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Original Article

Alignment of the tibial component in total knee arthroplasty procedures using an intramedullary or extramedullary guide: double-blind randomized prospective study☆

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ABSTRACT

Objectives: To evaluate the results obtained through using an intramedullary or extramedullary guide for sectioning the tibia in total knee arthroplasty procedures, with a view to identifying the accuracy of these guides and whether one might be superior to the other.

Methods: This was a randomized double-blind prospective study on 41 total knee arthroplasty procedures performed between August 2011 and March 2012. The angle between the base of the tibial component and the mechanical axis of the tibia was measured during the immediate postoperative period by means of radiography in anteroposterior view on the tibia that encompassed the knee and ankle.

Results: There was no demographic difference between the two groups evaluated. The mean alignment of the tibial component in the patients of group A (intramedullary) was 90.3° (range: 84–97°). In group B (extramedullary), it was 88.5° (range: 83–94°).

Conclusion: In our study, we did not find any difference regarding the precision or accuracy of either of the guides. Some patients present an absolute or relative contraindication against using one or other of the guides. However, for the other cases, neither of the guides was superior to the other one.

☆ Work developed in the Hip and Knee Surgery Group of Hospital de Clínicas, Universidade Federal do Paraná, Curitiba, PR, Brazil.

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Alinhamento do componente tibial em artroplastia total do joelho com o uso de guia intramedular ou extramedular: um estudo prospectivo, randomizado, duplo cego

Palavras-chave:
Artroplastia
Joelho
Instrumentação
Osteoartrite do joelho

RESUMO

Objetivos: Avaliar os resultados obtidos com o uso de guia intramedular ou extramedular para o corte tibial em artroplastias totais do joelho, com vistas a identificar sua acurácia e a superioridade de um em relação ao outro.

Métodos: Estudo prospectivo, randomizado, duplo cego de 41 artroplastias totais de joelho feitas entre agosto de 2011 e março de 2012. Foi medido o ângulo entre a base do componente tibial e o eixo mecânico da tíbia no período pós-operatório imediato por meio de radiografia em incidência anteroposterior da tíbia que englobou joelho e tornozelo.

Resultados: Não houve diferença demográfica entre os dois grupos avaliados. O alinhamento médio do componente tibial nos pacientes do grupo A (intramedular) foi de 90,3° (84°-97°). No grupo B (extramedular), foi de 88,5° (83°-94°).

Conclusão: Não encontramos, em nosso estudo, diferença quanto à precisão ou acurácia de qualquer um dos guias. Alguns pacientes apresentam contraindicação, absoluta ou relativa, para o uso de um ou outro guia. Todavia, para os demais casos, não há superioridade de algum deles.

Introduction

Currently, the number of total knee arthroplasty (TKA) procedures performed is increasing greatly, influenced by the aging of the population, increasing numbers of indications and larger numbers of procedures performed on young patients.[1–3] Thus, the search for better clinical results and longer survival of implants has become the subject of many studies on this topic.

The long-term results from TKA are influenced by several factors, such as patient selection, implant characteristics and surgical technique.[4] Regarding the technique, one factor that is believed to have an important role is the alignment of the lower limb, with regard to restoration of the mechanical axis, and especially, an adequate angle for the tibial component[4–8] (Fig. 1). Several authors have correlated an angle of 88–92° in the coronal plane, between the tibial plateau and the mechanical axis of the tibia, with better results and greater survival of the implant.[5,7,9]

Technological advances and the evolution of surgical instruments and components have enabled greater intraoperative precision and, through this, greater possibilities of achieving positioning and alignment closer to what would be considered ideal. In this regard, the guides used for the femoral and tibial cuts, which may be intra or extramedullary, are of great importance. For the femur, the standard is an intramedullary orientation in most cases. However, for the tibia, there is no consensus regarding the best reference point to use.[5–8]

We conducted the present study with the aim of comparing the alignments of tibial components obtained by means of intra and extramedullary guides, in cases of TKA.

Materials and methods

The present study was approved by our institution's ethics committee for research on human beings. For this study, we selected patients with an indication for TKA who fulfilled the following inclusion criteria: primary operation; without deformities of the tibia in the sagittal or coronal plane; without presence of osteosynthesis material that would impede the passage of the intramedullary guide; and without severe

Fig. 1 – Radiographs in anteroposterior view.

obesity or increased soft-tissue volume that would cause difficulty in palpating the bone structures to locate the reference points for the extramedullary guide. Other patients were excluded, as were those who did not agree to sign the free and informed consent statement.

