	-.08
		SSH	.06	.01	.000	.03	.09
42	NiTiH	NiTiL	.00	.00	1.000	-.02	.01
		SSH	.00	.00	1.000	-.01	.01

		SSL	.01	.00	1.000	-.01	.02
	NiTiL	NiTiH	.00	.00	1.000	-.01	.02
		SSH	.00	.00	1.000	-.01	.02
		SSL	.01	.00	.347	.00	.02
	SSH	NiTiH	.00	.00	1.000	-.01	.01
		NiTiL	.00	.00	1.000	-.02	.01
		SSL	.00	.00	1.000	-.01	.02
	SSL	NiTiH	-.01	.00	1.000	-.02	.01
		NiTiL	-.01	.00	.347	-.02	.00
		SSH	.00	.00	1.000	-.02	.01
41	NiTiH	NiTiL	.00	.01	1.000	-.01	.02
		SSH	.02	.01	.000	.01	.04
		SSL	.01	.01	.050	.00	.03
	NiTiL	NiTiH	.00	.01	1.000	-.02	.01
		SSH	.02	.01	.002	.01	.03
		SSL	.01	.01	.149	.00	.03
	SSH	NiTiH	-.02	.01	.000	-.04	-.01
		NiTiL	-.02	.01	.002	-.03	-.01
		SSL	-.01	.01	.872	-.02	.01
	SSL	NiTiH	-.01	.01	.050	-.03	.00
		NiTiL	-.01	.01	.149	-.03	.00
		SSH	.01	.01	.872	-.01	.02
31	NiTiH	NiTiL	.00	.00	1.000	-.01	.00
		SSH	.00	.00	1.000	-.01	.01
		SSL	.00	.00	1.000	-.01	.01
	NiTiL	NiTiH	.00	.00	1.000	.00	.01
		SSH	.00	.00	1.000	-.01	.01
		SSL	.00	.00	1.000	-.01	.01
	SSH	NiTiH	.00	.00	1.000	-.01	.01
		NiTiL	.00	.00	1.000	-.01	.01
		SSL	.00	.00	1.000	-.01	.01
	SSL	NiTiH	.00	.00	1.000	-.01	.01
		NiTiL	.00	.00	1.000	-.01	.01
		SSH	.00	.00	1.000	-.01	.01
32	NiTiH	NiTiL	.00	.01	1.000	-.04	.04
		SSH	-.04	.01	.025	-.08	.00
		SSL	.00	.01	1.000	-.03	.04
	NiTiL	NiTiH	.00	.01	1.000	-.04	.04
		SSH	-.04	.01	.035	-.08	.00
		SSL	.00	.01	1.000	-.03	.04
	SSH	NiTiH	.04	.01	.025	.00	.08
		NiTiL	.04	.01	.035	.00	.08
		SSL	.04	.01	.014	.01	.08
	SSL	NiTiH	.00	.01	1.000	-.04	.03
		NiTiL	.00	.01	1.000	-.04	.03
		SSH	-.04	.01	.014	-.08	-.01
33	NiTiH	NiTiL	.00	.02	1.000	-.05	.04
		SSH	-.15	.02	.000	-.19	-.10
		SSL	-.04	.02	.189	-.08	.01
	NiTiL	NiTiH	.00	.02	1.000	-.04	.05
		SSH	-.14	.02	.000	-.18	-.10

