Intra and inter-rater reliability of the HALO digital goniometer and the tractograph in a podiatric setting: a comparative study

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Abstract

Background: Joint angles are commonly measured in the podiatric setting to determine the range of motion and position of a joint in order to make assumptions regarding foot function[1]. These measurements can be used in treatment plans for footwear and orthotic prescription or to establish the effectiveness of a management plan[2, 3]. As there is currently no 'gold standard' device for measuring joint angles in a podiatric setting this study investigated a new goniometric device, the HALO digital goniometer. The tractograph is the current goniometric measurement tool which is widely accepted and used in the podiatric setting[3-5]. The present study aimed to investigate the reliability of two goniometric devices, the tractograph and the HALO digital goniometer, for passive measurements of ankle joint dorsiflexion and subtalar joint (STJ) range of motion in a podiatric setting.

Methods: A sample of 32 subjects was recruited from the University of Western Australia (UWA) Podiatric Medicine student cohort. The examiners in the study were the four 4th year UWA Podiatric Medicine students who undertook the study. Each examiner performed three measurements, including ankle joint dorsiflexion, STJ inversion and eversion on a given subject with both the HALO digital goniometer and the tractograph. All measurements were performed twice on the right foot with subjects in the prone positions.

Results: Intra-class Correlation Coefficients (ICC) were calculated to determine intra and inter-rater reliability. For the tractograph inter-rater reliability for dorsiflexion, inversion and eversion the ICC for single measures was 0.84, 0.85 and 0.75 respectively. For the same measurements with the HALO digital goniometer the ICC values were 0.81, 0.77 and 0.52 respectively. The comparison of the tractograph and the HALO digital goniometer resulted in ICC values of 0.70, 0.67 and 0.45. Intra-rater reliability for one examiner provided the following results: tractograph 0.75, 0.87 and 0.75; HALO digital goniometer 0.78, 0.82 and 0.50 and for the comparison of the tractograph and the HALO digital goniometer 0.69, 0.79 and 0.42. These values fall within the acceptable ICC ranges for excellent (>0.75) and good (0.4-0.75) reliability[6].

Conclusion:

The study demonstrated ICC values in inter-rater and intra-rater reliability which indicated the HALO digital goniometer is a reliable and reproducible tool in a podiatric setting. Although we experienced limitations with HALO digital goniometer within this study we feel that most of these limitations can be overcome as the device moves out of prototype development. The HALO digital goniometer has the potential to become a reliable and valuable tool for biomechanical joint measurements in podiatry and across many allied health fields.

Key words: Podiatry, Tractograph, Goniometer, Range of Motion, Reproducibility of Results, Ankle, Subtalar Joint, Dorsiflexion, HALO digital Goniometer.

Background

In podiatric clinical practice there has been considerable progress in the biomechanical understanding of foot function resulting in significant advances in the quality of care and treatment plans for patients[1]. The biomechanical assessment involves measuring joint angles in a clinical setting to determine the range of motion and position of a joint in order to make assumptions regarding foot function[1]. These measurements can be used in treatment plans for footwear and orthotic prescription or to establish the effectiveness of a management plan[2, 3].

A goniometer is a device which measures the range of motion or position of a joint[2, 3, 7]. The tractograph, a two-armed goniometer with fifteen centimetre arms, is the current goniometric measurement tool which is widely accepted and used in the podiatric setting[3-5] . The current literature suggests there is a weakness in reliability and accuracy in the way these measurements are taken[1, 3, 5, 7], which has been noted within the podiatric community[1].

The HALO digital goniometer is a goniometer which uses laser arms and provides a digital reading[7]. The HALO digital goniometer is designed to be simpler to use and to be more accurate and reliable than the traditional tractograph[7].

Within the podiatric setting there are numerous potential benefits of regularly using a goniometric device which is more accurate and reliable than a tractograph. Intervention plans would be more accurately prescribed, as well as monitoring a patient's progress during and after therapeutic interventions. The device would be most useful in podiatric settings where patients may see more than one podiatrist such as in hospitals or large private and public clinics as measurements would be more consistent between different practitioners. Ultimately it would result in better treatment for the patients.

