



Radiographic Evaluation of Postoperative Alignment in Total Knee Arthroplasty*

Avaliação radiográfica do alinhamento pós-operatório na artroplastia total de joelho

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Abstract

Keywords

- ▶ arthroplasty, replacement, knee
- ▶ knee joint
- ▶ radiography

Objective To demonstrate the greater accuracy of panoramic radiographs of the lower limbs (long) in relation to short radiographs of the knee in the measurement of the mechanical axis of the lower limb after total knee arthroplasty (TKA).

Methods A retrospective study was conducted to evaluate the accuracy of long and short postoperative radiographic images of 70 patients submitted to TKA in our service. The images were analyzed at random, at different times, by three orthopedists. In all images, the mechanical axis of the limb, femur and tibia were traced and femorotibial angles (FTAs) were calculated. The intraclass correlation coefficient (ICC) was calculated to evaluate the agreement of the measurement of the inter- and intra-observer mechanical axis.

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Results It was observed that there was high intra and interobserver agreement when panoramic radiographs were used, with minimum intra and interobserver ICC of 0.89, equivalent to a very strong agreement. On short radiographs in the anteroposterior incidence (AP) of the knee, the ICC showed moderate agreement, obtaining a maximum value of 0.75.

Conclusion There is a significant difference in accuracy for the measurement of the mechanical axis of the lower limb, comparing long and short radiographs of the lower limb. Thus, for the proper measurement of the mechanical axis of the lower limb, we suggest the performance of long radiography in the postoperative period of TKA.

Resumo

Objetivo Demonstrar a maior acurácia das radiografias panorâmicas de membros inferiores (longa) em relação às radiografias curtas do joelho na medida do eixo mecânico do membro inferior após a artroplastia total de joelho (ATJ).

Métodos Foi realizado um estudo retrospectivo para avaliar a acurácia de imagens radiográficas longas e curtas pós-operatórias de 70 pacientes submetidos à ATJ em nosso serviço. As imagens foram analisadas ao acaso, em momentos distintos, por três ortopedistas. Em todas as imagens, o eixo mecânico do membro, do fêmur e da tíbia foram traçados e os ângulos femorotibiais (AFTs) foram calculados. O coeficiente de correlação intraclassa (CCI) foi calculado para avaliar a concordância da medida do eixo mecânico inter e intraobservador.

Resultados Observou-se que existe alta concordância intra e interobservador quando foi utilizado as radiografias panorâmicas, apresentando CCI mínimo intra e interobservador de 0,89, equivalente a uma concordância fortíssima. Já nas radiografias curtas na incidência anteroposterior (AP) do joelho, o CCI mostrou-se com concordância moderada, obtendo valor máximo de 0,75.

Conclusão Existe uma diferença significativa na acurácia para a medida do eixo mecânico do membro inferior, comparando-se radiografias longas e curtas do membro inferior. Assim, para a adequada mensuração do eixo mecânico do membro inferior, sugerimos a realização de radiografia longa no pós-operatório de ATJ.

Palavras-chave

- artroplastia do joelho
- articulação do joelho
- radiografia

Introduction

Total knee arthroplasty is a type of surgery widely performed worldwide, with high success rates. It is estimated that in the USA there will be an increase of 673% (approximately 3.48 million) in the surgical demand for this procedure in the period from 2005 to 2030.¹ The surgical postoperative evaluation requires a few steps in its care. In addition to the control of the surgical wound, measures of range of motion and evaluation of pain scales, the postoperative evaluation of the radiographic alignment of the mechanical and anatomical axes is also a fundamental part for the success of the procedure.¹⁻³

Panoramic radiography of the lower limbs has been shown to be essential in preoperative planning. In addition to the radiological measurement of the axes, possible femoral and tibial deformities can be identified that may hinder the surgical procedure.⁴ Short radiographs in anteroposterior incidence (AP) and profile with monopodal support, in addition to the incidence of Rosenberg, are great for staging and classification of degenerative pathology.