		SSL	-.03	.02	.359	-.08	.01
	SSH	NiTiH	.15	.02	.000	.10	.19
		NiTiL	.14	.02	.000	.10	.18
		SSL	.11	.02	.000	.06	.15
	SSL	NiTiH	.04	.02	.189	-.01	.08
		NiTiL	.03	.02	.359	-.01	.08
		SSH	-.11	.02	.000	-.15	-.06
34	NiTiH	NiTiL	.00	.01	1.000	-.02	.02
		SSH	-.02	.01	.205	-.04	.00
		SSL	-.01	.01	1.000	-.03	.01
	NiTiL	NiTiH	.00	.01	1.000	-.02	.02
		SSH	-.01	.01	.654	-.03	.01
		SSL	.00	.01	1.000	-.02	.02
	SSH	NiTiH	.02	.01	.205	.00	.04
		NiTiL	.01	.01	.654	-.01	.03
		SSL	.01	.01	.941	-.01	.03
	SSL	NiTiH	.01	.01	1.000	-.01	.03
		NiTiL	.00	.01	1.000	-.02	.02
		SSH	-.01	.01	.941	-.03	.01
35	NiTiH	NiTiL	-.17	.02	.000	-.22	-.11
		SSH	-.14	.02	.000	-.20	-.09
		SSL	-.20	.02	.000	-.25	-.15
	NiTiL	NiTiH	.17	.02	.000	.11	.22
		SSH	.02	.02	1.000	-.03	.08
		SSL	-.03	.02	.564	-.09	.02
	SSH	NiTiH	.14	.02	.000	.09	.20
		NiTiL	-.02	.02	1.000	-.08	.03
		SSL	-.06	.02	.027	-.11	.00
	SSL	NiTiH	.20	.02	.000	.15	.25
		NiTiL	.03	.02	.564	-.02	.09
		SSH	.06	.02	.027	.00	.11
36	NiTiH	NiTiL	2.89	.05	.000	2.75	3.03
		SSH	.23	.05	.000	.09	.37
		SSL	2.97	.05	.000	2.83	3.11
	NiTiL	NiTiH	-2.89	.05	.000	-3.03	-2.75
		SSH	-2.65	.05	.000	-2.79	-2.51
		SSL	.08	.05	.732	-.06	.22
	SSH	NiTiH	-.23	.05	.000	-.37	-.09
		NiTiL	2.65	.05	.000	2.51	2.79
		SSL	2.73	.05	.000	2.60	2.87
	SSL	NiTiH	-2.97	.05	.000	-3.11	-2.83
		NiTiL	-.08	.05	.732	-.22	.06
		SSH	-2.73	.05	.000	-2.87	-2.60
37	NiTiH	NiTiL	.00	.03	1.000	-.07	.08
		SSH	.02	.03	1.000	-.06	.09
		SSL	.10	.03	.004	.02	.17
	NiTiL	NiTiH	.00	.03	1.000	-.08	.07
		SSH	.01	.03	1.000	-.06	.09
		SSL	.09	.03	.007	.02	.17
	SSH	NiTiH	-.02	.03	1.000	-.09	.06
		NiTiL	-.01	.03	1.000	-.09	.06

			SSL	.08	.03	.028	.01	.16
		SSL	NiTiH	-.10	.03	.004	-.17	-.02
			NiTiL	-.09	.03	.007	-.17	-.02
			SSH	-.08	.03	.028	-.16	-.01
Mz	47	NiTiH	NiTiL	-.02	.01	.793	-.05	.01
			SSH	.11	.01	.000	.08	.14
			SSL	.12	.01	.000	.09	.15
		NiTiL	NiTiH	.02	.01	.793	-.01	.05
			SSH	.12	.01	.000	.09	.15
			SSL	.14	.01	.000	.11	.17
		SSH	NiTiH	-.11	.01	.000	-.14	-.08
			NiTiL	-.12	.01	.000	-.15	-.09
			SSL	.01	.01	1.000	-.01	.04
		SSL	NiTiH	-.12	.01	.000	-.15	-.09
			NiTiL	-.14	.01	.000	-.17	-.11
			SSH	-.01	.01	1.000	-.04	.01
	46	NiTiH	NiTiL	1.71	.04	.000	1.60	1.82
			SSH	-.52	.04	.000	-.63	-.41
			SSL	1.48	.04	.000	1.37	1.59
		NiTiL	NiTiH	-1.71	.04	.000	-1.82	-1.60
			SSH	-2.23	.04	.000	-2.34	-2.12
			SSL	-.23	.04	.000	-.34	-.12
		SSH	NiTiH	.52	.04	.000	.41	.63
			NiTiL	2.23	.04	.000	2.12	2.34
			SSL	2.00	.04	.000	1.89	2.11
		SSL	NiTiH	-1.48	.04	.000	-1.59	-1.37
			NiTiL	.23	.04	.000	.12	.34
			SSH	-2.00	.04	.000	-2.11	-1.89
	45	NiTiH	NiTiL	.00	.01	1.000	-.02	.03
			SSH	.03	.01	.024	.00	.05
			SSL	.03	.01	.009	.01	.05
		NiTiL	NiTiH	.00	.01	1.000	-.03	.02
			SSH	.02	.01	.068	.00	.05
			SSL	.03	.01	.028	.00	.05
		SSH	NiTiH	-.03	.01	.024	-.05	.00
			NiTiL	-.02	.01	.068	-.05	.00
			SSL	.00	.01	1.000	-.02	.03
		SSL	NiTiH	-.03	.01	.009	-.05	-.01
			NiTiL	-.03	.01	.028	-.05	.00
			SSH	.00	.01	1.000	-.03	.02
	44	NiTiH	NiTiL	.03	.01	.065	.00	.06
			SSH	.02	.01	.638	-.01	.05
			SSL	.04	.01	.010	.01	.06
		NiTiL	NiTiH	-.03	.01	.065	-.06	.00
			SSH	-.01	.01	1.000	-.04	.02
			SSL	.01	.01	1.000	-.02	.04
		SSH	NiTiH	-.02	.01	.638	-.05	.01
			NiTiL	.01	.01	1.000	-.02	.04

