Analysis of intra-examiner reliability of the tape method measure to leg length discrepancy

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ABSTRACT

Introduction: The aim of this study was to analyze the intra-examiner reliability of the tape method (TM) measure to leg length discrepancy (LLD) on symptomatic and asymptomatic volunteers, and verify if the presence of deformities in low limbs (LL), history of fracture in LL and obesity influence the level of LLD. Materials and Methods: One trained examiner performed measurements of both lower limbs in two different occasions, with an interval of 48 hours between them. The sample consisted of 37 volunteers (28 women and 9 men) characterized as follows: history of fracture of lower limbs (n=5), presence of deformities of lower limbs (n=9), obese (n=9) and asymptomatic (n=14). The intraclass correlation coefficient (ICC), Pearson’s correlation (reliability of the measures) and t-test for independent samples (influence of symptoms on the level of LLD) were used. Results: While the volunteers had asymptomatic value of r=0.98, symptomatic volunteers were classified as small reliability. Furthermore, there was no difference in the level of severity of DCMI among the volunteers (p>0.05). Discussion: It was concluded that the TM measure to LLD is reliable for your application if include asymptomatic individuals.

KEYWORDS
Evaluation; Reproducibility of Results; Lower Extremity; Rehabilitation.

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ANÁLISE DA CONFIABILIDADE INTRAEXAMINADOR DO MÉTODO DA FITA MéTRICA PARA AVALIAÇÃO DA DISCREPÂNCIA DE COMPRIMENTOS DOS MEMBROS INFERIORES

RESUMO
Introdução: O objetivo deste estudo foi analisar a confiabilidade intraexaminador do método da fita métrica (FM) para mensuração da discrepância de comprimentos dos membros inferiores (DCMI) em voluntários sintomáticos e assintomáticos, bem como verificar se presença de deformidades em membros inferiores (MMII), história de fratura em MMII e obesidade influenciam o grau de DCMI. Materiais e Métodos: Um examinador treinado realizou mensurações de ambos os MMII em duas ocasiões distintas, em um intervalo de 48 horas. A amostra constitui-se de 37 voluntários (28 mulheres e 9 homens) caracterizados da seguinte forma: história de fratura de MMII (n=5), presença de deformidades de MMII (n=9), obesos (n=9) e assintomáticos (n=14). Foram utilizados: coeficiente de correlação intraclass, teste de correlação de Pearson (confiabilidade das medidas) e teste t para amostras independentes (influência da sintomatologia sobre o grau de DCMI). Resultados: Enquanto os voluntários assintomáticos apresentaram valor de r=0,98, voluntários sintomáticos tiveram classificação de confiabilidade baixa. Não foi observada diferença quanto ao grau de gravidade da DCMI entre os voluntários (p>0,05). Discussão: Concluiu-se que o método da FM para avaliação da DCMI é confiável para sua aplicação, ao envolver indivíduos assintomáticos.

PALAVRAS-CHAVE
Avaliação; Reprodutibilidade dos Testes; Extremidade Inferior; Reabilitação.

INTRODUCTION
The leg length discrepancy (LLD), or anisomelia, is the difference between the length’s (dissymmetry) caused by anatomical or structural change of the low limbs (LL)\(^1\). The LLD represents a worldwide relative problem, whose incidence comprises 65 to 90% of the population\(^2\). In a retrospective study, it was found that the LLD higher than 20mm affects at least one in a thousand people\(^3\). This change may have many etiologies, including: postsurgical discrepancy of total arthroplasty of the hip, inborn alterations, infectious processes, neuromuscular paralysis, neoplasms, traumas and mechanical-functional disturbances\(^4,5,6\). Considering that the LL are responsible for body’s sustentation in the biped position and for deambulation, dissymmetry in the LL may directly affect the realization of these functions. In this manner, studies have investigated the effect of LLD over lombalgia, hip osteoarthrosis, stress fractures, increase of energetic consumption during gait, and lesions associated with the practice of certain sports modalities, in which running is present\(^7,8,9,10\).

