

# Reproducibility analysis of knee circumference in individuals with osteoarthritis

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## ABSTRACT

Knee osteoarthritis presents pain, loss of function, and joint swelling as its main symptoms. The joint swelling is defined as an accumulation of fluid in the joint due to the inflammatory process that contributes to progressive joint damage; it causes limitation in the range of knee motion, decreases proprioception, and affects the functional capacity and the quality of life of the individual. The measurement of articular cartilage volume is essential in clinical practice. The measurement of knee circumference using a measuring tape is a widely used, inexpensive, and accessible technique. However, as it is considered subjective, there is no evidence to support its use. **Objective:** To examine the reproducibility of this technique in patients with knee osteoarthritis. **Method:** Participants underwent two evaluations performed by two independent raters, at different times. The measurement of knee circumference was performed using a measuring tape 150 cm in length, taking as reference the superior pole of the patella. **Results:** The knee circumferences of 114 individuals were measured. According to the intraclass correlation coefficient (ICC), we observed a strong correlation (ICC = 0.98) between raters. **Conclusion:** The use of a measuring tape as a resource to measure knee circumference in individuals with osteoarthritis is a reliable and reproducible method.

**Keywords:** Osteoarthritis, Knee, Reproducibility of Results, Rehabilitation

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## INTRODUCTION

Osteoarthritis (OA) is a degenerative musculoskeletal affection of multifactorial origin, characterized by joint pain and functional limitation. The American College of Rheumatology defines osteoarthritis as a heterogeneous group of conditions that entails signs and symptoms of the joint, associated with defects in the integrity of the articular cartilage.<sup>1,2</sup>

Knee osteoarthritis is currently considered a public health issue. In the United States, approximately 240 new cases are estimated for every 100 thousand people a year, with a predominance among females over 60 years of age.<sup>3,4</sup> The World Health Organization (WHO) positions OA as the fourth most disabling affection among women and eighth among men, being considered a public health issue. In Brazil, it is estimated that 4% of the population presents OA, with the knee being the second articulation most afflicted by the disease, with 37% of the cases.<sup>5,6</sup>

The clinical presentation is characterized by pain, edema, morning joint stiffness, crepitation, muscular atrophy, and instability.<sup>7</sup> The joint edema is defined as an accumulation of liquid in the joint stemming from the progressive inflammatory process of the OA. The increase in volume contributes to the joint damage, provoking a limitation in the movement amplitude of the knee, diminishing joint proprioception, and affecting the functional capacity and quality of life of the individual.<sup>8,9</sup>

Measuring the joint volume is essential in clinical practice, for it quantifies the severity and the extension of the edema, making it possible to demonstrate the effectiveness of interventions specific for the treatment of this symptom, such as puncture, cryotherapy, rest, appropriate positioning, and the elevation of the lower limb.<sup>8</sup> The knee circumference is a widely used technique that measures the articular volume using a measuring tape, from an anatomical point previously established.<sup>9,10</sup> It is a quick, low cost, accessible, and easy to handle device in comparison with other more recent methods of evaluation such as the Leg-O-Meter (equipment to measure the circumference of the lower limb), the water displacement method, optical electronic methods, and computerized tomography, among others, all characterized as expensive devices that demand more time for the evaluation and more financial expenses for the public health system.<sup>11,12</sup> Current scientific literature shows few studies about the use of a measuring tape as an instrument to evaluate joint edema.

## OBJECTIVE

This being the case, the purpose of the present study was to analyze the reproducibility of this technique in individuals with knee osteoarthritis.

## METHOD

This was a transversal study, approved by the Committee for Ethics in Research at the Universidade Federal de São Paulo (Approval Nº 51420). The study was conducted at the *Hospital São Paulo*, in the Knee Pathologies Outpatient Clinic of the Orthopedics and Traumatology department of the Universidade Federal de São Paulo - UNIFESP/EPM. The collection of data lasted from June to September of 2012.