In postoperative evaluations, it is extremely common to find only short radiographs of the knee, making it impossible

to establish a comparison with preoperative alignment and to identify those implants that may be at risk of premature failure.⁵ Many authors justify the non-performance of long radiographs because they increase costs to the health system, besides the fact that this type of test is not available in all imaging centers.

Studies in the literature differ in relation to the level of inter and intraobserver agreement on the mechanical and anatomical alignment of the lower limb using long and short radiographs of the knee.^{6,7} The aim of the present study is to compare the intra and interobserver accuracy of the evaluation of the mechanical axis between panoramic radiographs of the lower limbs and knee radiographs in the postoperative period of patients submitted to TKAs performed at our service.

Materials and Methods

The present study was submitted and approved by the Research Ethics Committee of our institution under the number CAAE 33420820.5.0000.5535. The postoperative radiographs of 70 patients submitted to TKA were

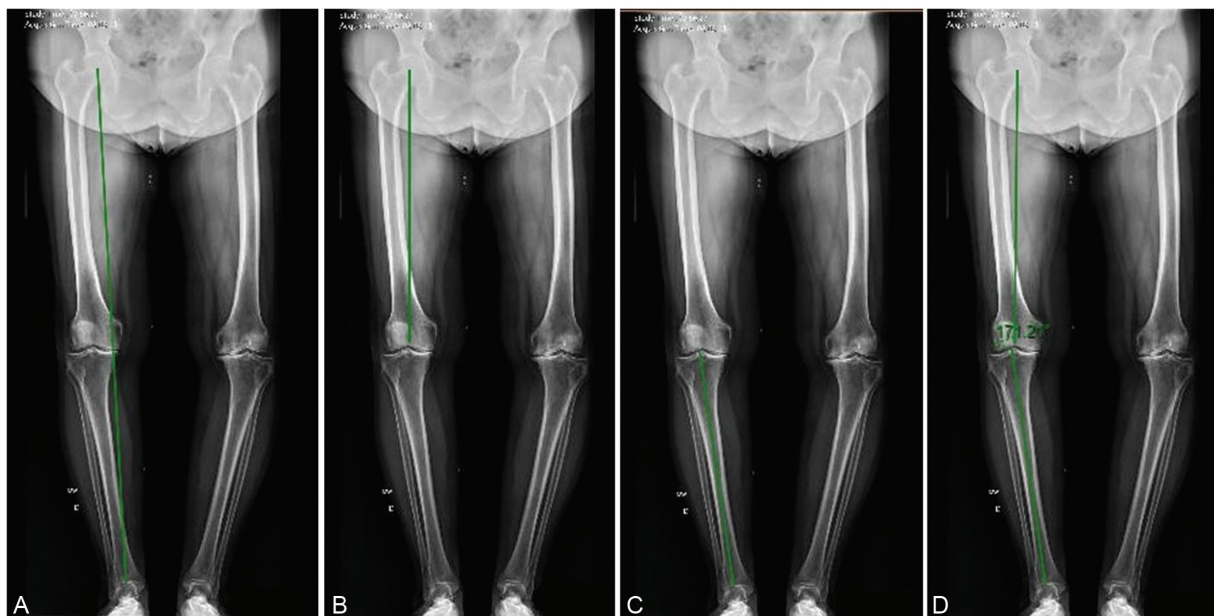


Fig. 1 Panoramic radiographs presenting: (A) mechanical axis of the limb; (B) mechanical axis of the femur; (C) mechanical axis of the tibia; (D) femorotibial angle-FTA.

retrospectively analyzed. The inclusion criteria included patients presenting primary gonarthrosis as the cause of surgery and classified, according to the Ahlback classification,⁸ between stages 3 and 5. The exclusion criteria were low-quality radiological images and long-ilinear patients, whose panoramic radiographs did not include hip, knee and ankle joints in the same image.

All 70 patients underwent long radiographs in bipodal support when they were still staying in our hospital during the postoperative period of TKA. The radiographs were digitized and observed through the PixvieweR imaging program (PixvieweR Web Solutions, The Bronx, NY, USA). The short radiographs of the knee were made from the long radiographs, using the joint line as reference and cutting the image 10 centimeters above and 10 centimeters below it, according to a previous study by Ishii et al.⁹ Thus, we avoided the influence of possible rotations from the performance of a new radiography.