The present study aimed to investigate the reliability of two goniometric devices, the tractograph and the HALO digital goniometer, for passive measurements of ankle joint dorsiflexion and subtalar joint (STJ) range of motion and the reliability of four podiatric medicine student examiners in utlising new and current joint measurement tools[8]. Comparison of the intra-rater reliability and inter-rater reliability of both the HALO digital goniometer and the tractograph will help to assess the accuracy and therefore, determine if the new device has a place in podiatric practice.

Methods

Participants

A convenience sample of 32 subjects was recruited from the University of Western Australia (UWA) Podiatric Medicine student cohort.

All UWA Podiatric Medicine students level 1-4 were considered for inclusion. Participants were chosen at random depending on availability at the time of data collection. Four subjects were measured at any one time.

Examiners

The examiners in the study were the four 4th year UWA Podiatric Medicine students who undertook the study. The four examiners, identified here as 1 to 4 were used for the inter-rater reliability trial and one examiner used for the intra-rater reliability trial. All examiners tested all 32 subjects and did each of the three measurements twice. All examiners were blinded to the results of each other's assessments.

Tools

Measurements of STJ range of motion (eversion and inversion) and ankle joint dorsiflexion were taken in this study using both the traditional tractograph method and with the HALO digital goniometer.

Tractograph

The tractograph is the current goniometric measurement tool which is widely accepted and used in the podiatric setting[3-5].The tractograph is a two armed goniometer with fifteen centimetre arms which are to line up with the appropriate joint landmarks.

HALO digital Goniometer

The HALO digital goniometer is a goniometer which uses laser arms and provides a digital reading[7]. The laser arms are placed on either side of the joint and the electronic goniometer calculates the angle and/or the range of motion[3, 7]. The long laser arms intersect with landmarks to give an accurate and repeatable reading for multiple users. It also can be used with one-handed application so the patient position can be supported at the same time. It is both an inclinometer and a goniometer. The HALO digital goniometer has a zero infection risk, as it does not touch the skin, it is compact and pocket size and has built-in user instructions[7].

Procedure

Ethical approval was granted from the Human Research Ethics Office at the University of Western Australia. Prior to data collection all examiners were briefed on the study protocol and a one hour training session was conducted to ensure familiarisation and standardisation of the three ranges of motion tests using the HALO digital goniometer. The training session was conducted by Hayley Warren, the inventor of the HALO digital goniometer. Each examiner had the opportunity to practice measuring the three angles on one another. As each examiner currently uses the tractograph regularly during clinical practice, there was no need for a training session with the tractograph.

Informed consent was gained with subjects reading the information form and signing the consent form before any data was collected (see Appendix 1 and 2). Before each data collection set, the HALO digital goniometers were maximally charged and calibrated.

Each round of data collection involved 4 subjects and took between 20 and 30 minutes. Each subject was provided a separate cubicle and instructed to lie in the prone position on the podiatric treatment chair.

All measurements were non-weight bearing and passively measured with the subject lying prone, the knee extended and the feet positioned beyond the edge of the clinical chair[4, 9] Examiner 'number 4' consistently drew bisection lines on the posterior calcaneus and the posterior lower one third of the right leg of each subject before data collection began. At the completion of the bisection lines, each examiner was allocated a cubicle and simultaneously measured the subjects. All examiners were blinded to the results of each other's assessments. Measurements included STJ eversion, STJ inversion and ankle joint dorsiflexion. Each measurement was measured once with the HALO digital goniometer and once with the tractograph. Each examiner performed all three measurements on a given subject with both the HALO digital Goniometer and the tractograph before commencing assessment of the next subject. The examiners rotated around all four cubicles until they had completed the three measurements with both instruments on each subject twice. This will allow statistical analysis between examiners, between the two tools on the same subjects and overall between the subjects. This will also reduce repeatability errors. The order of the examiners was randomised for each subject.

Measurement Tests

All measurements were done on the subject's right foot. Measurements were passive with the subject in the prone position on the podiatric treatment chair. The three range of motion measurements tested were:

Ankle joint dorsiflexion

Passive ankle joint dorsiflexion was measured with the subject non-weight bearing, prone and with the knee in a flexed position[9]. The range of passive ankle joint dorsiflexion was measured by aligning one arm or laser beam of the measuring tool laterally with the shaft of the fibula and the other with the lateral aspect of the 5th metatarsal[4, 9, 10]. The axis of the measuring tool should be over the lateral aspect of the calcaneus. The ankle is then dorsiflexed and the angle ascertained, as seen in Figures 1 and 2 [4, 9].