		SSL	.02	.01	.716	-.01	.05
	SSL	NiTiH	-.04	.01	.010	-.06	-.01
		NiTiL	-.01	.01	1.000	-.04	.02
		SSH	-.02	.01	.716	-.05	.01
43	NiTiH	NiTiL	.00	.01	1.000	-.03	.04
		SSH	-.49	.01	.000	-.52	-.45
		SSL	-.24	.01	.000	-.28	-.20
	NiTiL	NiTiH	.00	.01	1.000	-.04	.03
		SSH	-.49	.01	.000	-.53	-.45
		SSL	-.25	.01	.000	-.28	-.21
	SSH	NiTiH	.49	.01	.000	.45	.52
		NiTiL	.49	.01	.000	.45	.53
		SSL	.24	.01	.000	.21	.28
	SSL	NiTiH	.24	.01	.000	.20	.28
		NiTiL	.25	.01	.000	.21	.28
		SSH	-.24	.01	.000	-.28	-.21
42	NiTiH	NiTiL	.00	.00	1.000	-.01	.01
		SSH	.00	.00	1.000	-.01	.02
		SSL	.01	.00	.143	.00	.02
	NiTiL	NiTiH	.00	.00	1.000	-.01	.01
		SSH	.00	.00	1.000	-.01	.02
		SSL	.01	.00	.078	.00	.02
	SSH	NiTiH	.00	.00	1.000	-.02	.01
		NiTiL	.00	.00	1.000	-.02	.01
		SSL	.01	.00	.703	-.01	.02
	SSL	NiTiH	-.01	.00	.143	-.02	.00
		NiTiL	-.01	.00	.078	-.02	.00
		SSH	-.01	.00	.703	-.02	.01
41	NiTiH	NiTiL	-.01	.01	.992	-.03	.01
		SSH	-.01	.01	1.000	-.03	.01
		SSL	-.01	.01	1.000	-.03	.01
	NiTiL	NiTiH	.01	.01	.992	-.01	.03
		SSH	.00	.01	1.000	-.01	.02
		SSL	.00	.01	1.000	-.01	.02
	SSH	NiTiH	.01	.01	1.000	-.01	.03
		NiTiL	.00	.01	1.000	-.02	.01
		SSL	.00	.01	1.000	-.02	.02
	SSL	NiTiH	.01	.01	1.000	-.01	.03
		NiTiL	.00	.01	1.000	-.02	.01
		SSH	.00	.01	1.000	-.02	.02
31	NiTiH	NiTiL	.00	.01	1.000	-.02	.01
		SSH	.00	.01	1.000	-.01	.01
		SSL	.00	.01	1.000	-.02	.01
	NiTiL	NiTiH	.00	.01	1.000	-.01	.02
		SSH	.00	.01	1.000	-.01	.02
		SSL	.00	.01	1.000	-.01	.01
	SSH	NiTiH	.00	.01	1.000	-.01	.01
		NiTiL	.00	.01	1.000	-.02	.01