Forty-three patients fulfilled the criteria and underwent operations between August 2011 and March 2012. Two of these patients were subsequently excluded because their radiographic control examinations were of poor quality, thus making it impossible to adequately measure the alignment of the tibial component. Thus, 41 patients remained and were evaluated in the present study.

At the time when anesthesia was induced, these 41 patients were randomized by means of a draw that consisted of using sealed envelopes that each contained a group allocation. In the first group (A), the tibial cut was made using an intramedullary guide; and in the second group (B), an extramedullary guide was used. All the patients had undergone preoperative radiography to produce the following views: anteroposterior view of the knee while standing on one foot; lateral view; axial view of the patella; and panoramic view of the lower limbs. These were used for diagnostic purposes and for preoperative planning.

The surgical procedures were performed by surgeons with different levels of experience, including some who were undergoing training at our service. The same surgical technique was used in all the cases, consisting of using a pneumatic tourniquet on the root of the thigh; a medial longitudinal cutaneous access to the knee; medial parapatellar arthrotomy; and lateral dislocation of the patella. After debridement and resection of osteophytes, menisci and the anterior cruciate ligament (ACL), a femoral cut with made using the intramedullary guide, at a valgus angle of 5° or 6° and at an external rotation of 3°. Following this, a tibial cut was made, with sacrificing of the posterior cruciate ligament (PCL) and use of an intramedullary guide among the patients in group A, or and extramedullary guide in group B. This was followed by component testing and ligament balancing. Lastly, the definitive components were cemented in. In all cases, the Advance® Medial Pivot prosthesis was used (Wright Medical, Arlington, TN, USA).

The alignment of the tibial component was evaluated by means of radiographs of the tibia in anteroposterior view, encompassing the knee and ankle, with the patella absent as a reference for neutral rotation of the lower limb (Fig. 1). These were produced during the immediate postoperative period. The angle of the tibial component, formed between the tibial base and the mechanical axis of the tibia (Fig. 2), was measured using a goniometer with a precision of 1°. Values of 88–92° were considered normal; those greater than 92° were varus angles; and those lower than 88° were valgus angles (Fig. 3). The radiographs were evaluated by an examiner without previous knowledge of the group to which each patient belonged (Fig. 4). Varus angles (over 90°) were considered to be positive, and valgus angles were considered to be negative (Fig. 3).

The statistical analysis was performed using the BioCalc application (Enet Inc., Columbus, OH, USA). The null hypothesis was rejected at the significance level of 0.05 and the parametric T test was used to compare unpaired samples.

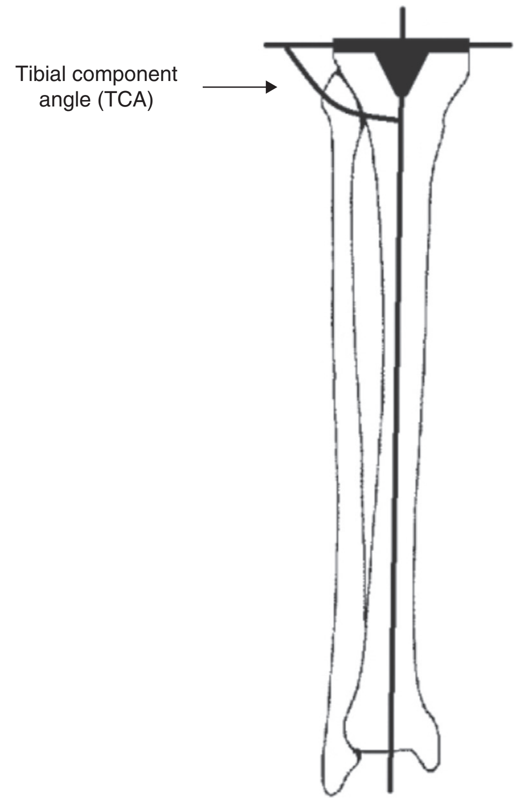

Fig. 2 – Tibial component angle (TCA) and lateral view of the leg, encompassing the knee and ankle. Postoperative situation.

