SCANOMETRY OF LOWER EXTREMITIES: REVISITING DR. JUAN FARILL*

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Abstract **Orthoradiographic measurement employing the "Farill technique" is a routine study in the majority of radiological services. For more than half a century, this method has been widely utilized by specialists in several areas for both measuring and treating differences in length between lower extremities. Nevertheless, technical procedural details during examination and measurements evaluation have usually been neglected or ignored, affecting the final results and consequently the effectiveness of this method. The present study is aimed at publicizing the details standardized by the authors, restoring accuracy to the technique, besides discussing it in comparison with other methods.**
Keywords: Farill; Orthoradiographic measurement; Lower extremities; Difference.

Resumo *Escanometria dos membros inferiores: revisitando Dr. Juan Farill.*
A escanometria pelo "método de Farill" é exame rotineiro na maioria dos serviços radiológicos. Ela permanece, há mais de meio século, como um método amplamente utilizado para diagnóstico da diferença entre os membros inferiores e seu respectivo tratamento pelos especialistas de diversas áreas. Contudo, detalhes na técnica do exame e na avaliação das medidas costumam ser ignorados ou negligenciados, comprometendo o resultado final. Este trabalho tem por objetivo divulgar os detalhes preconizados pelo autor, restaurando a precisão do método, bem como discuti-lo em relação aos demais métodos.
Unitermos: Farill; Escanometria; Membros inferiores; Diferença.

INTRODUCTION

The most accurate way to evaluate the difference in length between lower extremities is by means of imaging studies(1). Scanography was first described by Merrill in 1942(2). In 1953, Dr. Juan Farill described a practical technique for measuring differences in length between the lower limbs(3). The principle is very simple: in the measurement of the difference between the two distances, the elimination of equal segments from both distances does not change the final result. Since it is an easy-to-perform method and does not require any specific equipment, it is routinely performed in any general Radiology service. However, few specialists had the opportunity to read the original article of Dr. Juan Farill; they have almost always learned the method with someone who also has not read it. Consequently, the measuring method is not standardized and incorrect results are obtained, affecting the patient's treatment, which varies according to the type and degree of deformity observed(4). This method, likewise others is limited, and is contraindicated in some cases.

The objective of the present study is to restore and divulge the measurement technique recommended by the author, as well as to compare its efficiency with the other methods available (scanography with millimetric ruler, panoramic radiography and computed tomography).

SCANOGRAPHY (TECHNIQUE)

The examination is performed in two stages. In the first one, with the patient lying in supine position on a Potter-Bucky table, his/her feet are placed together with their longest axes forming an angle of approximately 90º with the table (Figure 1); the longitudinal, central axis of the collimator is aligned in a way that it passes exactly

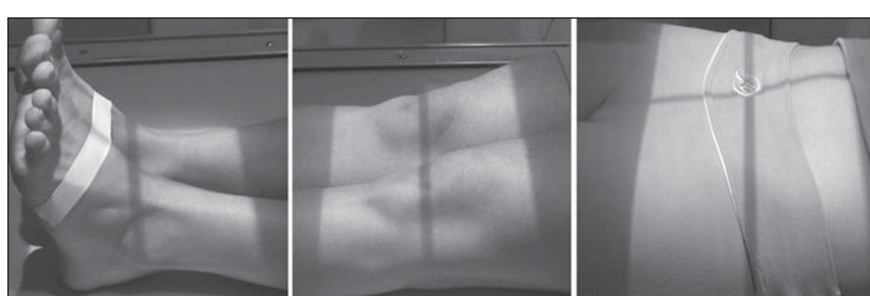

Figure 1. Sites of collimation of the x-ray beams for performance of scanography. The result is shown on Figure 5.

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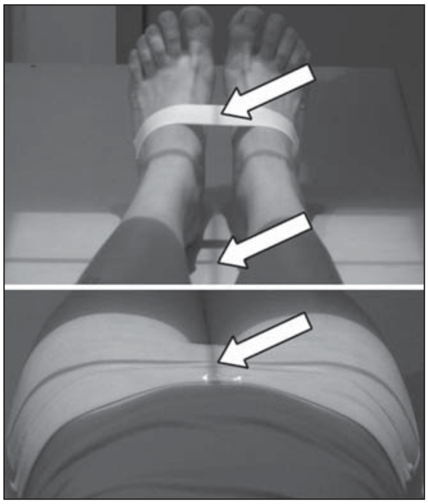


Figure 2. Before the x-ray imaging is initiated, the x-ray tube must be moved to assure that the central beam axis passes exactly between the feet and the pubic symphysis, with no need for the patient to be moved.