Figure 1: Ankle dorsiflexion with knee flexed as measured by the tractograph.

Figure 2: Ankle dorsiflexion with knee flexed as measured by the HALO digital goniometer.

Subtalar joint range of motion (STJ ROM) – Inversion and Eversion

Assessment of frontal plane STJ motion has the subject lying prone, the knee is placed in frontal plane with ankle and foot hanging over the edge of the clinical chair[4, 11]. The distal one third of the leg and the posterior aspect of the calcaneus is bisected[4, 11]. The heel is passively moved into the maximally inverted position and the measuring tool at hand used to measure the angle between the bisection of the leg and the bisection of the calcaneus[4, 11]. This is done by placing one arm or laser beam of the measuring tool on the superior line of the leg and the other arm is placed at the heel bisection line. The same method is used with the calcaneus maximally everted and a measurement is taken[11]. Care was taken by the examiners to avoid inadvertent plantarflexion of the foot as it can inaccurately increase the total range of motion[4].

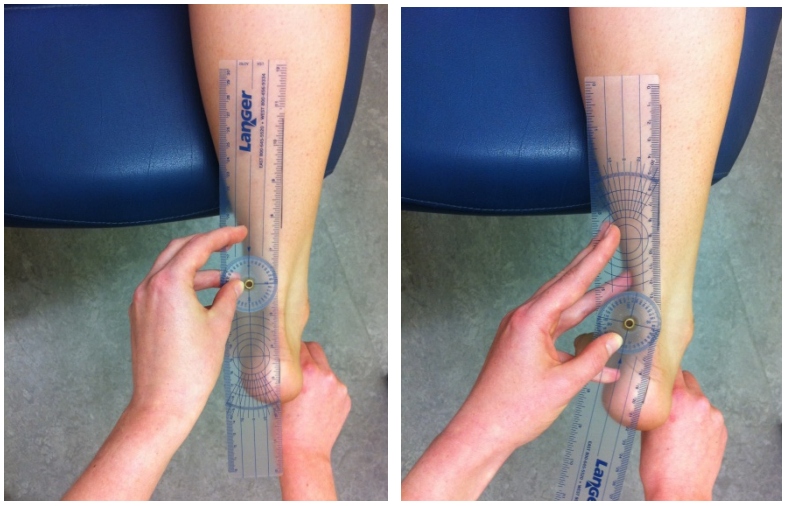

Figure 3: Subtalar joint eversion and inversion as measured with the tractograph.

Figure 4: Subtalar Joint Neutral and Subtalar Joint Inversion as measured with the HALO digital goniometer.

Statistical Analysis

In goniometry the intra-rater reliability determines the uniformity of repeated measurements of angles taken by the same examiner. If intra-rater reliability is present with either the HALO digital goniometer or the tractograph we can assume that there is high accuracy in the measurements compared with the measurements by the same examiner under similar circumstances at another time[5]. Inter-rater reliability determines the uniformity of repeated measurements taken individually by two or more examiners. If inter-rater reliability is present then we can assume that there is high accuracy in the measurements compared to the measurements taken by other examiners under similar circumstances[5, 12].

Data from the tractograph and the HALO digital goniometer was compared. Agreement between these two sets of data was calculated by Intraclass Correlation Coefficient (ICC) to demonstrate the reliability of the two devices[2]. ICC statistical techniques are now considered much more appropriate and powerful statistical tools than classic t-tests or linear correlations for estimating inter and intra reliability[13]. For the inter-rater and intra-rater reliability trials, two way random effect Intra-class Correlation Coefficients together with their confidence intervals, were calculated with SPSS statistical software[6]. The ICC varies from 0 to 1, the value above 0.75 indicates excellent, results between 0.75 and 0.4 indicates fair to good reliability and those below 0.4 indicate poor reliability[6].