Results

Out of the 41 patients, 22 were allocated to group A (intramedullary guide). These comprised 16 women and six men, with a mean age of 61.4 years (range: 39–78), with a preoperative diagnosis of primary gonarthrosis in 16 cases, rheumatoid arthritis in five cases and juvenile rheumatoid arthritis in one case. In group B (extramedullary guide), there were 19 patients, of whom 13 were women and six were men, with a mean age of 62.4 years (range: 26–79) and with a diagnosis of primary gonarthrosis in 13 cases, rheumatoid arthritis in four cases, juvenile rheumatoid arthritis in one case and osteonecrosis of the femoral condyle in one case. There was no difference between the groups with regard to age, sex or preoperative diagnosis (Table 1).

The mean alignment of the tibial component among the patients in group A (intramedullary) was 90.3° (range: 84–97°). In 13 of the 22 cases (59.1%), the alignment was considered to be adequate, while four cases presented valgus (18.2%) and five presented varus (22.7%). In group B (extramedullary), the mean alignment was 88.5° (range: 83–94°). It was considered to be adequate in 10 of the 19 cases (52.6%), while seven cases presented valgus (36.8%) and two presented varus (10.6%) (Table 2).

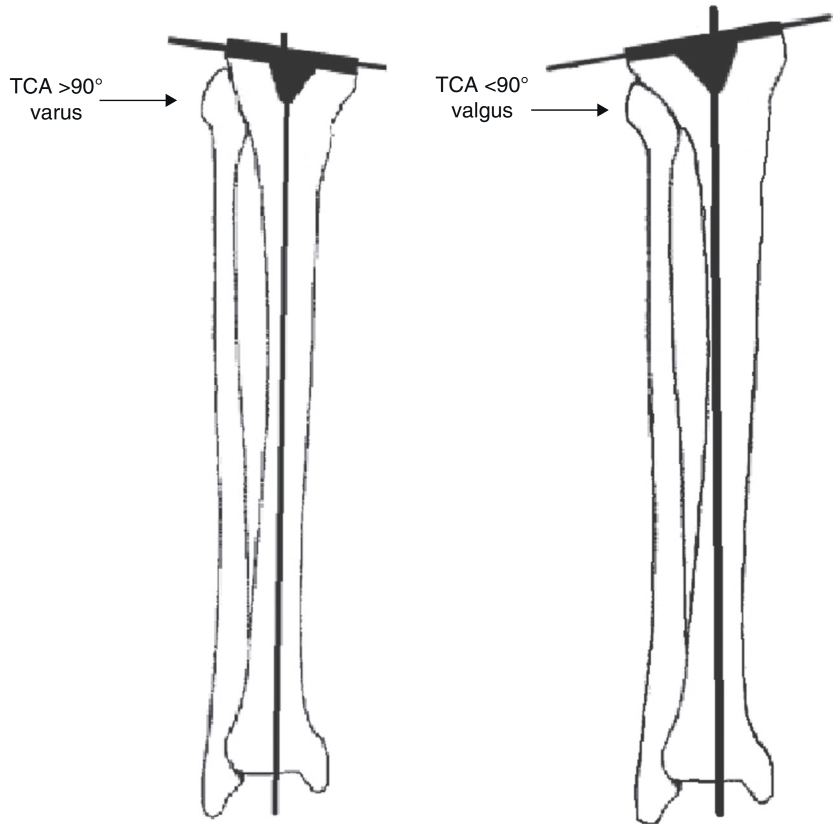

Fig. 3 – Tibial component angle (TCA) > 90°: varus. Tibial component angle (TCA) < 90°: valgus.

Table 1 – Demographic data.

Variables	Group A	Group B	*p*-Value
Patients	22	19	NS
Age	61.4 ± 9.3[a]	62.4 ± 11.8[a]	NS
Gender (male/female)	16/6	13/6	NS
Diagnosis			
Primary	16	13	NS
RA	5	4	
JRA	1	1	
ON		1	

RA, rheumatoid arthritis; JRA, juvenile rheumatoid arthritis; ON, osteonecrosis; NS, not significant.

[a] Mean ± standard deviation.

Table 2 – Tibial component angle (TCA).

	Group A	Group B	*p*-Value
Patients	22	19	NS
TCA (degrees)	90 ± 3.2°[a]	88.5 ± 3.1°[a]	NS
TCA adequate	13/22 (59.1%)	10/19 (52.6%)	NS
TCA inadequate	9/22	9/19	NS
Varus	5	2	
Valgus	4	7	

TCA, tibial component angle; NS, not significant.

