ARTIGO ORIGINAL

Medidas clínicas da coxa e da perna por meio de reparos anatômicos e correlação com o comprimento radiográfico em crianças entre 7 a 12 anos da cidade de Londrina/Paraná, Brasil

Clinical assessment of the thigh and leg with the use of anatomic repairs and correlation with the radiographic evaluation in children between 7 and 12 years of age in the city of Londrina, state of Parana, Brazil

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RESUMO

Introdução: Assimetrias de comprimento dos MMII são comuns na população, porém apenas quando maiores que 1,5 cm deixam de ser um problema estético e podem levar a alterações funcionais. Objetivo: Estabelecer uma correlação entre as medidas clínicas e radiográficas da coxa e da perna em crianças entre 7-12 anos, sendo esta obtida através da escanometria. Material e Método: Avaliação prospectiva do comprimento da coxa e perna de 300 crianças entre 7-12 anos, de ambos os sexos, através da medida clínica com fita milimetrada e radiográfica pela escanometria. A correlação entre as medidas foi feita através da regressão linear simples. Resultado e discussão: Através da análise estatística verificou-se que há diferença estatisticamente significativa entre as medidas clínicas e radiográficas de coxa e perna (p<0,05). Por este motivo foi feita a regressão linear simples entre os valores encontrados e verificou-se a existência de correlação entre elas e definiu-se uma equação de correlação. Com base nesta equação é possível que a medida radiográfica seja pressuposta a partir da medida clínica. Conclusão: As medidas clínicas e radiográficas são estatisticamente diferentes, porém existe uma correlação entre elas, permitindo que seja estabelecida uma fórmula que possibilita a predição das medidas radiográficas a partir dos valores obtidos clinicamente.

PALAVRAS-CHAVE

extremidade inferior, medidas, criança

ABSTRACT

Introduction: Limb length discrepancies are common in the general population, but they only cause functional problems when they are over 1.5 cm. Objective: To make a correlation between clinical and radiological assessments of children´s thigh and leg lengths between 7-12 yrs, through slit scanogram measurement. Method: Prospective study of limb length in 300 children between 7-12 yrs, of both sexes, through clinical measurement using a measuring tape and radiographic assessment using the supine slit scanogram technique. The correlation between the assessments was made by simple linear regression. Results and discussion: The statistical analysis showed that there are differences between the clinical and the radiographic assessments (p<0.05). The simple linear regression was used to verify the correlation and to define the correlation equation. Using this equation, it is possible to define the radiographic values based on the clinical assessment. Conclusion: The clinical and radiographic assessments are statistically different; however, there is a correlation between them, which allows the use of an equation to predict the radiographic values based on the clinical assessment.

KEYWORDS

lower extremity, measures, child

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INTRODUCTION

To follow the physical growth of children and adolescents is of great importance regarding the maximization of the human body development. Several factors can positively or negatively contribute to the genetically predetermined growth, such as the diet, the environment and some diseases.

The development of the skeleton comprehends three components that are related, but not dissociable: increase in size (growth), increase in maturation and aging. The growth occurs from birth to the end of puberty, which, in the long bones, is basically characterized by the proliferation and cellular ossification of the metaphyseal layer of these bones, allowing the assessment of this increase through the measurement of the limb length in children.

Limb length discrepancy is a common orthopedic problem, of which origin can be the shortening or excessive growth of one or more bones in the affected limb. It can be caused by multiple conditions, such as fractures or infections with physeal injury, asymmetric paralysis, tumor or pseudotumor lesions that affect bone growth[1]. There are also cases of idiopathic hypoplasia or hyperplasia. It is important to point out that small variations in limb length due to asymmetry between the right and left sides of the body are very common and do not have clinical significance, with differences of up to 1 cm being found in approximately 70% of the world's adult population[2].

These asymmetries have a minimal effect when they occur in the upper limbs (UULL), as they are used independently, most of the time. In these cases, the alteration is more evident from an esthetical, rather than functional, point of view. However, when these asymmetries occur in the lower limbs (LLLL), they cease to be an esthetical problem only, as they can interfere in the dynamics of the motor system and lead to the development of compensatory mechanisms and higher energy consumption during gait[3].