The radiographs were performed at the imaging diagnostic center of our institution. The 140 images were randomly analyzed, at different times, by three generalist orthopedists. All images were reevaluated by the same orthopedists in a period of 15 days. On all radiographs, the mechanical axis of the limb, femur and tibia were traced and the femorotibial angles calculated (► **Figure 1**).

The mechanical axis of the limb was traced by a line that passes through the center of the femoral head to the center of the ankle (► **Figure 1A**). The mechanical axis of the femur was defined as the line that joins the center of the femoral head to the apex of the femoral intercondyle (► **Figure 1B**). The mechanical axis of the tibia was defined as a line between the center of the tibial plateau and the center of the talus (► **Figure 1C**). The measurement of the femorotibial angle (FTA) was performed from the mechanical axes of the femur and tibia (► **Figure 1D**). In the short radiography of the knee,

as it is not possible to visualize the image of the hip and ankle, an image was traced inferring the location of these points to trace the mechanical axis (► **Figure 2**).

The statistical analysis was performed using the SPSS Statistics for Windows, Version 13.0 software (SPSS Inc., Chicago, IL, USA). The intraclass correlation coefficient (ICC) was calculated to evaluate the agreement of the measurement of the inter and intraobserver mechanical axis. It is known that the closer the ICC is to 1, the stronger the agreement among the observers. On the contrary, the closer to 0 (zero), the weaker the agreement becomes.

Results

A mean femorotibial angle of 2.5 degrees was observed on short radiographs, while on panoramic radiographs we observed a value of 1.8 degrees. Considering each examiner alone, the measurement of the mechanical axis varied 8 degrees at most between the long and short radiographs (► **Figure 3**). After the statistical analysis, it was observed that there was high intra and interobserver agreement when panoramic radiographs were used, presenting minimum intraobserver ICC of 0.89 and interobserver of 0.92, equivalent to a very strong agreement. On short radiographs of the knee in AP incidence, the minimum intraobserver ICC was 0.70 and maximum of 0.75, evidencing a moderate-good agreement. The interobserver ICC showed a value of 0.80, which is considered good (► **Table 1**).

Discussion

The present study compared the intra and interobserver accuracy of the evaluation of the mechanical axis between panoramic radiographs of the lower limbs and knee radiographs in the postoperative period of patients submitted to



Fig. 2 Preoperative femorotibial mechanical axis on short radiography.

Table 1 Values obtained for intra and interobserver agreement

		ICC (intraclass correlation coefficient)
Intraobserver		Mechanical
1	Long Short	0.90 0.73
2	Long Short	0.89 0.75
3	Long Short	0.92 0.70
Interobserver	Long Short	0.92 0.80

Observations: $ICC \leq 0.20$ - no agreement; $0.20 < ICC \leq 0.40$ - weak agreement; $0.40 < ICC \leq 0.60$ - moderate agreement; $0.60 < ICC \leq 0.80$ - strong agreement (good); $ICC > 0.80$ - very strong agreement (optimal). 95% confidence interval for ICC; $p < 0.001$.

TKAs performed in our service. Panoramic radiographs of the lower limbs are classically used when one wants to analyze mechanical and anatomical axes accurately.¹⁰⁻¹² However, it is known that such radiographic images increase the actual cost to the institution, add unnecessary radiation to pelvic organs, and require special rooms and equipment for their