### Participants

In this study, were included adults (older than 18 years old), of both genders, with clinical and radiographic diagnoses of either unilateral or bilateral knee osteoarthritis, according to the criteria from the American College of Rheumatology.<sup>2</sup>

Individuals who presented a history of other diseases that may influence either the increase or the decrease of knee edema, such as a history of knee joint infection, diseases similar to Deep Venous Thrombosis (DVT), Chronic Renal Insufficiency, Rheumatoid Arthritis, Systemic Lupus Erythematosus, Lymphedemas, and Varicose veins, among others, were excluded from this study.

The participants diagnosed with knee osteoarthritis were selected consecutively according with the order of arrival at the Knee Pathologies Outpatient Clinic of the Orthopedics and Traumatology department of the *Universidade Federal de São Paulo*. After signing the Free and Informed Consent form, the individuals were submitted to two evaluations made by two independent raters. The measuring of the circumference was made with a flexible 150 cm long measuring tape of the brand Carci®, composed of 95% polyester and 5% fiberglass, using the superior pole of the patella as the reference point.<sup>11,12</sup>

The individuals were positioned in a supine position on the examination table, and instructed to keep their knees extended and the muscles of the lower limb being evaluated relaxed so as to minimize the risk of changing the reference point adopted for the evaluation (the superior pole of the patella), which could

be modified by the elevation of the patella due to the contraction of the quadriceps.

The first rater (R1) initiated the procedure marking the symptomatic knee and the superior pole of the patella using a dermatographic pen. Afterwards, the measurement was made passing the measuring tape around the evaluated segment (Figure 1) and the value in centimeters corresponding to the first measurement was recorded on a standardized form. In the bilateral OA cases, the lower limb evaluated was the one that presented more pain intensity.

At the end of the first phase, the rater (R1) gently removed the marking made on the skin of the patient with cotton and water without leaving any signs that could influence the second evaluation. Approximately 30 minutes after the first evaluation, the second rater (R2) made the measurement following the same procedure as before.

### Statistical Analysis

The statistical analysis of the demographic data was descriptive. The reproducibility of the measurements of the knee circumference was analyzed, using the intraclass correlation coefficient (ICC) (the closer to 1, the better) with a confidence interval of 95%.<sup>12</sup> For this study, the calculation was from a sample size of 30 individuals. In order to evaluate possible tendencies between the raters, the Bland-Altman plot was used.<sup>13</sup>

## RESULTS

The sample was composed of 114 individuals, of both genders, aged on average 63.2 years (ranging from 39 to 84 years and with a standard deviation of 9.5 years). There was predominance of the female gender (74.6%). Regarding the lower limbs examined, 59 were the right lower limb (51.8%) and 55 were the left (48.2%).

According to the intraclass correlation coefficient (ICC), a strong correlation was found (ICC = 0.98) in the inter-rater reproducibility analysis (relation between R1 and R2). The first rater (R1) obtained an average reading of 43.2 cm ( $\pm$  4.9 cm) and the second rater (R2), an average of 42.9 cm ( $\pm$  5.1 cm). The difference between the two raters was 0.48 cm. (Table 1). This result was represented in the Bland-Altman plot (Figure 2), which demonstrates that there were no tendencies and that the values behaved in a random manner around zero, illustrating the strong correlation obtained.