Differences higher than 1.5 cm in the thigh and leg are factors of esthetical alteration and have clinical repercussion. The shorter limb is weaker during gait, leading to an increase of energy consumption due to the constant need of vertical equalization to compensate the pelvic inclination, which can result in scoliosis and lumbar pain[4]. Hence, the early diagnosis of these differences is an important factor when establishing the best treatment approach[5].

Therefore, the present study was proposed aiming at determining a clinical-radiographic correlation that will prevent children from being successively exposed to X-rays while providing accurate data that will allow the definition of the best treatment method for LLLL discrepancies.

OBJECTIVE

To establish a correlation between the clinical and radiographic measurements of the thigh and leg in children aged 7 to 12 years, through scanometry of body segments.

METHODS

A prospective study was carried out in children of both sexes aged 7-12 years, treated at the Orthopedic Outpatient Clinic of Hospital Infantil de Londrina and at a private orthopedic clinic (Clínica Ortotrauma de Londrina), who did not present congenital malformation of the LLLL, neuro-muscular problems or a history of alterations in the LLLL.

The sample was determined by aliquot parts determined by sex and age, in patients whose previous authorization was given by parents or tutors (Appendix 1). A total of 300 children were assessed clinically and radiographically, with 25 male and 25 female children for each age range considered.

The clinical measurements were performed with a glass fiber measuring tape, (Cardiomed™) with millimetrical definition and maximum length of 150 cm. To perform the thigh and leg length measurements, the patients were instructed to lie in the dorsal decubitus position, with complete extension and neutral rotation of the LLLL. The anatomical reference used was:
• Thigh length: from the anterior superior iliac spine to the upper border of the patella[5] (Figure 1)
• Leg length: upper border of the patella to the medial malleolus[5] (Figure 2)

The radiographic measurements were carried out through parameters defined at the scanometry, being the latter the upper border of the femoral head and the medial condyle for femur analysis and the articular surface of the medial femoral condyle and the distal tibial articular surface for the leg[6] (Figure 3).

The statistical analysis was carried out using the paired t-test[7] in order to verify whether the clinical and radiographic measurements presented statistically significant differences, with a level of significance of 5%. The hypothesis of nullity under test is that there is no significant difference between the means. The alternative hypothesis is that there is a significant difference between the means.

A Simple Linear Regression (SLR)[9] was also carried out, considering the dependent variable as the radiographic measurement (RM), with error adjustment through the minimum square method. The regression analysis is performed to discover the probable correlation form between the variables clinical measurement and radiographic measurement, with a desirable coefficient of correlation close to 1.

RESULTS

Considering that the same number of children of both sexes was assessed and all of them had the segments corresponding to the femur and the tibia measured and that there was no significant difference regarding the gender, they were all treated as a single sample. There was no significant difference considering the distinct age ranges either, therefore, all the 600 measurements of thigh/femur and leg/tibia were considered for the statistical analysis.

Table 1 shows the results of the tests (paired t-test) that demonstrates the existence of a significant difference between the mean
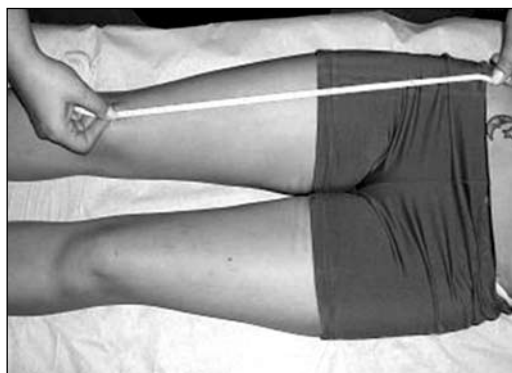
Figure 1
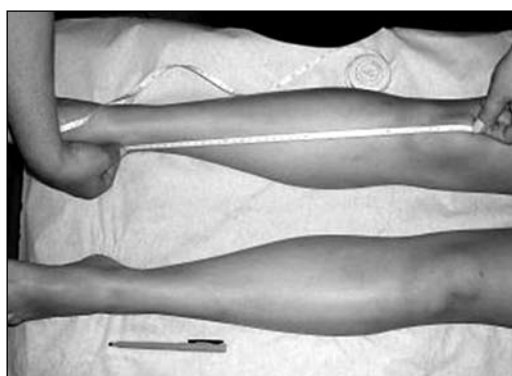Clinical measurement technique of thigh length

Figure 2
Clinical measurement technique of leg length

Figure 3
Scanometry of the LLLL

measurements of the thigh and femur and the mean measurements of the leg and tibia. In this case, the difference found was, on average, 6 cm, which can be explained by the different points of reference used to perform the clinical and radiographic measurements. Considering that for the first, the point of reference is the superior border of the patella and for the latter it is the femoral condyle, the difference can represent the distance that exists between the two, which was not assessed in the present study.