Results

Table1:
Inter-rater reliability: comparison of the tractograph and HALO

	Mean ±SD	ICC Single measure	ICC single measures 95% CI	ICC Average measures	ICC average measures 95% CI
Tractograph dorsiflexion measurement 1&2	18.42; 5.65	0.84	0.78-0.88	0.91	0.87-0.94
Tractograph inversion measurement 1&2	19.00; 6.25	0.85	0.791- 0.89	0.92	0.83-0.94
Tractograph eversion measurement 1&2	7.48; 3.15	0.75	0.67-0.82	0.86	0.80-0.90
HALO dorsiflexion measurement 1&2	22.43; 7.02	0.81	0.74-0.86	0.89	0.85-0.92
HALO inversion measurement 1&2	18.65; 7.28	0.77	0.69-0.83	0.87	0.82-0.91
HALO eversion measurement 1&2	6.26; 3.79	0.52	0.38-0.64	0.69	0.55-0.78
Tractograph dorsiflexion 1&2 to HALO dorsiflexion 1&2	20.42; 6.67	0.70	0.63-0.76	0.90	0.87-0.93
Tractograph inversion 1&2 to HALO inversion 1&2	18.83; 6.78	0.67	0.59-0.74	0.89	0.85-0.92
Tractograph eversion 1&2 to HALO eversion 1&2	6.87; 3.53	0.45	0.36-0.56	0.77	0.69-0.83

Table 2:
Intra-rater reliability: comparison of the tractograph and HALO digital goniometer

	Mean ±SD	ICC Single measure	ICC single measures 95% CI	ICC Average measures	ICC average measures 95% CI
Tractograph dorsiflexion measurement 1&2	16.93; 5.02	0.75	0.55-0.87	0.86	0.77-0.93
Tractograph inversion measurement 1&2	21.00; 7.73	0.87	0.75-0.93	0.93	0.86-0.97
Tractograph eversion measurement 1&2	6.94; 2.99	0.75	0.54-0.87	0.85	0.71-0.93
HALO dorsiflexion measurement 1&2	19.94; 6.04	0.77	0.59-0.88	0.87	0.74-0.94
HALO inversion measurement 1&2	20.97; 6.86	0.81	0.66-0.91	0.90	0.79-0.95
HALO eversion measurement 1&2	6.92; 4.66	0.50	0.19-0.72	0.67	0.32-0.84
Tractograph dorsiflexion 1&2 to HALO dorsiflexion 1&2	18.44 5.73	0.69	0.55-0.82	0.90	0.83-0.95
Tractograph inversion 1&2 to HALO inversion 1&2	20.98; 7.28	0.79	0.67-0.88	0.94	0.89-0.96
Tractograph eversion 1&2 to HALO eversion 1&2	6.93; 3.90	0.42	0.24-0.61	0.75	0.56-0.86

Inter-rater Reliability

Tractograph

For the inter-rater reliability of measurements of the ankle joint dorsiflexion, the ICC was 0.84 for single measures and 0.91 for average measures. For the inter-rater reliability of measurements of STJ inversion and eversion, the ICC was 0.85 and 0.75 respectively for single measures and 0.918 and 0.86 respectively for average measures.

HALO digital goniometer

For the inter-rater reliability of measurements of the ankle joint dorsiflexion, the ICC was 0.81 for single measures and 0.896 for average measures. For the inter-rater reliability of measurements of STJ inversion and eversion, the ICC was 0.77 and 0.52 respectively for single measures and 0.87 and 0.68 respectively for average measures.

Tractograph vs. HALO digital goniometer

For the inter-rater reliability of measurements of the ankle joint dorsiflexion, the ICC was 0.70 for single measures and 0.90 for average measures. For the inter-rater reliability of measurements of STJ inversion and eversion, the ICC was 0.67 and 0.45 respectively for single measures and 0.89 and 0.77 respectively for average measures.

Intra-rater Reliability

Tractograph

For the intra-rater reliability of measurements of the ankle joint dorsiflexion, the ICC was 0.75 for single measures and 0.86 for average measures. For the intra-rater reliability of measurements of STJ inversion and eversion, the ICC was 0.87 and 0.75 respectively for single measures and 0.93 and 0.85 respectively for average measures.

HALO digital goniometer

For the intra-rater reliability of measurements of the ankle joint dorsiflexion, the ICC was 0.78 for single measures and 0.87 for average measures. For the intra-rater reliability of measurements of STJ inversion and eversion, the ICC was 0.82 and 0.50 respectively for single measures and 0.89 and 0.67 respectively for average measures.