Figure 3. Positioning for x-ray imaging of the foot height. The result is shown on Figure 6.

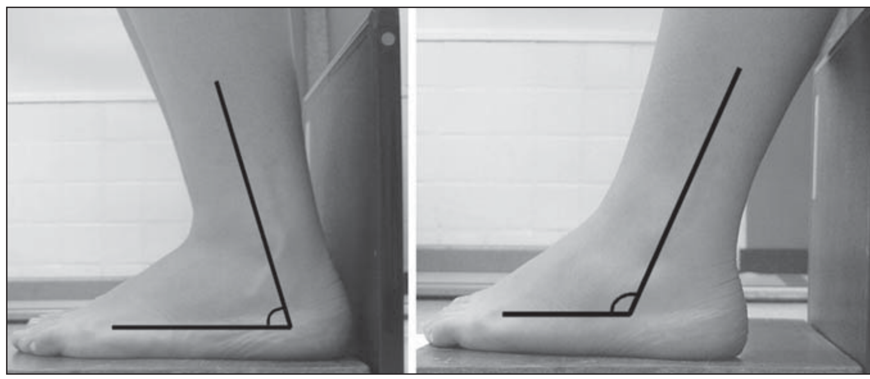


Figure 4. Positioning adopted for balancing in cases of feet deformity.

between the ankles and the pubic symphysis of the individual (Figure 2). The patient must remain still until the examination is completed. With two lead plates, the film is divided into three segments, which are separately radiographed: in the first one, the hip x-ray is performed; in the second one, the knees; in the third one, the ankles. The numbering device at the patient's right, indicates the side. Between images acquisitions, only x-ray-drawers can be moved. In no hypothesis should the chassis be removed from the drawer until the three exposures are completed.

In a second stage, the study proceeds to measure the feet height. With the feet internally rotated about 30º on a wood platform whose posterior surface is covered with lead, the chassis is positioned immediately behind the feet, and an anteroposterior x-ray view from the ankles is made. This positioning determines a dissociation of malleolus, allowing a total visualization of the tali. For an adequate imaging the foot soles must be totally resting on the platform (Figure 3). In case this is not possible because of any deformity, for example, towards or backwards inclination should be tried, as necessary, until an appropriate positioning is achieved (Figure 4).

This second stage usually is neglected because of unawareness or because most of times there are no significant differences between feet height. However, there are situations where this may happen (congenital lesions, poliomyelitis sequelae, osteocartilaginous destruction by inflammatory or surgical processes, etc.).

Contraindications of the method

The most important aspect is the impossibility of a complete contact of all the surfaces of the lower limb with the table surface, because flexed positions distort bone images on x-ray films. This occurs when external fixators are utilized[5], in femur and tibia deformities on sagittal plane or contractures with flexion of hip or knee.

Pronounced valgus, varus or equinus deformities hinder a reliable evaluation of the differences between foot heights.

SCANOMETRY (MEASUREMENTS)

The first measurement is performed in the scanography, between the highest point on the femoral head and the projection of the center of the intercondylar notch on a line touching the femoral condyles (Figure 5a). The same procedure is performed in the contralateral limb (Figure 5a'); the difference between these two measurements representing the femoral shortening.

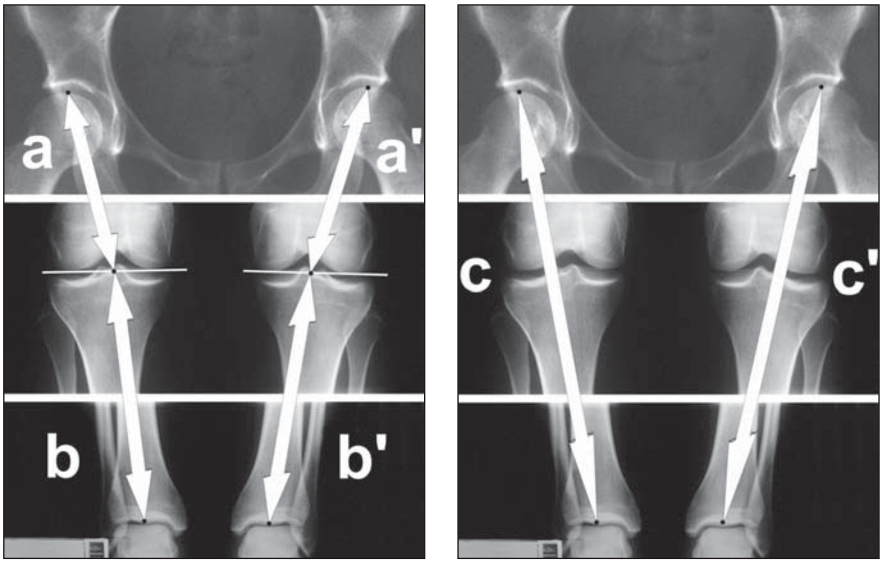
The second measurement is the distance from the same point on the line between the femoral condyles up to the lowest point on the tibial articular surface, in the ankle (Figure 5b). This measurement is repeated for the contralateral bone (Figure 5b'); the difference between these two measurements represents the tibial shortening.

