ORIGINAL PROF-2183

LEG LENGTH DISCREPANCY;

The reliability of tape measure method

Hafiz Muhammad Asim, Ahmad Qayyum, Jawad Ali Hashim

ABSTRACT: Objective: Leg length discrepancy (LLD) has been deemed one of the causative factors for back, sacroiliac conditions and hip pathologies in patients. Increased LLD can exacerbate musculoskeletal impairments in patients that would require the clinician to reflect on the appropriate treatment strategies. The objective of the study was to measure the reliability of "Tape Measure Method" in Leg length discrepancy. **Methodology:** This is a hospital based study. The procedures for obtaining leg length measures in the study were similar to those described by Magee DJ (Orthopedic physical assessment. 5thed).The primary investigator briefly reviewed the procedures for measuring the leg length with the subjects. Only the subject's right side was measured for the study. The subject's weight and height were measured using a standard scale and recorded. The first rater palpated the prominent aspect of the ASIS. The rater then guided the string to the prominent aspect of the MM. The rater repeated this procedure three times for each subject. After the first rater obtained three strings that correspond to the leg length, the second rater repeated the three measurements using the same procedure. After all cuts of strings were obtained each rater measured the lengths of his three strings with a standard tape measure and was recorded on a separate data sheet. Each rater was blinded to the other measures. **Results:** Means and standard deviation for each subject's age, height, weight and BMI were measured. Mean standard deviation and 95% Confidence interval (95% CI) for leg length measurements for both raters are provided in Table 2. According to the results derived from data there were no significant differences in leg length measures between Rater 1 and Rater 2 (t-value = - 0.000; df = 58; p-value = .9981). The ICC (3, 3) for Rater 1 was .999, (95% CI = .998 to .999). This value indicates almost perfect agreement between the measures for Rater 1. The ICC (3, 3) for Rater 2 was .979 (95% CI = .962 to .990). These findings are indicative of almost perfect agreement between the measures. The ICC (2, 2) between Rater 1 and Rater 2 was .987 (95% CI = .972 to .994). A Bland-Altman plot identifies any bias between the two raters. The bias line is almost on zero, indicating no bias between the two raters. It can be concluded that any observed bias was not clinically important. **Conclusions and Discussion:** It was concluded measuring leg length using the tape measure was simple and highly reliable. There were several limitations that may have influence overall results of the study.

Key words: Leg length discrepancy, Measuring leg length discrepancy, Tape measure and length discrepancy, plain radiography in length discrepancy measurement.

Article Citation
Asim HM, Qayyum A, Hashim JA. Leg length discrepancy; the reliability of tape measure method. Professional Med J 2013;20(6): 995-998.

INTRODUCTION

Leg length discrepancy (LLD) has been deemed one of the causative factors for back, sacroiliac conditions and hip pathologies in patients. Increased LLD can exacerbate musculoskeletal impairments in patients that would require the clinician to reflect on the appropriate treatment strategies[1]. There are definitive origins of leg length discrepancy such as fibular hemimelia and post traumatic bone loss involving the foot where significant portion of the limb shortening is distal to the ankle mortise[3].

There are different methods of measuring the leg length including tape measure, plain radiography, orthoroentogenogram, ultrasonography, computed radiography, microdose digital radiography, computed tomography, and magnetic resonance imaging[2,3]. Leg length measurement using with a common tape measure is one of the common tests used in musculoskeletal examination for patients with back and sacroiliac conditions caused by LLD[4]. Though no particular test has been recommended as valid[5], using a common tape measure is a simple and common tool for measuring leg length for patients with LLD. The use of tape measure requires an appropriate clinical experience, protocol and palpation skills. The rater measures the distance between two anatomical landmarks: the anterior superior iliac spine (ASIS) and the medial malleolus (MM)[6]. The purpose of this study was to determine the interrater and intrarater reliability

when measuring leg length between the ASIS and MM. The hypothesis of the study was the reliability coefficients were greater than zero. A second hypothesis was there were no differences in measures between the two raters.

METHODS

Subjects

Thirty subjects between the ages ranging from 15 and 55 years volunteered to participate in the study after signing the consent form. Subjects were included in the sample if they were able to follow simple instructions; walk at least 40 meters with assistance or with use of any assistive device, were able to perform low sitting and could lie on the floor or plinth. Subjects were excluded from the sample if they could not follow simple instructions or commands, were not able to walk for at least 40 meters, and required assistance from other individuals to walk or to participate in simple activities of daily life, and required wheel chair as their primary means of mobility.