Tractograph vs. HALO digital goniometer

For the intra-rater reliability of measurements of the ankle joint dorsiflexion, the ICC was 0.69 for single measures and 0.90 for average measures. For the intra-rater reliability of measurements of STJ inversion and eversion, the ICC was 0.79 and 0.42 respectively for single measures and 0.94 and 0.74 respectively for average measures.

Discussion

Inter-rater reliability

The results of this study demonstrated that there is fairly good inter-rater reliability for tractograph, HALO digital goniometer and the comparison of the two tools for ankle joint dorsiflexion, inversion and eversion measurements. Contrary to the results of other studies, we found the ICC for tractograph to be of good inter-rater reliability with dorsiflexion 0.84, inversion 0.85 and eversion 0.75 respectively. Previous studies have had significantly lower ICC, the inter tester reliability found by Elveru et al[14] were 0.32 for STJ inversion and 0.17 for STJ eversion. Van Gheluwe[13] et al also noted that ICC values for the inter-rater reliability of ankle dorsiflexion was poor at 0.29. Our results which are deemed to be reliable may be attributed to several factors. Firstly, we are all 4th year Podiatric Medicine students with the same clinical skills and degree of experience. Additionally, as undergraduate students we have all been taught the same technique for measuring ankle joint dorsiflexion and STJ inversion and eversion with the tractograph and this may have influenced the reliable ICC value.

The main purpose of this present study was to test the reliability of this newly developed instrument, the HALO digital goniometer. The HALO digital goniometer demonstrated good inter-rater reliability of ankle joint dorsiflexion, STJ inversion and eversion, with the following results: 0.81, 0.77, and 0.52 respectively. During our training with the HALO digital goniometer we believed we were producing clinically accurate measurement angles while using a single prototype. During collection of data, we encountered some technical difficulties using the HALO digital goniometer. Three HALO digital goniometers were supplied by the inventor for the duration of the study and these devices were considered to be in the prototype stage of development. Unfortunately, two of our three devices had slight mechanical faults, which we believed influenced the reliability of the data collected. In one particular device, the angle would not consistently return back to zero degrees when joint angle measurement was complete. Another difficulty encountered involved the touch sensor button. At times during data collection it became less responsive affecting the way in which the device had to be held in order to take the joint measurement. Before each round of data collection it was ensured the HALO digital goniometer batteries were maximally charged. When the battery was suspected to be low, we believed inaccurate or random angles were given based on the previous round of measurements. Due to time constraints, any HALO digital goniometer that was suspected to be measuring false results or low in battery during data collection was eliminated and only two devices were used for the completion of data collection. Thus, the same HALO digital goniometer was not necessarily used for the second measurement of a particular angle on the same participant again possibly producing unreliable results.

Even with these limitations we encountered with HALO digital goniometer, tractograph vs. HALO, the ICC of 0.70 for ankle joint dorsiflexion and 0.67, 0.45 for inversion and eversion respectively, still indicate the device is still fairly reliable when compared to the currently accepted tool the tractograph in the podiatric setting.

Although there were a lot of limitations to the prototype HALO digital goniometer device, we believe there was anecdotal evidence to suggest that HALO digital goniometer is possible of producing clinically sound and accurate results. We thought that one particular prototype did not have any mechanical faults throughout the study therefore producing what we believed were consistent

measurements. However we were unable to isolate the data from this particular prototype as the same HALO digital goniometer was not always used for the second round of measurements.

Intra-rater reliability

The intra-rater ICCs for each measurement are displayed in Table 2.