		SSL	.00	.01	1.000	-.02	.01
	SSL	NiTiH	.00	.01	1.000	-.01	.02
		NiTiL	.00	.01	1.000	-.01	.01
		SSH	.00	.01	1.000	-.01	.02
32	NiTiH	NiTiL	.00	.02	1.000	-.05	.06
		SSH	-.19	.02	.000	-.24	-.14
		SSL	-.04	.02	.269	-.09	.01
	NiTiL	NiTiH	.00	.02	1.000	-.06	.05
		SSH	-.19	.02	.000	-.24	-.14
		SSL	-.04	.02	.218	-.10	.01
	SSH	NiTiH	.19	.02	.000	.14	.24
		NiTiL	.19	.02	.000	.14	.24
		SSL	.15	.02	.000	.09	.20
	SSL	NiTiH	.04	.02	.269	-.01	.09
		NiTiL	.04	.02	.218	-.01	.10
		SSH	-.15	.02	.000	-.20	-.09
33	NiTiH	NiTiL	.00	.01	1.000	-.04	.03
		SSH	-.03	.01	.080	-.07	.00
		SSL	-.05	.01	.001	-.08	-.02
	NiTiL	NiTiH	.00	.01	1.000	-.03	.04
		SSH	-.03	.01	.104	-.07	.00
		SSL	-.05	.01	.002	-.08	-.01
	SSH	NiTiH	.03	.01	.080	.00	.07
		NiTiL	.03	.01	.104	.00	.07
		SSL	-.02	.01	1.000	-.05	.02
	SSL	NiTiH	.05	.01	.001	.02	.08
		NiTiL	.05	.01	.002	.01	.08
		SSH	.02	.01	1.000	-.02	.05
34	NiTiH	NiTiL	-.01	.01	1.000	-.03	.01
		SSH	.00	.01	1.000	-.02	.02
		SSL	.03	.01	.005	.01	.05
	NiTiL	NiTiH	.01	.01	1.000	-.01	.03
		SSH	.01	.01	1.000	-.02	.03
		SSL	.03	.01	.000	.01	.06
	SSH	NiTiH	.00	.01	1.000	-.02	.02
		NiTiL	-.01	.01	1.000	-.03	.02
		SSL	.03	.01	.003	.01	.05
	SSL	NiTiH	-.03	.01	.005	-.05	-.01
		NiTiL	-.03	.01	.000	-.06	-.01
		SSH	-.03	.01	.003	-.05	-.01
35	NiTiH	NiTiL	.04	.03	1.000	-.05	.13
		SSH	-1.03	.03	.000	-1.12	-.94
		SSL	-.19	.03	.000	-.28	-.10
	NiTiL	NiTiH	-.04	.03	1.000	-.13	.05
		SSH	-1.07	.03	.000	-1.16	-.98
		SSL	-.23	.03	.000	-.32	-.14
	SSH	NiTiH	1.03	.03	.000	.94	1.12
		NiTiL	1.07	.03	.000	.98	1.16

		SSL	.84	.03	.000	.75	.93
	SSL	NiTiH	.19	.03	.000	.10	.28
		NiTiL	.23	.03	.000	.14	.32
		SSH	-.84	.03	.000	-.93	-.75
36	NiTiH	NiTiL	-.14	.02	.000	-.20	-.08
		SSH	-.31	.02	.000	-.37	-.26
		SSL	-.24	.02	.000	-.30	-.19
	NiTiL	NiTiH	.14	.02	.000	.08	.20
		SSH	-.17	.02	.000	-.23	-.12
		SSL	-.10	.02	.000	-.16	-.05
	SSH	NiTiH	.31	.02	.000	.26	.37
		NiTiL	.17	.02	.000	.12	.23
		SSL	.07	.02	.007	.01	.13
	SSL	NiTiH	.24	.02	.000	.19	.30
		NiTiL	.10	.02	.000	.05	.16
		SSH	-.07	.02	.007	-.13	-.01
37	NiTiH	NiTiL	.00	.02	1.000	-.04	.05
		SSH	.40	.02	.000	.36	.44
		SSL	.10	.02	.000	.05	.14
	NiTiL	NiTiH	.00	.02	1.000	-.05	.04
		SSH	.40	.02	.000	.35	.44
		SSL	.10	.02	.000	.05	.14
	SSH	NiTiH	-.40	.02	.000	-.44	-.36
		NiTiL	-.40	.02	.000	-.44	-.35
		SSL	-.30	.02	.000	-.35	-.26
	SSL	NiTiH	-.10	.02	.000	-.14	-.05
		NiTiL	-.10	.02	.000	-.14	-.05
		SSH	.30	.02	.000	.26	.35

Appendix G – Pairwise Comparisons of Lateral Deviations with Center Position

- Fx, Fy and Fz measured in Newton's (N)
- My measured in Newton-millimeters (Nmm)