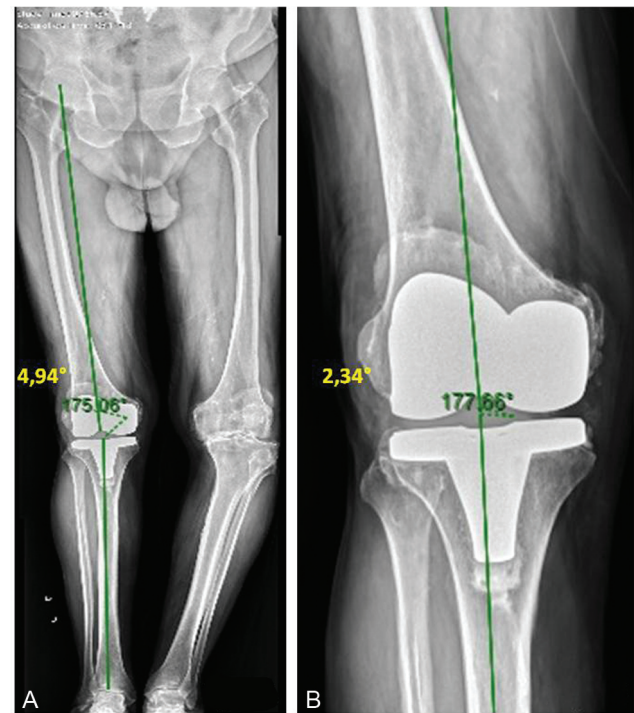


Fig. 3 Comparison of femorotibial angle on long (A) and short (B) postoperative radiographs.

performance.² Due to these limitations, several studies have proposed alternative ways to long radiographs to make a reliable mechanical axis.⁹

One of the pioneering studies in the evaluation of the mechanical axis was that of Abu-Rajab et al.⁵ The group evaluated 50 consecutive radiographs of patients in the postoperative period of TKA and compared the ICC of panoramic radiographs and standardized radiographs of the knee. The interobserver ICC of lower limbs radiography was 0.95, compared to 0.51 when only knee radiographs were evaluated. Dargel et al.¹³ obtained results similar to those of the present study but compared the ICC of panoramic radiographs and radiographs cut in 80%, 60% and 40% of the total length of the lower limb. An ICC of 0.95 was found when analyzing the mechanical axis with panoramic imaging, compared with 0.89 radiography at 80%, 0.76 radiography at 60% and 0.61 radiography cut at 40% of the limb. These data strongly suggest that the axis evaluation becomes more accurate as larger segments of the lower limbs are shown on radiography. The group concluded that knee radiography is insufficient to evaluate the mechanical axis, suggesting routine panoramic examination in the postoperative period of TKA.

The present study found results similar to those described in the international literature. Our results showed a very strong intra and interobserver agreement of the measurements of the axes in panoramic radiographs, which is in accordance with the studies previously described.^{5,13} In addition, we demonstrated that short radiographs were lower in the ability to accurately assess the coronal alignment of the lower limb, since they showed only a moderate intra and interobserver level.

One of the criticisms in relation to alignment evaluation studies is that it is performed in only one plane, but arthroplasties are part of a three-dimensional procedure. Chauhan et al.¹⁴ used tomographic evaluation in 12 operated knees of 6 cadavers using the Perth Protocol. Six positional parameters of the components were found, which, individually or summed, may interfere with the clinical results of the patients. They are the positions of the femoral and tibial components in flexion or extension, in varus or valgus, in external or internal rotation and, finally, the poor selection of the components' sizes. Despite the numerous information that computed tomography can provide, it is important to highlight that it is not routinely used in the postoperative period, because, in addition to not being an easily accessible examination in our country due to its high cost, it still significantly increases the radiation to which the patient is submitted.

Among the positive aspects of the present study, it is worth mentioning that it is the first national study evaluating the mechanical alignment in the postoperative period of TKAs. Furthermore, our results are in agreement with those published in the international literature and with a similar sample. Among its limitations, we highlight that the evaluation of postoperative alignment was performed only in the coronal plane, while we know that a good functioning of TKA needs balance and good positioning in the three planes. In addition, other significant indicators of clinical results, such as evaluation of pain scores in the pre and postoperative periods and evaluation of complications were not measured.

Conclusion

Panoramic radiographs of the knee are more accurate to evaluate the mechanical axis of the limb in the postoperative period of patients undergoing TKA. Following the previously conducted international studies, we suggest the inclusion of panoramic radiography in the postoperative routine of this procedure.

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Conflict of Interests

The authors declare that there is no conflict of interests.

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