The LLD can be characterized as real, when resulting from a disproportion between the osseous components, or functional, when resulting from secondary deformities, even with bony proportion\(^11\). According to McCaw and Bates\(^11\), there are three categories of the LLD based on...
the discrepancy’s magnitude: light (differences <30mm), gradual (differences comprising 30 ≥ to ≤60mm, and severe (differences >60mm). The LLD’s degree considered clinically significant still remains controversial in literature, but it seems to be a consensus about the fact that subjects with the LLD >20mm are more inclined to present some sintomatology9.

The LLD’s association with countless dysfunctions of the LL and lumbar column makes the measurement of this variable a routine analysis to investigate the biomechanics of the inferior member, especially with regard to the deambulation aspects and sustainment of the body weight10. Thus, the estimation of this clinical measure is important to be done by validated techniques and those that show intra and inter-examiner adequate trustworthiness. However, there is not a clinical method universally accepted for the LLD’s determination. The method considered as gold standard is the conventional radiography, but its regular use is financially expensive and offers risks associated with radiation13,14. Consequently, other more practical methods, of easy realization and lowermost cost have been developed to measure the LLD. Interestingly for this study, the method of the metric tape (MT), described by Beattie et al.13, is currently investigated as for its validity and trustworthiness13,14,15. Beattie et al.13 found legal estimatives for the LLD with an intraclass correlation coefficient (ICC) of 0.683, when only one measurement by MT with length values of the LL was related, by the scometry. Therefore, when the mean of the two measurements were linked, the validity of the MT’s method had an ICC of 0.793. Gogia and Braatz15 reported an ICC of values obtained by the MT’s method with radiographies of 0.98 and intra and inter-examiner of 0.98. Besides these studies, Hoyle, Lautour and Bohannon16 used a MT’s method to assess 25 subjects with light LLD, finding ICC for the inter-examiner trustworthiness of 0.98 to 0.99. Despite these studies, until the moment, the actual state of art is still contradictory and requires new research to sustain the validity and reliability of the MT’s method.

If not treated, the LLD may result in global skeletal muscle instability, with the need of searching for an effective clinical evaluation by a valid and trustable instrument. Such clinical measures are essential not only for the diagnosis, evaluation and reevaluation, but also for the interdisciplinary communication, since the patients are frequently assessed by different professionals of a rehabilitation team.

Before this context, the aim of this study was to analyze the intra-examiner trustworthiness of the MT’s method to measure the LLD in symptomatic and asymptomatic volunteers, as well as to verify if the presence of deformities in LL, fractures history in LL and obesity influence LLD’s degree.

**MATERIALS AND METHODS**

**Sample**

This study complied with the rules of realization of experiments involving human beings, according to the specific resolution of the National Health Counsel (number 196/96) and had the approval of the Ethics Committee of Universidade Federal dos Vales do Jequitinhonha e Mucuri (UFVJM), as protocol number 053/08.

Initially, 54 voluntaries with a mean age of 50±18 years old participated in this study: 28 female (75.7%) and 9 male (24.3%). All the volunteers were randomly invited by a verbal convocation to participate in the research and, after being clarified about the objectives and the systematic of study intervention, they signed the informed consent.

The study was carried out in a room reserved for physical therapeutic attending and was done by students from the course of Physical Therapy of UFVJM, which belongs to the Basic Health Unit (Cuidar Rio Grande 2), located in the Diamantina city (MG).

**Experimental criteria**

In this study, the aim was to assess the intra-examiner reliability of the application of MT’s method to measure the length of LL using a sample with different characteristics (symptomatic and asymptomatic subjects). Thus, the volunteers interested in taking part in the study needed to fulfill one of the following criteria, possibly related to a difficulty measurement of the LLD and described by Brady et al.17: presence of deformities in LL, fracture history in LL and obesity (characterized by BMI ≥30 kg.m⁻²). Furthermore, the return to the same evaluation place became an inclusion criterion after 48 hours for a reevaluation.