The third measurement is performed directly from the highest point on the femoral head up to the lowest point on the tibial articular surface (Figure 5c). This procedure is repeated for the contralateral limb (Figure 5c'); the difference between these two measurements was named *functional shortening* by Farill.

Finally, the fourth measurement concerns the foot height; it is performed from the lowest point of the talus, on the tibiotarsal joint surface, up to the line resulting from the lead plate on the posterior surface of the wood platform (Figure 6d); this measurement is repeated for the contralateral foot (Figure 6d'). The difference between these two measurements corresponds to the foot shortening.

Calculation and discrepancies analysis

Lower limbs length discrepancy may



Indirect measurements **Direct measurements**

Figure 5. Sites of measurements for calculation of femurs and tibias shortening.

Figure 6. Sites of measurements for calculation of feet shortening.

basically be due to three types of alterations: The first one is bones with different lengths in relation to their contralateral; the second, is a patient with varus deviation or valgus asymmetry, that is, when a limb presents a greater curvature than its contralateral; the third one is isometric femurs and tibias and discrepant foot heights. Overlapping of such alterations is frequently found, so these measurements should be evaluated as whole.

Initially, the right functional measurement must be added to the right foot height. This calculation is repeated for the left side. Then, one measurement is subtracted from the other, so the functional discrepancy between the lower limbs is found. This is the discrepancy that must be mentioned in the medical report, the indirect measurements being utilized only for analyzing the deformity.

So, once the discrepancy between lower limbs is found, we must perform a comparative analysis of the indirect (Figures 5a + 5b; Figures 5a' + 5b') and direct measurements (Figure 5c; Figure 5c'). The results will be:

– The lower limbs length discrepancy is the same both for direct and indirect measurements. This means that the shortening is real, i.e., femurs and/or tibias present different lengths (example 1);

– Indirect measurements indicate limb length equality, and direct measurements indicate limb length discrepancy. This indicates that the shortening is probably due to a varus or asymmetrical valgus deformity (example 2);

– Both the direct and indirect measurements indicate a discrepancy between lower limbs. In this case, there is summation of these deformities (actual shortening + varus/valgus deformity)(example 3).

Although the indirect measurement is aimed only at defining whether the limbs shortening is real or is due to a varus/valgus deviation, this analysis should be always performed, since it may affect directly the therapy of the patient.

As regards the feet, the evaluation of the discrepancy between heights provides essential information. Some times femurs and tibias may present lengths equality and a discrepancy between foot heights; if this discrepancy is significant and we fail to perform this part of the examination, we are likely to fail in diagnosing an asymmetry in the total lower limbs length. On the other hand, a discrepancy between femurs and/or tibias could be balanced by an opposite asymmetry in foot heights; in this case, a treatment for the functional measurements discrepancy would be contraindicated (example 4). The Farill technique does not take into consideration the highest point from the iliac crest to the acetabulum – Figure 7). However, this measurement might to be

Example 1

	Right	Left	Shortening
Femur (cm)	23.4	23.4	—
Tibia (cm)	15.2	14.7	0.5 < at left
Total femur + tibia (cm) (indirect measurement)	38.6	38.1	0.5 < at left
Femorotibial distance (functional) (cm)	38.6	38.1	0.5 < at left
Foot height (cm)	9.2	9.2	—
Total shortening (cm) (functional × foot height)	The left lower limb is 0.5 cm < than the right lower limb (shortening due tibial discrepancies – the differences between indirect measurements is equal the direct measurements)		

