

Inter and Intra Rater Reliability of Different Measurement Techniques of Weight Bearing Ankle Dorsiflexion Range of Motion

Aayushi Rathi *¹, Priya Sahasrabuddhe ².

*¹ Clinical Physiotherapist in LH Hiranandani Hospital, Mumbai, Maharashtra, India.

² Assistant Professor, Smt Kashibai Navale College of Physiotherapy, Pune, Maharashtra, India.

ABSTRACT

Background: Measurement of range of motion is a crucial parameter in the physiotherapeutic evaluation and follow up. Ankle dorsiflexion is important for functional activities like running, jogging, waking, stair climbing. Restricted ankle dorsiflexion is seen in various lower limb injuries. Therefore, assessment of dorsiflexion is important to assess function. Goniometer, tape measure, mobile goniometer, inclinometer is used to measure ankle dorsiflexion range of motion in weight bearing and non-weight bearing positions. Weight bearing dorsiflexion has reported higher intra and inter-rater reliability as compared to non-weight bearing ankle dorsiflexion. All these measures may be taken by the same and by different therapists in the management of one patient. Therefore, it is necessary to determine if the measurements used are reliable both within and between the therapists.

Material and Methods: 50 healthy subjects were recruited and their role was explained in the study. Written consent was taken from all the subjects. Weight bearing lunge was done in which the subject was asked to stand with the heel in contact with the ground and the great toe 10 cm away from the wall and the knee touching the wall. Inclinometer, standard goniometer, mobile goniometer and tape measure were administered to check for ankle dorsiflexion range of motion.

Results: ICC for inter rater reliability was almost perfect for tape measure and goniometer (0.968 and 0.837 respectively) and it was substantial for inclinometer and mobile goniometer (0.746 and 0.796 respectively). ICC for intra rater reliability was almost perfect for tape measure, inclinometer and goniometer (0.965, 0.894 and 0.837 respectively) and it was substantial for mobile goniometer (0.802).

Conclusion: The inter-rater reliability of tape measure, goniometer is almost perfect and for mobile goniometer, inclinometer is substantial. The intra rater reliability of tape measure, inclinometer, goniometer is almost perfect and mobile goniometer is substantial.

KEY WORDS: Dorsiflexion, Mobile goniometer, Tape measure, Goniometer, Inclinometer, Reliability.

Address for correspondence: Dr Aayushi Rathi, Clinical Physiotherapist in LH Hiranandani Hospital, Mumbai, Maharashtra, India. **E-Mail:** aayushirathi1511@gmail.com

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INTRODUCTION

Measurement of range of motion is a crucial parameter in the physiotherapeutic evaluation and follow up [1]. Ankle dorsiflexion is important for functional activities like running, jogging, waking, stair climbing [2-4].

Ankle dorsiflexion is also an important parameter to be assessed in patients with impaired gait and balance [5]. Reduced ankle dorsiflexion range of motion is a risk factor for various lower extremity injuries like ankle sprain, patellar tendinopathies, patellofemoral pain

syndrome and plantar fasciitis [6].

Ankle dorsiflexion forms an important kinematic aspect of the initial stance and swing phase of the gait cycle. Therefore, assessment of dorsiflexion is important to assess function [3].

There are various instruments and methods to measure ankle dorsiflexion range of motion in weight bearing and non-weight bearing positions. Weight bearing dorsiflexion methods include the weight bearing lunge test or variations involving the use of inclinometer, goniometer, tape measure and mobile goniometer [2-5].

Non weight bearing methods to measure ankle dorsiflexion range of motion include the use of goniometer, inclinometer, mobile goniometer. Weight bearing lunge test is commonly used for assessing dorsiflexion at the ankle joint. Weight bearing dorsiflexion has reported higher intra and inter-rater reliability as compared to non-weight bearing ankle dorsiflexion [4]. Tape measure method is an inexpensive method and can be performed anywhere. Goniometer is an inexpensive measure and is mostly used in clinical practice but it requires greater degree of accuracy. Inclinometer is an easy-to-use instrument but is expensive when compared to goniometer and tape measure method. Goniometer records app is a mobile application which is handy and can be used in all clinical settings [7] and it will provide us a single numeric value. All, these measures may be taken by the same and by different therapists in the management of one patient. Therefore, it is necessary to determine if the measurements used are reliable both within and between the therapists.

METHODOLOGY

Outcome Measure: Standard Goniometer, Mobile Goniometer, Tape Measure, Inclinometer.