From the 54 evaluated volunteers who initially participated in this study, 17 were excluded from the research for not appearing in the reevaluation. From the 37 remaining ones, 9 presented some deformity in visually noted LL, 5 reported fracture history in LL and 9 presented obesity. Although the 14 volunteers did not possess any of the criteria previously established, they still joined the study and were classified as asymptomatic.

**LLD’s evaluation by the MT method**

All the volunteers were assessed by an examiner who was previously trained for this measurement (realization of 70 previous measurements to the study)13. To evaluate the LLD, the MT method, described by Beattie et al.13, was used. During this evaluation, the volunteers used summary clothes, so that the examiner could observe, touch and position the MT adequately over the anatomical points of reference, as well as all the LL articulations.
Initially, after the volunteers had received information about the procedures that would be done, they were positioned in dorsal decubitus over a stretcher, obeying the anatomical position, with neuter rotation of the hip and medial malleolus the nearest as possible of the body sagittal line. Forthwith, the examiner positioned besides the corresponding stretcher beside the member to be evaluated, the anterior superior iliac spine (ASIS) was identified by touching and, using a MT which did not permit its numerical identification, positioned itself over this anatomical reference. The other extremity of the MT was adequately directed by the anteromedial portion of the thigh, kneecap and anteromedial of the volunteers’ legs, until the most distal and medial point of the medial malleolus of the same member (Figure 1).

The MT did not allow the numerical identification by the examiners, because it did not present any scale in the used side for checking. Nevertheless, after the measurement of LLD had been done, the MT’s side with the numerical identification was promptly introduced for the other researcher, who did not participate of the measurement procedures (Figure 2). This procedure was adopted for not influencing in the measurement done by the examiner.

The examiner performed the measurements of both LLD in the following manner: for a certain volunteer, the examiner measured consecutively the right inferior member (RIM) and the left inferior member (LIM). Next, this same volunteer was instructed to stay in the orthostatic position on firm land and performed natural deambulation for about one minute, for the repetition of the measures by the examiner and future mean calculus. The whole procedure was carried out again 48 hours after the first evaluation. It is important to emphasize that, in the evaluation room, remained, during the data collection, the volunteer, an examiner and the researcher that wrote the reading values in MT.

**Statistical analysis**

After a data descriptive analysis had been performed, the intra-examiner reliability of the evaluation of LLD measured by the MT’s method was determined by the ICC calculus, using the LLD mean achieved in the evaluation and the LLD mean in the reevaluation. The LLD was calculated subtracting the values found in each inferior member observed. The Pearson’s correlation test was also achieved in this situation in order to gain the r-value. These procedures have been applied in the whole sample and individually because of the criteria which difficult the measurement: presence of deformities in LL, fractures history in LL and obesity. Later, the t test was applied for independent samples to verify if the volunteers who presented any of the described criteria had a mean of LLD different from the one seen in the asymptomatologic volunteers. For the data processing, the program Statistical Package for the Social Sciences (SPSS), version 11.0 was used. The reliability was considered small (up to 0.25), low (0.26 to 0.49), gradual (0.50 to 0.69), high (0.70 to 0.89) and very high (above 0.90), according to the reference values described by Johnson and Gross.

When necessary, standard deviation was used, with significance level of p<0.05 adopted.