Figure 1. Standardized procedure to evaluate the circumference of the knee

Table 1. Inter-rater reproducibility analysis

	Average (SD) (in cm)	ICC	CI (95%)		Average difference between raters (in cm)
R1	43.2 ± 4.9	0.989	Inferior	Superior	0.48
R2	42.9 ± 5.1		0.97	0.99	

R1: Rater 1; R2: Rater 2; SD: Standard deviation; ICC: Intraclass Correlation Coefficient; CI: Confidence Interval

## Dispersion Graph

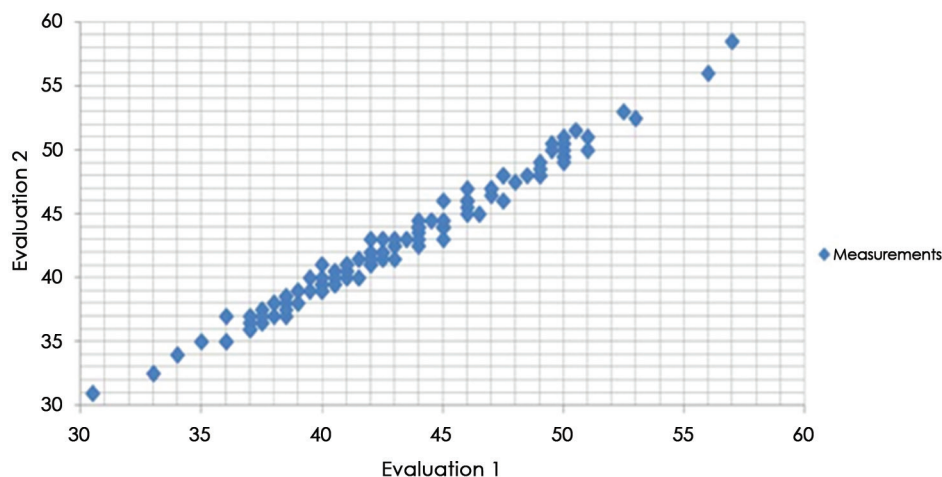


Figure 2. Pearson correlation (dispersion graph - inter-raters analysis)

## DISCUSSION

The purpose of the present study was to analyze the reproducibility of measuring the knee circumference using a measuring tape on patients with osteoarthritis. This is a quick, inexpensive, and easy to handle method that can be used in the clinical practice of outpatient clinics and hospital infirmaries and

that seeks to quantify the joint edema.<sup>14,15</sup> However, due to its being considered subjective by some authors,<sup>16,17</sup> the reproducibility test analysis of this instrument has become essential.

Studies that use the same technique to evaluate the presence of edema in lower limbs obtained similar results regarding the reproducibility of the method,<sup>17-19</sup> however,

these are studies with a heterogeneous and reduced sample (ranging between 11-66 patients). In the present study, the sample of 114 individuals was considered significant and homogeneous, since all the patients included presented diagnoses of knee osteoarthritis. In addition, the measurements were made by the same raters, and they were trained for this in order to minimize the subjectivity of the evaluation. No similar study was found in the literature that specifically evaluated the measurement of the knee circumference in individuals with OA.

In contrast, Dervin et al.<sup>16</sup> made a study in 1998 that discredited the effectiveness of this method and reported the existence of an inter-rater error margin of up to 1 cm in the measurements of the knee circumference made with measuring tape; however, there was no description of how the analysis of this measurement was made. The results of the present study point out an average difference between the raters of 0.48 centimeters.

It is noteworthy that in that 1998 study, the authors chose not to make an intra-rater analysis for, according to Slaa et al.,<sup>19</sup> the reliability of the measurements by measuring tape decreased in relation to the time interval between the measurements, being therefore, efficient only during the short period of evaluation. For its being a systemic disease with an inflammatory character, OA may present periods in which the symptoms are more exacerbated, especially during the movement of the knee in a physical activity, promoting overload in the joint and, in the most advanced cases of the disease, pain episodes can occur even during resting periods.<sup>20,21</sup>

The limitations of this study were the reduced size of the sample and the subjectivity of the technique used, since the results may be highly influenced by the raters training. Nevertheless, in accordance with the results shown, measuring the circumference of the knee has practical and reproducible clinical application in the evaluation of joint edema in patients with OA.

## CONCLUSION

The use of a measuring tape as a resource for measuring the circumference of the knee in individuals with osteoarthritis is a reliable and reproducible method.

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