Raters

Two raters participated in the study. The first rater was a licensed physical therapist who had four years of clinical experience in hospital, outpatient and private rehabilitation settings. The second rater was a licensed physical therapist with over two years of clinical experience in hospital and outpatient settings.

Data Collection Procedure

The procedures for obtaining leg length measures in the study were similar to those described by Magee. The primary investigator briefly reviewed the procedures for measuring the leg length with the subjects. The subjects were instructed to wear loose and easy clothing at the time of data collection. Only the subject's right side was measured for the study. The subject's weight and height were measured using a standard scale and recorded. The subject's were then instructed to lie in supine on the examination plinth. The first rater palpated the prominent aspect of theASIS.

The rater then guided the string to the prominent aspect of the MM. The rater repeated this procedure three times for each subject. After the first rater obtained three strings that correspond to the leg length, the second rater repeated the three measurements using the same procedure. After all cuts of strings were obtained each rater measured the lengths of his three strings with a standard tape measure and was recorded on a separate data sheet. Each rater was blinded to the other measures.

Data analysis procedures

Means and standard deviations (SD) for age, height, weight and body mass index (BMI) were calculated. Means, SD and 95% confidence intervals (95% CI) were calculated for each leg length measures of both raters. A t test was calculated to determine difference between the leg lengths measures of the two raters. An alpha level of 0.05 was used for significance. Interclass correlation coefficient (ICC) with a 95% CI was calculated to observe the intra-rater reliability in leg length measures for each rater. An ICC with a 95% CI was calculated to observe the inter-rater reliability in length measurement between the raters. A Bland-Altman plot was constructed to find any bias in leg length measures between the two raters. All statistics were calculated using SPSS 15.0 (Chicago, I11) statistical package and Microsoft Excel spreadsheet (Redmond, Wash)

RESULTS

Means and standard deviation for each subject's age, height, weight and BMI can be found in Table I. Mean standard deviation and 95% Confidence interval (95% CI) for leg length measurements for both raters are provided in Table II. According to the results derived from data there were no significant differences in leg length measures between Rater 1 and Rater 2.

(t-value = - 0.000; df = 58; p-value = .9981). The

	$\bar{x}$	S.D
Age (yrs)	33.93	6.17
Height (cm)	172.86	8.01
Weight (kg)	68.34	11.22
BMI (kg/xm2)	22.85	3.40

Table-I. Descriptive statistics for sample (n=30)

	Rater 1	Rater 2
$\bar{x}$	89.00	89.00
S.D	4.70	4.53
95% CI	87.245-90.755	87.308-90.692

Table-II. Means, standard deviations, and 95% Confidence Intervals (95% CI) of leg length measures (cm) by the two raters

ICC (3, 3) for Rater 1 was .999, (95% CI = .998 to .999). This value indicates almost perfect agreement between the measures for Rater 1[8,9]. The ICC (3, 3) for Rater 2 was .979 (95% CI = .962 to .990)[8,9]. These findings are indicative of almost perfect agreement between the measures. The ICC (2, 2) between Rater 1 and Rater 2 was .987 (95% CI = .972 to .994). These findings were indicative of almost perfect agreement between the measurers.

A Bland-Altman plot (Figure 1) identifies any bias between the two raters. The bias line is almost on zero, indicating no bias between the two raters. There were an equal number of data points above zero and below zero and ranged between 87.38 cm and 90.62cm. There was no trend of data points with regard to the dispersal of the data around zero. It can be concluded that any observed bias was not clinically important.

DISCUSSION

Leg length measurement is one of the basic assessments performed by the therapists in patients with back conditions such as scoliosis and sacroiliac

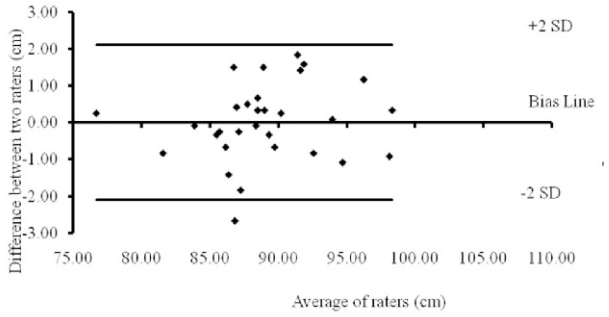

Fig-1. Bland-Altman Plot of agreement between rates for bias

joint dysfunction Magee[6] reported intra-rater and inter-rater reliability coefficients between .84 and .77 for measuring leg length with a tape measure. Cleveland et al[2] compared tape measurements of LLD of 10 erect patients with standing and supine radiographs. They reported poor to moderate correlation when comparing the clinical and radiographic techniques. Hanada et al[8] reported acceptable reliability when the LLD was greater than 17.7 mm, but leg length measures with a tape measure were more unreliable when the LLD was less than 6.4 mm. The validity of leg length measurement using a tape measure has not been determined[4].