**RESULTS**

**Intra-examiner reliability**

Figure 3 shows the data dispersion of the entire assessed sample (n=37). In this situation, ICC equals to 0.6799 and with r-value obtained by Pearson’s correlation test equals to 0.5136 were observed. Thus, in this study, the intra-examiner reliability for LLD evaluation using MT was characterized as gradual when the whole sample had been analyzed. It should be noted that the maximum value obtained of LLD did not overcome 30mm, indicating that, in the studied sample, there were no volunteers with LLD higher to the light gravity. When the r-value was obtained, because of experimental criteria, a reduction in the reliability classification was observed (Table 1). In fact, obesity showed to be a criterion
that may hugely difficult the reproducibility of measures, once the one found in this case was equal to 0.22. The volunteers with fractures history and presence of any deformity in LL also presented r-values considered low (0.39 and 0.33, respectively). When asymptomatic volunteers were considered, it could be observed that they presented a very high reliability classification for the MT’s method \((r=0.98)\), showing that the proposed experimental criteria in this study were the ones who made the measurement of LLD difficult.

**Influence of the criteria which makes difficult the measurement over LLD’s degree**

Aiming at noticing if the volunteers who presented some of the experimental criteria (presence of deformities, fracture history and obesity) had a LLD’s mean different from the one observed in the asymptomatic volunteers, the \(t\) test for independent samples was applied, however no statistical differences were found in all the tested situations \((p>0.05)\) (Table 1). Although these differences are not meaningful, in all the situations, volunteers who had any of the experimental criteria presented higher values of LLD in comparison to the asymptomatic ones.

**DISCUSSION**

The LL represent body segments responsible for locomotion and sustentation of the body weight. Considering that the skeletal muscle structures of the LL are functionally balanced, it may be developed the deambulation with less mechanical and energetic wastage\(^{20}\). The equalization of the LL’s length affects directly their functionality; therefore, it is an important overload factor for the vertebral column, besides the mechanical and aesthetical impairments, in case there are dyssymmetries\(^{2,3,4,5,6}\). Hence, LLD deserves special attention from the involved professionals with the rehabilitation process and/or sports training involving the LL. Although radiographic measurement may be considered more exact than many other clinical methods, radiography presents difficulties in its execution, because it needs specialized clinics, be financially onerous or radioactive\(^{12,14}\). So, the new clinical strategies of easy application and measurement should be developed and validated for its current application.

Recently, two clinical methods represented especially by the compensation indirect test of inequality of the LL with millimetered blocks of wood, and by the direct MT’s method have been investigated as to their results reproducibility\(^{12}\). It has been described in literature that the MT’s method can be done in two manners: (a) distance between ASIS and the medial malleolus\(^{13}\) and (b) distance between ASIS and the lateral malleolus\(^{21}\). Woerman and Binder-MacLeod\(^{21}\) compared the accuracy of the indirect method (millimetered blocks) to the realization forms of the MT’s methods and to the radiographic findings. It was reported that the indirect method was more exact than the two methods of MT, besides emphasizing that, in the case of MT’s method, the use of ASIS to the medial malleolus was superior to the use of ASIS to the lateral malleolus. The authors concluded that the use of the indirect method must be specially used in cases of functional LLD. On the other hand, other studies did not find favorable results for the indirect method. Friberg\(^{9}\) reported that the indirect method is inaccurate and of low accuracy, with a mean difference compared to the radiographic findings of 7.5mm. Therefore, although these clinical methods are easily executed and present low cost, the estimation of LLD’s needs an adequate reliability intra and inter-examiner. This premise is fundamental so that the patients and/or athletes may be frequently evaluated during the treatment evolution.

The present study had the purpose of assessing the intra-examiner reliability of the MT’s method, for the measurement of LLD in symptomatic and asymptomatic volunteers, as well as to verify if the presence of deformities in LL, fracture history in LL and obesity influence the LLD’s degree. Firstly, the tested reliability demonstrated in all the sample of the study, which can be considered heterogeneous, obtained ICC of 0.6799 (Figure 3).