Procedure: This reliability study was approved by the Institutional Review Board. Three raters were involved in this study-Rater A, rater B and rater C. 50 healthy subjects were recruited randomly according to convenience. Patients with neurological deficit, patients with

any lower extremity injury and patients with previous ankle injury were excluded from this study. Consent was taken from all the subjects prior to their enrollment in the study. Ankle dorsiflexion range of motion was measured using a weight bearing lunge position in which the subject was asked to stand with the heel in contact with the ground and the great toe 10 cm away from the wall. The subject was asked to maintain balance by allowing contact with the wall using two fingers from each hand. The subjects were asked to lunge forward until their knees touched the wall. The foot was progressed 1 cm away from the wall until they were unable to touch the wall with their knee without lifting the heel. Once the knee was not able to touch the wall, the foot was progressed towards the wall in installments of 1 to 2 mm at a time until the knee made contact with the wall and the heel made contact with the ground. Maximal dorsiflexion was defined as the maximum distance of the great toe from the wall while maintaining the heel in contact with the ground and the knee in contact with the wall. The maximal dorsiflexion was calculated using a tape measure, inclinometer, goniometer and mobile goniometer.

Tape Measure (Figure 3): At the maximum lunge point, the distance from the great toe to the wall was measured.

Inclinometer (Figure 1): It was placed on the anterior border of tibia when the subject was in maximum lunge point.

Goniometer (Figure 2): At the maximum lunge point, a standard goniometer was aligned with the stable arm parallel to the floor and the mobile arm in line to the shaft of the fibula by visually bisecting the lateral malleolus and the fibular head.

Mobile Goniometer (Figure 4): Mobile goniometer (goniometer records app) was placed on the anterior border of the tibia by keeping the knee and ankle at 90 degrees which was measured by goniometer and then the patient was asked to lunge.

Three measures were obtained using each technique. Measurements (tape measure, inclinometer, mobile goniometer, goniometer)

were obtained during the same session and then the subject was asked to rest for 10 minutes and the test sequence was repeated to find the inter-rater reliability. The test sequence was again repeated after 24 hours for finding the intra rater reliability.

Statistical analysis: The statistical analysis was done by using Statistical Package for Social Science (SPSS) version 16.0

Intra and inter-rater reliability was determined using Intraclass Correlation Co-efficient (ICC) and associated 95% confidence interval. Standard error of measurement (SEM)-(SEM=SDV1-ICC) [15] and the minimal detectable change (MDC)(MDC=SEM*1.96*v2) [15] for each measurement technique was calculated.

Agreement strengths for correlation co-efficient value have been classified by Landis 1977-

<0-Poor

0-0.20-Slight

0.21-0.40-Fair

0.41-0.60-Moderate

0.61-0.80-Substantial

0.81-1.00-Almost perfect

RESULTS

ICC for inter rater reliability was almost perfect for tape measure and goniometer (0.968 and 0.837 respectively) and it was substantial for inclinometer and mobile goniometer (0.746 and 0.796 respectively).

ICC for intra rater reliability was almost perfect for tape measure, inclinometer and goniometer (0.965,0.894 and 0.837 respectively) and it was substantial for mobile goniometer (0.802).



Fig. 1: Inclinometer placement on anterior border of tibia



Fig. 2: A standard goniometer aligned with the stable arm parallel to the floor and the mobile arm in line to the shaft of the fibula by visually bisecting the lateral malleolus and the fibular head.



Fig. 3: Tape measure placed from the great toe to the wall.



Fig. 4: Mobile goniometer (goniometer records app) was placed on the anterior border of the tibia.

Table 1: illustrates the Inter-rater reliability of goniometer, Inclinator, mobile goniometer and tape measure.

INTER RATER RELIABILITY			
	ICC (95% CI)	SEM	MDC
Goniometer	0.837(0.786-0.878)	A-2.23	A-6.18
		B-2.59	B-7.17
		C-2.54	C-7.01
Inclinometer	0.746(0.666-0.809)	A-2.41	A-6.68
		B-2.30	B-6.37
		C-2.32	C-6.15
Mobile Goniometer	0.796(0.796-0.732)	A-2.08	A-5.76
		B-2.03	B-5.62
		C-1.95	C-5.40
Tape Measure	0.968(0.958-0.976)	A-1.14	A-3.15
		B-1.15	B-3.18
		C-1.14	C-3.15

Table 2: illustrates the intra-rater reliability of goniometer, inclinometer, mobile goniometer and tape measure.

INTRA RATER RELIABILITY			
	ICC(95%CI)	SEM	MDC
Goniometer	0.837(0.775-0.882)	A-2.23	A-6.18
		A-1.85	A-5.12
Inclinometer	0.894(0.854-0.923)	A-2.41	A-6.68
		A-2.40	A-6.65
Mobile Goniometer	0.802(0.727-0.857)	A-2.08	A-5.76
		A-2.08	A-5.76
Tape Measure	0.965(0.952-0.975)	A-1.14	A-3.15
		A-1.15	A-4.46

DISCUSSION

This study indicates that tape measure and goniometer had almost perfect inter-rater reliability and inclinometer and mobile goniometer had substantial inter rater reliability.

This study also indicates that the intra rater reliability of tape measure, inclinometer and goniometer was almost perfect and the intra rater reliability for mobile goniometer was substantial.