The results of this study demonstrated that there is fairly good intra-rater reliability for tractograph, HALO digital goniometer and the comparison of the two tools for ankle joint dorsiflexion, STJ inversion and eversion measurements. In accordance with the results of other studies, we found the ICC for tractograph to be of good intra-rater reliability with dorsiflexion 0.75, inversion 0.87 and eversion 0.78. Menadue et al found the intra- observer reliability of inversion measurements to be 0.795[15], while Elveru et al[14] found the ICC values for intra tester reliability were 0.74 for inversion and 0.75 for eversion[14, 15]. Van Gheluwe et al[13] also noted that ICC values for intra-rater reliability for passive dorsiflexion rated by experienced and inexperienced clinicians ranged from 0.86 to 0.98 and from 0.87 to 0.95, respectively[5]. Andya et al evaluated the reliability of goniometric measurements of ankle dorsiflexion on patients with Duchenne's muscular dystrophy, and reported that intra-tester reliability was high[10]. The results indicated that the reliability of measurements is influenced by the specific patient problem and the results suggest a need for studies of the reliability of measuring ankle joint dorsiflexion among different patient types[10]. In the literature review by Menz, it was suggested that reliability studies of STJ measurements are numerous and whilst discrepancy exists, findings are generally in accordance with each other[1]. Studies have found that intra rater and inter rater reliability of non-weight bearing STJ range using a goniometer is poor[1, 13, 16]. Elveru et al also measured passive ankle joint dorsiflexion of 50 feet by 14 testers and showed a high intra- rater reliability compared with low inter-rater reliability[10, 14].

The HALO digital goniometer also demonstrated good intra-rater reliability of ankle joint dorsiflexion, STJ inversion and eversion, with the following results: 0.77, 0.82, and 0.50 respectively. As previously discussed, the limitations with inter-rater reliability also affect intra-rater reliability. Similar to inter-rater reliability eversion measurements are the least reliable for both tools. This is possibly due to the limited degree of eversion motion available at the subtalar joint combined with the difficulty in passive joint movement.

Similarly, tractograph vs. HALO digital goniometer, intra-rater reliability has fairly reasonable ICCs with ankle joint dorsiflexion 0.69, inversion 0.79 and eversion 0.42.

Further limitations identified in our study include the following. Joint angle measurements were taken with the subject in a relaxed fashion and the examiner performing a passive movement and consequent measurement of the joint angle. It was suspected that some of the participants were actively assisting joint movement and thus exaggerating the measurement and angle recorded. It is difficult to determine when and to quantify the degree to which the participant assisted. This meant that any skewed data could not be eliminated or altered properly.

It is important to note that repeatability of readings taken from passive range of motion is more difficult to achieve than active range of motion[10]. This is because the limit of the range of motion achieved is be dependent on the amount of force applied to the joint. Stretching to the limit many

times during measurement sessions, the muscles and joint structures were stretched with time, increasing the range of motion at that joint[10].

All examiners were provided with training and instructions for using the HALO digital goniometer by the inventor. However; after several practice sessions each of the examiners adopted a preferred way to use the device. This examiner preference may have negatively affected the inter-rater and intra-rater reliability.

The examiners identified some overall benefits with the HALO digital goniometer. The examiners felt the HALO digital goniometer easy and quick to use especially once they had more practice using the device and felt that towards the end of the data collection the HALO digital goniometer was quicker and easier to use than the tractograph. Additionally, a definite angle was clearly displayed on the screen was easier to interpret than the tractograph face.

Conclusions

Finding an accurate and reliable instrument to measure range of motion of a joint in a scientific setting is an ongoing research hurdle. Although there is ample evidence found for intra-rater reliability for ankle joint dorsiflexion, STJ inversion and eversion, and minimal evidence for inter-rater reliability[5], the tractograph currently remains the most versatile and widely used instrument to measure ankle joint range of motion in a podiatric setting[10, 17]. Although we experienced limitations with the HALO digital goniometer within this study the ICC values for inter-rater and intra-rater reliability indicated it may be a reliable and reproducible tool. The examiners felt that most of these limitations can be overcome as the device moves out of prototype development and the benefits of the device will outweigh the limitations.

In conclusion, the results of the current study demonstrated that the HALO digital goniometer has the potential to become a reliable and valuable tool for biomechanical joint measurements in podiatry and across many allied health and medical fields.

Appendix 1:

Participant Consent Form

Intra and Inter reliability of the HALO DISC goniometer and the tractograph in a Podiatric setting

I _____ have read the information provided and any questions I have asked have been answered to my satisfaction. I agree to participate in this activity, realising that I may withdraw at any time without reason and without prejudice.

I understand that all identifiable (attributable) information that I provide is treated as strictly confidential and will not be released by the investigator in any form that may identify me. The only exception to this principle of confidentiality is if documents are required by law.