**Table 1 - Reliability intra-examiner related to experimental criteria**

<table>
<thead>
<tr>
<th>Experimental criteria</th>
<th>r-value</th>
<th>Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Presence of deformities ((n=9))</td>
<td>0.33</td>
<td>Low</td>
</tr>
<tr>
<td>Fracture history ((n=5))</td>
<td>0.39</td>
<td>Low</td>
</tr>
<tr>
<td>Obesity ((n=9))</td>
<td>0.22</td>
<td>Small</td>
</tr>
<tr>
<td>Asymptomatic patients ((n=14))</td>
<td>0.98</td>
<td>Very high</td>
</tr>
</tbody>
</table>

**Figure 3 - Dispersion of the data of the whole sample \((n=37)\). Data represent the leg length discrepancy (LLD) mean in the two measurement situations: evaluation and reevaluation. The intraclass correlation index (ICC) was 0.6799 and the r-value by Pearson’s correlation test was 0.5136. Reliability considered gradual.**
However, when the sample was analyzed, because of the adopted experimental criteria, it could be seen the reduction in r-value of reliability (Table 1). Concomitantly, the asymptomatic volunteers presented a very high reliability classification for the MT’s method (r=0.98), so it is clear that the experimental criteria proposed in this study made the LLD measurement more difficult. Thus, the gradual classification of reliability for the entire sample, actually, represented a higher value gained in the asymptomatic volunteers opposed from the values of low reliability obtained in symptomatic volunteers. Our findings confirm the results of Cleveland et al., which reported low gradual reliability of the MT’s method when patients with LLD are evaluated.

Subjects with disturbances in LL could present higher risk of developing LLD, due to the exaggerated change in body biomechanics. In the present study, the maximum value obtained of LLD did not overcome 30mm, indicating that, in the studied sample, there were no volunteers with LLD higher than light gravity. When analyzing Table 2, no statistical differences of gravity in the LLD were found among the symptomatic and asymptomatic volunteers. Such finding could be justified because the reliability of the obtained data in the evaluation of symptomatic patients was small. So, all the comparison with asymptomatic volunteers with high reliability should be cautious to avoid extrapolations. The inexactness of the MT’s method elapses from its dependency on the osseous prominences, primordially of the anterior-superior iliac spine and of the medial or lateral malleolus.

Table 2 - LLD’s gravity comparison related to experimental criteria

<table>
<thead>
<tr>
<th>Experimental criteria</th>
<th>LLD’s mean (mm)</th>
<th>Standard deviation</th>
<th>t-test (p-value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deformities presence (n=9)</td>
<td>9.78</td>
<td>6.57</td>
<td>0.80</td>
</tr>
<tr>
<td>Asymptomatic (n=14)</td>
<td>7.69</td>
<td>5.56</td>
<td></td>
</tr>
<tr>
<td>Fractures history (n=5)</td>
<td>15.40</td>
<td>11.26</td>
<td>0.16</td>
</tr>
<tr>
<td>Asymptomatic (n=14)</td>
<td>7.69</td>
<td>5.56</td>
<td></td>
</tr>
<tr>
<td>Obesity (n=9)</td>
<td>10.67</td>
<td>6.04</td>
<td>0.96</td>
</tr>
<tr>
<td>Asymptomatic (n=14)</td>
<td>7.69</td>
<td>5.56</td>
<td></td>
</tr>
</tbody>
</table>

The established criteria which difficult this study are believed to have reduced the reliability of the MT’s method, but it is considered that the data herein presented add sustentation to the MT’s method for evaluation LLD in asymptomatic individuals. Gary, in his study, reported that there seems to be a consensus in literature that the mean of LLD for symptomatic subjects is practically identical to the mean of LLD for asymptomatic ones, suggesting that the mean of LLD is not correlated to LL pathologies. Moreover, McCaw and Bates described that LLD inferior to 30mm do not relate to diseases of LL, which could also explain our findings.

Based on the abovementioned results, the conclusion was that the MT’s method for evaluation of LLD is reliable for its application when it is the asymptomatic individuals who are involved. Nevertheless, further studies should be conducted to better elucidate the reliability and reproducibility of this method.

REFERENCES


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