Table 1
Results of the tests (paired t test) between the clinical and radiographic measurements considering the mean differences between the measurements between thigh and femur and between leg and tibia.

	Mean	SD	n	Difference of means	Difference SD	t Test	p*
Thigh	38,67	3.5669					
Femur	38,36	3.6446	600	0,3170	0,9959	7,7965	0,000000
Leg	36,92	3.4552					
Tibia	30,83	3.0571	600	6,0822	0,8779	169,7055	0,000000

SD= standard deviation

Additionally, when testing whether the difference between the measurement of the leg less the measurement of the tibia is higher than 6 cm, the paired *t* test demonstrated a statistically significant difference (t = 2.29 and p = 0.011).

Considering that, on average, the clinical measurement (thigh and leg measurement) is significantly higher than the radiographic measurement (measurement of the femur and tibia, respectively) (p<5%), it is of interest to try and quantify this difference. Hence, in order to verify whether the clinical measurement can be as efficient as the radiographic measurement, the linear regression of the radiographic measurement value was considered over the clinical measurement in an attempt to quantify this relation. Therefore, it was verified what the capacity of the clinical measurement in "predicting" the radiographic measurement was and whether there was a mathematical relation between these two measurements.

The following graphs show the relations obtained in each case and the respective mathematical expressions, first between the thigh and the femur (Figure 4) and then between the leg and the tibia (Figure 5).

The intensity of the correlation between the variables thigh and femur is 96.2% and the model of adjusted linear regression (estimated regression equation) is given by:

$$_{estimated} FEMUR = 0.3383 + 0.9831\ THIGH$$

(standard error of the estimate of the intercept is 0.4426 and of the angular coefficient, 0.0114). The variations in the radiological measurement are accompanied by the variations in the clinical measurement in 92.6%, which indicates a good model adjustment.

With the regression equation, one can estimate the value of the radiological measurement for values of the clinical measurement within the studied interval (from 30 to 50 cm, approximately). Thus, in order to make a prediction for a value of the measurement of the femur that corresponds to one measurement obtained from the thigh, one simply has to substitute it in the regression equation and find the value of the $_{estimated}$ FEMUR. The prediction interval of 95% for the estimated radiological measurement, for a certain value of the clinical measurement is given by:

$$_{estimated} FEMUR \pm 1.96 \sqrt{0.99 \left(\frac{601}{600} + \frac{(\textbf{THIGH} - 38.67)^2}{7620.94} \right)}$$

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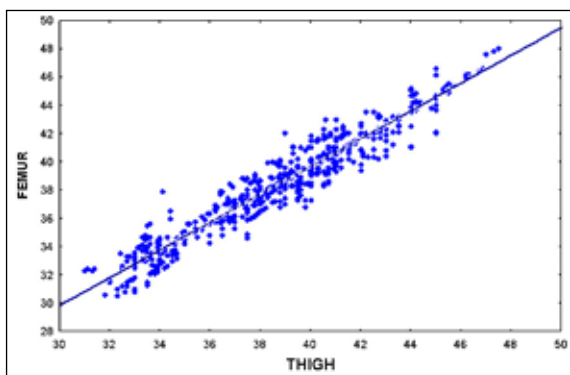
Figure 4
Dispersion diagram of the radiographic measurement of the femur related to the clinical measurement of the thigh in cm and estimated linear regression line
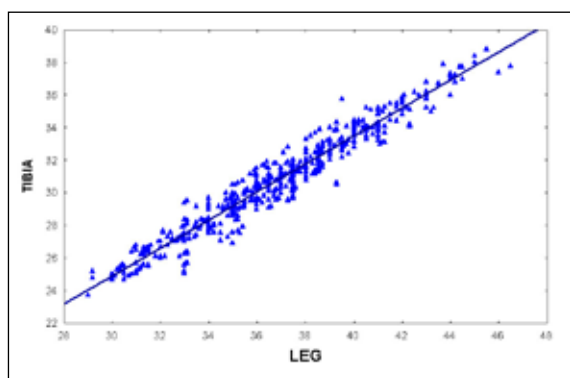