I have been advised as to what data is being collected, the purpose for collecting the data, and what will be done with the data upon completion of the research.

I agree that research data gathered for the study may be published provided my name or other identifying information is not used.

Participant

_____

Date

_____

Approval to conduct this research has been provided by The University of Western Australia, in accordance with its ethics review and approval procedures. Any person considering participation in this research project, or agreeing to participate, may raise any questions or issues with the researchers at any time.

In addition, any person not satisfied with the response of researchers may raise ethics issues or concerns, and may make any complaints about this research project by contacting the Human Research Ethics Office at The University of Western Australia on (08) 6488 3703 or by emailing to hreo-research@uwa.edu.au

All research participants are entitles to retain a copy of any Participant Information For and/or Participant Consent Form relating to this research project."

Appendix 2:

Participant Information Form

Intra and Inter reliability of the HALO DISC goniometer and the tractograph in a Podiatric setting

Participants for this study have been recruited from the Podiatric Medicine student group to participate in the study entitled 'Intra and inter reliability of the HALO DISC goniometer and the tractograph in a Podiatric setting'. In this study measurements of participant's ankle joint motion will be obtained using two different measuring tools, the tractograph and the HALO DISC goniometer. The collection of these measurements will allow the comparison of the two different tools for measuring joint motion in the podiatric setting.

The two different measurements being taken are subtalar joint range of motion and ankle dorsiflexion. To take these measurements participants will have to lie flat on their stomachs on a podiatric clinical chair for approximately 20 minutes. Two pen lines will be drawn on the back of the participant's heel and on the lower section of their leg. The participant's joint will be passively moved by the examiner and measurements taken. Four different examiners will take a total of six measurements each, additionally a fifth examiner may undertake measurements on some participants and so the total measurements taken on will be approximately 30.

The additional examiner will be a qualified podiatrist who is a member of the UWA Podiatric Medicine teaching staff. They will have been provided with an instructional handout and video to be able to use the HALO DISC goniometer effectively.

The data collected from this study will not be identifiable to any participant. No hard copies of data will be kept and data on computers will be password protected. All consent forms will be kept in a locked cabinet in a locked office on university premises.

Participation in this study is voluntary and any participant is free to withdraw from the research at any time without prejudice. The participant does not need give a reason or justification for withdrawing. If this occurs all data and records of the participant will be destroyed, unless the participant agrees that the researcher may retain and use the information obtained prior to the participant's withdrawal.

The study is being undertaken by four 4^{th} year Podiatric Medicine students; Claire Forde, Lucy Johnston, Emily Longo and Fiona Sherriff under the supervision of A/Prof Jennifer Bryant.

If the participants have any questions or concerns directly before or during the data collection they may raise them with any of the examiners present or can ask to speak with the academic supervisor of the research. The academic supervisor A/Prof Jennifer Bryant is also contactable by email with any questions or concerns regarding the study on jennifer.bryant@uwa.edu.au

Approval to conduct this research has been provided by The University of Western Australia, in accordance with its ethics review and approval procedures. Any person considering participation in this research project, or agreeing to participate, may raise any questions or issues with the researchers at any time.

In addition, any person not satisfied with the response of researchers may raise ethics issues or concerns, and may make any complaints about this research project by contacting the Human Research Ethics Office at The University of Western Australia on (08) 6488 3703 or by emailing to hreo-research@uwa.edu.au
All research participants are entitled to retain a copy of any Participant Information Form and/or Participant Consent Form relating to this research project.

STATEMENT OF ORIGINALITY

This is to certify that the assignment attached herewith, titled:

Intra and inter-rater reliability of the HALO digital goniometer and the tractograph in a Podiatric setting: a comparative study.

and submitted by the undersigned students, is original work undertaken by the students named under, and that all material drawn from other sources has been fully acknowledged.

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Fiona	Sherriff	20350229

Those individuals who have signed this statement declare that the information is original and each has made an equal contribution to the overall assignment.

Signature _____ **Date** / /

Signature _____ **Date** / /

Signature _____ **Date** / /

Signature _____ **Date** / /

All group members contributed equally to the project in all aspects.

List of abbreviations

- STJ: subtalar joint
- ICC: Intra class correlation coefficient

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