Measure	Tooth	Deviation (I)	Deviation (J)	Mean Difference (I-J)	Std. Error	Sig. [b]	95% Confidence Interval for Difference[b]	
							Lower Bound	Upper Bound
Fx	13	0mm	L1mm	-.08*	.03	.04	-.17	.00
			L2mm	-.15*	.03	.00	-.23	-.07
			R1mm	-.07	.03	.14	-.15	.01
			R2mm	-.02	.03	1.00	-.10	.06
	23	0mm	L1mm	-.01	.33	1.00	-.98	.96
			L2mm	-.07	.33	1.00	-1.04	.90
			R1mm	-.11	.33	1.00	-1.08	.86
			R2mm	.59	.33	.80	-.38	1.56
Fy	13	0mm	L1mm	.00	.04	1.00	-.12	.12
			L2mm	.05	.04	1.00	-.08	.17
			R1mm	.11	.04	.12	-.01	.23
			R2mm	.10	.04	.24	-.03	.22
	23	0mm	L1mm	.02	.07	1.00	-.20	.23
			L2mm	.12	.07	1.00	-.10	.33
			R1mm	-.01	.07	1.00	-.22	.20
			R2mm	-.15	.07	.42	-.36	.06
Fz	13	0mm	L1mm	-.01	.03	1.00	-.11	.08
			L2mm	-.08	.03	.23	-.17	.02
			R1mm	-.06	.03	.69	-.16	.04
			R2mm	.00	.03	1.00	-.10	.09
	23	0mm	L1mm	.00	.05	1.00	-.15	.14
			L2mm	-.08	.05	1.00	-.23	.07
			R1mm	-.01	.05	1.00	-.16	.13
			R2mm	.02	.05	1.00	-.13	.17
My	13	0mm	L1mm	.31	.24	1.00	-.41	1.04

		L2mm	.88*	.24	.01	.16	1.61
		R1mm	.39	.24	1.00	-.33	1.11
		R2mm	.00	.24	1.00	-.72	.72
23	0mm	L1mm	-.05	.86	1.00	-2.60	2.50
		L2mm	.27	.86	1.00	-2.28	2.82
		R1mm	.12	.86	1.00	-2.43	2.67
		R2mm	-1.85	.86	.37	-4.40	.70

Appendix H – Pairwise Comparisons of Teeth 13 and 23

- Fx, Fy and Fz measured in Newton's (N)
- My measured in Newton-millimeters (Nmm)

Measure	WireElastic	Tooth (I)	Tooth (J)	Mean Difference (I-J)	Std. Error	Sig. [b]	95% Confidence Interval for Difference [b]	
							Lower Bound	Upper Bound
Fx	NITIH	13	23	-.26*	.02	.00	-.30	-.22
		23	13	.26*	.02	.00	.22	.30
	NITIL	13	23	-.08*	.02	.00	-.12	-.04
		23	13	.08*	.02	.00	.04	.12
	SSH	13	23	-.43*	.02	.00	-.47	-.39
		23	13	.43*	.02	.00	.39	.47
	SSL	13	23	-.12*	.02	.00	-.16	-.08
		23	13	.12*	.02	.00	.08	.16
Fy	NITIH	13	23	-.02	.03	.53	-.08	.04
		23	13	.02	.03	.53	-.04	.08
	NITIL	13	23	-.02	.03	.45	-.08	.04
		23	13	.02	.03	.45	-.04	.08
	SSH	13	23	-.16*	.03	.00	-.21	-.10
		23	13	.16*	.03	.00	.10	.21
	SSL	13	23	.06*	.03	.03	.01	.12
		23	13	-.06*	.03	.03	-.12	-.01
Fz	NITIH	13	23	.23*	.02	.00	.20	.26
		23	13	-.23*	.02	.00	-.26	-.20
	NITIL	13	23	.06*	.02	.00	.03	.09
		23	13	-.06*	.02	.00	-.09	-.03
	SSH	13	23	.26*	.02	.00	.23	.29
		23	13	-.26*	.02	.00	-.29	-.23
	SSL	13	23	.16*	.02	.00	.13	.19
		23	13	-.16*	.02	.00	-.19	-.13
My	NITIH	13	23	-3.49*	.10	.00	-3.70	-3.29

		23	13	3.49*	.10	.00	3.29	3.70
	NITIL	13	23	-1.13*	.10	.00	-1.33	-.92
		23	13	1.13*	.10	.00	.92	1.33
	SSH	13	23	-3.71*	.10	.00	-3.91	-3.50
		23	13	3.71*	.10	.00	3.50	3.91
	SSL	13	23	-1.62*	.10	.00	-1.82	-1.41
		23	13	1.62*	.10	.00	1.41	1.82