Figure 5
Dispersion diagram of the radiographic measurement of the tibia in relation to the clinical measurement of the leg in cm and estimated linear regression line

The intensity of the relation between the variables leg and tibia is 97.1% e and the linear regression model (estimated regression equation) adjusted to these data is given by:

$$_{estimated}TIBIA = -0.8821 + 0.8591\ LEG$$

(standard error in the estimate of the intercept is 0.3206 and of the angular coefficient is 0.0086). The variations in the radiographic measurement are accompanied by the variations in the clinical measurement in 94.3%, which indicates a good model adjustment.

With the regression equation, one can estimate the value of the radiographic measurement for the values of the clinical measurement within the studied interval (from 28 to 50 cm, approximately). Thus, in order to make a prediction for a value of the measurement of the tibia that corresponds to a measurement obtained for the leg, one simply has to substitute it in regression equation and find the $_{estimated}TIBIA$ value.

$$_{estimated}TIBIA \pm 1,96 \sqrt{0,535\left(\frac{601}{600} + \frac{(\mathbf{LEG} - 36,92)^2}{7151,29}\right)}$$

The interval of prediction of 95% for the estimated radiological measurement, for a certain value of the clinical measurement is given by:

DISCUSSION

There are several available techniques to verify the length of the LLLL and, as the main objective when this measurement is performed is to use it for the calculation of the length prediction at the end of the growth process, these measurements must be reproducible and must present a statistical precision $\geq 95\%$[8,10].

Several methods have been used to perform the measurement of the LLLL: clinical measurement, with measuring tape or blocks, radiographic measurement by scanometry, by teleradiography and by computed tomography (CT). However, none of these techniques can be considered perfect[10,11]. According to Terry and cols. (2005)[12], among the clinical measurements, the most accurate one is performed by using blocks, which takes the equalization of the pelvis into account, when verifying the difference; however, this technique can only be used before compensatory alterations occur and preferably for differences < 3 cm. The clinical measurements can be used if one considers the statistical point of view, as its accuracy is > 95%, when they compared to measurements obtained through imaging assessment[12,13].

The best radiographic measurement is that obtained through scanometry, even when compared to values obtained by CT, as their accuracy is similar and the latter submits the patient to higher degrees of radiation[11].

At the end of the present study, it was observed that, although the clinical and radiographic measurements were statistically different, they presented good correlation, allowing the latter to be estimated based on the first. Using the formulas obtained in the study, one can verify that if a child aged 7 to 12 years presents a leg measurement of 40 cm, its radiographic measurement shall be 33.5 cm (32.04-34.92cm). Similarly, if the measurement of the thigh is 40 cm, the femur shall measure 39.7cm., with a confidence interval between 37.71 and 41.61 cm.

The mean difference of 6 cm found between the measurements of the leg (clinical) and the tibia (radiographic) can be explained by the different points of reference used in the two techniques. In the clinical assessment, the proximal repair point is the superior border of the patella, whereas in the radiographic measurement, it is the joint surface of the medial femoral condyle. This is not used clinically due to the lack of precision for its definition during the semiologic assessment. On the other hand, it was observed that this is a mean value that increases progressively, which can be explained by the children's constant growth.

Considering all these facts, the present study is in agreement with Little, Nigo and Aiona (1996)[11], who state that it is not always necessary to perform the radiographic assessment and that the follow-up can be attained clinically. The growth prediction will be

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made based on the clinical data, with the radiographic assessment being reserved for the pre-operative period[13], especially if the method for the calculation at the time of the discrepancy correction is carried out using the technique described by Paley, Herzemberg and Bowen (2000)[3] and validated by Aguilar and cols. (2005)[13,14], which can take a single measurement into account.

CONCLUSION

The clinical and radiographic measurements are statistically different; however, there is a high correlation between them. Therefore, it was possible to establish a formula that allows the prediction of radiographic measurements based on the values obtained clinically.

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