There were several limitations that may have influence overall results of the study. One issue was space limitation for conducting the measurement. The raters recorded measurement at cabins in close proximity that were not sound proof. This factor could have affected the quality of blinding between the raters. There was difficulty in identifying bony prominences as well as angular deformities or contractures at hip and knee that may have contributed to errors in measuring leg length using the measuring tool.

CONCLUSIONS

Leg length measurement using a tape measure is a common assessment tool used to measure for LLD in patients with a variety of conditions. It was concluded measuring leg length using the tape measure was

simple and highly reliable. The clinician should have adequate palpation skills when using this technique. It is suggested that the mean of at least two measures be used for clinical purposes. The clinician should select similar landmarks (medial malleolus or lateral malleolus) during the clinical data collection every time.

REFERENCES

1. Petty NJ, Moore AP. **Neuromusculoskeletal examination and assessment: A handbook for therapists.** 2nd ed. Philadelphia, PA: Churchill Livingstone; 2001.
2. Cleveland RH, Kushner DC, Ogden MC, Herman TE, Kermond W, Correia JA. **Determination of leg length discrepancy. A comparison of weight-bearing and supine imaging.** Invest Radiol. 1988; 23:301–304.
3. Sabharwarl S, Kumar A. **Methods of assessing leg length.** Clin Orthop Relat Res. 2008; 466(12):2910-22.
4. Beattie P, Isaacsons K, Riddle DL, Rothstein JM. **Validity of derived measurements of leg-length differences obtained by use of a tape measure.** Phys Ther. March 1990; 70:150-157.
5. Middleton T, George K, Batterham A. **The reliability and validity of the 'Tape' and 'Block' methods for assessing anatomical leg-length discrepancy.** Physical Therapy in Sport.2000; 1:91-99.
6. Magee DJ. **Orthopedic physical assessment.** 5thed. New Delhi, India: Ed Saunders; 2008:688.
7. Hanada E, Kirby RL, Mitchell M, Swuste JM. **Measuring the leg-length discrepancy by the iliac crest palpation and book correction" method: Reliability and validity.** Arch Phys Med 2001 Jul; 82 (7):938-42.
8. Shrout PE, Fleiss JL. **Interclass correlations: Use in assessing rater reliability.** Psychol Bull. 1979; 86:2, 420-428.
9. Wadkins MP, Portney LG. **Foundations of clinical research: applications to practice.** 3rd ed.New Jersy. Prentice Hall.2008.
10. Cross Validated. **How does one interpret a Bland-Altman plot?** http://stats.stackexchange.com/questions/128/how-does-one-interpret-a-bland-altman-plot.

AUTHOR(S):

1. **HAFIZ MUHAMMAD ASIM, P.T – DPT**
   Doctor of Physical Therapy AT Still University, Arizona
   BSPT (Pak)
   Assistant Professor/ Head of Department-
   Lahore College of Physiotherapy
   Lahore Medical and Dental College, Lahore
   Tulspura, Canal Bank, North Lahore
2. **AHMAD QAYYUM, P.T**
   Bachelor in Physiotherapy (Pak)
   PGD in Hospital and Healthcare Management (Pak)
   Senior Lecturer
   Lahore College of Physiotherapy
   Lahore Medical and Dental College, Lahore
   Tulspura, Canal Bank, North Lahore
3. **JAWAD ALI HASHIM, P.T**
   Bachelor in Physiotherapy (Pak)
   Msc. Sociology (Pak)
   PGD in Hospital and Healthcare Management (Pak)
   Senior Lecturer
   Lahore College of Physiotherapy
   Lahore Medical and Dental College, Lahore
   Tulspura, Canal Bank, North Lahore

Correspondence Address:
Hafiz Muhammad Asim, P.T – DPT
Doctor of Physical Therapy AT Still University, Arizona
BSPT (Pak)
Assistant Professor/ Head of Department-
Lahore College of Physiotherapy
Lahore Medical and Dental College, Lahore
Tulspura, Canal Bank, North Lahore
hafizasim@gmail.com

Article received on: 10/01/2013
Accepted for Publication: 15/08/2013
Received after proof reading: 03/12/2013