The ICC for inter rater reliability for goniometer was 0.837 with 95 percent confidence interval ranging from 0.786 to 0.878. The standard error of measure of rater A, B and C was 2.23,2.59 and 2.54 respectively. This indicates a low measurement error between the three raters. The minimal detectable change of rater A, B, C was 6.18,7.17 and 7.01 respectively in which the MDC of rater A is comparatively much lower than rater B and C.

The ICC for intra rater reliability for goniometer was 0.837 with 95 percent confidence interval ranging from 0.775 to 0.882. The standard error of measure of between rater A

was 2.23 and 1.85. This indicates a low measurement error. The minimal detectable change of between rater A was 6.18 and 5.12. Study by Khyati Gohil et al [8] found almost perfect intra rater reliability (0.92) for goniometer. Megan M Konor et al [2] found almost perfect intra rater reliability (0.85) which is similar to this study.

Goniometer is easily accessible and is an important tool for measuring range of motion of different joints. There are not many evidences that have been found about goniometer to measure weight bearing ankle dorsiflexion range of motion, so this study illustrates the use of it. Since lateral malleolus is a reliable anatomical landmark to place the goniometer, any physiotherapist can use goniometer as a measurement tool.

The ICC for inter rater reliability for inclinometer was 0.746 with 95 percent confidence interval from 0.666 to 0.809. The standard error of measure of rater A, B and C was 2.41,2.30 and 2.32 respectively. This indicates a low measurement error between the three raters. The minimal detectable change of rater A, B, C was 6.68,6.37 and 6.15 respectively. Benell et al [3] also found almost perfect inter-rater reliability (0.99).

The ICC for intra rater reliability for inclinometer was 0.894 with 95 percent confidence interval ranging from 0.854 to 0.923. The standard error of measure of between rater A was 2.41 and 2.40. This indicates a low measurement error. The minimal detectable change of between rater A was 6.68 and 6.65. Khyati Gohil [9] found almost perfect intra rater reliability (0.89) for inclinometer since there was a fixed point to place the inclinometer (15 cm below the middle of the tibial tuberosity). Benell et al [3] also found almost perfect intra rater reliability (0.97).

Inclinometer was placed on the anterior border of tibia which had no fixed reference point unlike goniometer and tape measure method. Therefore, the ICC was comparatively less for inclinometer when compared to other measures. Since all physiotherapists have their personal goniometers, hence it can be used on large population and hence it is not time consuming. The same is not possible with

inclinometer because it is expensive and not all set ups have one.

The ICC for inter rater reliability for mobile goniometer was 0.796 with 95 percent confidence interval ranging from 0.796 to 0.732. The standard error of measure of rater A, B and C was 2.08, 2.03 and 1.95 respectively. This indicates a low measurement error between the three raters. The minimal detectable change of rater A, B, C was 5.76, 5.62 and 5.40 respectively.

The ICC for intra rater reliability for mobile goniometer was 0.802 with 95 percent confidence interval from 0.727 to 0.857. The standard error of measure of between rater A was 2.08. This indicates a low measurement error. The minimal detectable change of between rater A was 5.76.

Goniometer records app was used which is a reliable and valid tool to measure range of motion of various joint [7]. There are no such evidences that have measured ankle dorsiflexion range of motion in weight bearing position with the goniometer records app, so this study illustrates the use of it since mobile goniometer is easily available. But the problem faced by the raters was that, before using mobile goniometer, the universal goniometer was placed on the lateral malleolus so that the tibia and ankle were at 90 degrees and then the mobile goniometer was placed on the anterior border of tibia. Therefore, for the measurement to be accurate, universal goniometer was also required to measure weight bearing ankle dorsiflexion range of motion.

The ICC for inter rater reliability for tape measure was 0.968 with 95 percent confidence interval ranging from 0.958 to 0.976. The standard error of measure of rater A, B and C was 1.14, 1.15, 1.14 respectively. This indicates a very low measurement error between the three raters. The minimal detectable change of rater A, B, C was 3.15, 3.18 and 3.15 respectively. Benell et al used tape measure and found almost perfect reliability for inter rater reliability (0.99).

The ICC for intra rater reliability for tape measure was 0.965 with 95 percent confidence

interval ranging from 0.952 to 0.975. The standard error of measure of between rater A was 1.14 and 1.15. This indicates a very low measurement error. The minimal detectable change of between rater A was 3.15 and 4.46. Megan M Konor [2] also found almost perfect intra rater reliability (0.98). Benell et al [3] used tape measure and found almost perfect reliability for intra rater reliability (0.98).

Tape measure method is a very cheap and is easily available in all clinical set ups.

CONCLUSION

The inter-rater reliability of- Tape measure, goniometer is almost perfect and substantial for mobile goniometer and inclinometer. The intra rater reliability of- Tape measure, inclinometer and goniometer are almost perfect and is substantial for mobile goniometer.

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Conflicts of interest: None

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