Example 2

	Right	Left	Shortening
Femur (cm)	23.4	23.4	—
Tibia (cm)	14.7	14.7	—
Total femur + tibia (cm) (indirect measurement)	38.1	38.1	—
Femorotibial distance (functional) (cm)	38.6	38.1	0.5 < at left
Foot height (cm)	9.2	9.2	—
Total shortening (cm)	The left lower limb is 0.5 cm < than the right lower limb (shortening due the difference of varus or valgus deviation)		

Example 3

	Right	Left	Shortening
Femur (cm)	23.4	23.4	—
Tibia (cm)	15.2	14.7	0.5 < at left
Total femur + tibia (cm) (indirect measurement)	38.6	38.1	0.5 < at left
Femorotibial distance (functional) (cm)	38.6	37.6	1.0 < at left
Foot height (cm)	9.2	9.2	—
Total shortening (cm)	The left lower limb is 1.0cm < than the right lower limb (0.5cm due the tibial shortening, and 0.5cm due the varus or valgus shortening)		

Example 4

	Right	Left	Shortening
Femur (cm)	23.4	23.4	—
Tibia (cm)	15.2	14.7	0.5 < at left
Total femur + tibia (cm) (indirect measurement)	38.6	38.1	0.5 < at left
Femorotibial distance (functional) (cm)	38.6	38.1	0.5 < at left
Foot height (cm)	8.7	9.2	0.5 < at right
Total shortening (cm)	There is no difference between the lower limbs, since the discrepancy between femurs + tibias is balanced by the inverted difference between feet.		

performed with the same objective of the foot height measurement[6].

In the cases where there are knees dysplasias, and a line cannot be drawn between femoral condyles, Farill recommends that only direct measurements are utilized in conjunction with the foot height measurements.

In cases of hip or ankle dysplasias, the author does not mention alternatives; for these cases, we suggest the method employed by Terry et al.[7], where the measurement is performed directly from the anterior superior iliac spine to the outermost point of the lateral malleolus. For this purpose a film with only two exposures is necessary, with each exposure including the anatomical points of reference (anterosuperior iliac spine and lateral malleolus). Even so, it is our understanding that the foot height as well as the iliac wings measurements should be performed and included in the discrepancies calculation.

In our opinion, the Bell-Thompson method (with a millimetric ruler), although being recommended by some authors[8,9], does not offer any substantive advantages over the Farill technique. As the ruler remains positioned on the chassis, it does not follow the magnification of the long bones in the radiographic imaging, which could result in measurement errors[10]. Additionally, for demanding a strict immobilization of the patient, it is very difficult to employ this method in children[8].

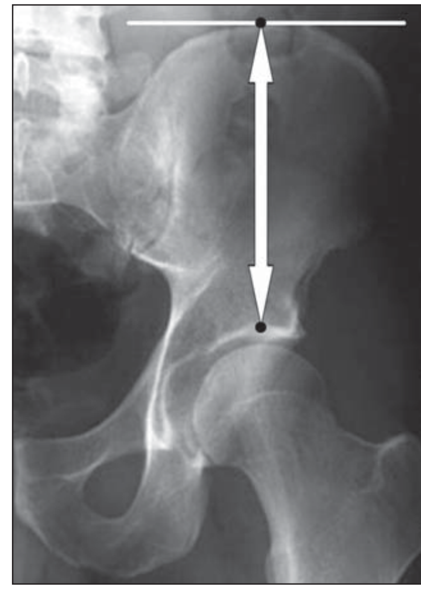


Figure 7. Sites of iliac measurements.

The panoramic x-ray of lower limbs is a very accurate method and presents as an advantage the possibility of being performed in orthostasis[10]. However, it presents the inconvenience of not being widely available, besides the high cost. Also, it does not measure appropriately feet and iliac wings heights, and must be complemented by x-rays appropriate for such measurements.

The measurement of lower limbs discrepancy by means of CT topogram is mentioned by some authors as the most accurate method for diagnosis of lower limbs asymmetry[5,11]. This is true, mainly in the cases where a complete resting of the foot soles on the platform is not achieved (deformities, utilization of external fixators, etc.); in these cases, it is necessary to perform a lateral topogram with the measurements on this view[5]. Additionally, amongst the methods analyzed in the present study, this is the method with lowest radiation dose[5,10,11], and is the method of choice for young patients who need serial studies during the therapy management. But, besides not being widely available, presents high cost[10].

In summary, considering the low cost, high availability and reasonable accuracy, we recommend the Farill technique, complemented with an iliac wing measurement. In cases where there is a contraindication, we recommend a panoramic x-ray or computed tomography.

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