[a] Mean ± standard deviation.

Discussion

Several factors have been correlated with success in TKA procedures. There are characteristics relating to the patient, such as age, sex and body mass index.[1–3] Others relate to the surgical technique: restoration of the limb alignment, correct positioning of the components and satisfactory ligament balance.[4–8] It was observed that there has been major evolution in instrument design, which now allows surgeons to perform precise operations. This seems to have influenced the results more significantly than the prosthesis model has.

Although not the main objective of our study, we observed considerable variance in the values for the angle of the tibial component. Nonetheless, the mean obtained was satisfactory. We believe that there are other factors just as important for the success of a TKA procedure as the angle of the tibial component, particularly with regard to the ligament balance of the knee. Hence, the exactness of the tibial component angle of 90° perhaps is not fundamental. However, since the objective in using the guides (both intra and extramedullary) was to obtain a tibial component angle of 90°, the result was disappointing. In making comparisons with the results found in the literature, there have been great variations in the accuracy of the tibial component angle (Table 3). One explanation for this divergence in the results may lie in the fact that, particularly in our study, the procedure was performed by a heterogenous group of surgeons (both experienced and under training), which tends to occur in teaching hospitals. The results were

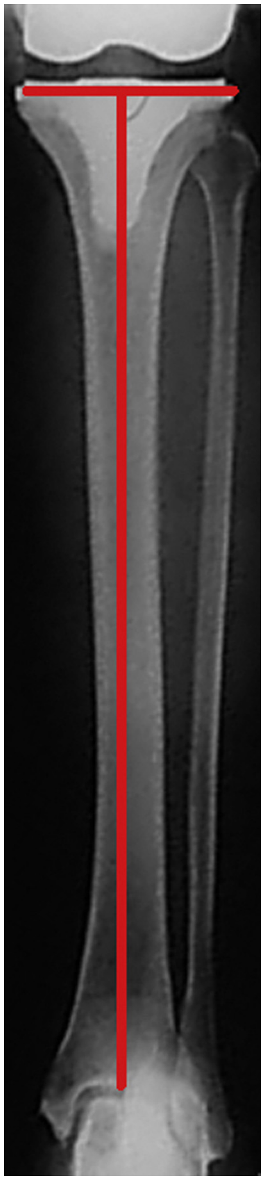

Fig. 4 – Tibial component angle (TCA) measured on a postoperative radiograph.

Table 3 – Accuracy of the TCA after TKA.

Reference	N	Accuracy (%)[a]
Jeffery et al.[13]	115	68
Reed et al.[8]	135	85 (intra)–65 (extra)
Ishii et al.[6]	100	88
Dennis et al.[5]	120	88 (intra)–72 (extra)
Maestro et al.[4]	116	90.1 (intra)–87.2 (extra)
Our study	41	59.1 (intra)–52.6 (extra)

[a] Tibial component angle (TCA) neutral ± 2°.

not separated according to surgeon, although this might have clarified the extent to which personal experience plays a role in obtaining the expected results. In any event, we believe that there is room for discussion on the use of navigation systems in TKA procedures. Given that precise cuts and adequate final alignment are sought, navigation may reduce the variation resulting from individual judgment and produce results that are more homogenous.[1,10] There are certain difficulties in undertaking general introduction of navigation systems, such as the cost, the increased duration of surgery and the need for specific software for each implant.[11] There is also the possibility of complications, such as fractures at the fixation points for the femoral and tibial guides, because of the pins that firmly hold the position sensors for the navigation. Nonetheless, we believe that technological tools that improve the general results and make them less divergent should be studied and possibly used, so that the final results from TKA might become more predictable.

Regarding the surgical technique, restoration of the mechanical axis of the lower limb is usually sought through a joint line that is parallel to the ground, and the final anatomical axis is at a valgus angle ranging from 5° to 7° in most cases.[5] According to Ishii et al.,[6] the overload on the medial compartment reaches approximately 75% of the load transmitted to the knee, even in patients with a neutral mechanical axis.[6] Another important factor is the inclination of the tibial component, which according to some authors should be $90 \pm 2°$.[5,7,9]

Considering that one of the surgeon's objectives during the procedure is to achieve adequate cuts, with a view to obtaining satisfactory final alignment, the existence of precise guides is fundamental. In this regard, intra and extramedullary guides have been developed to perform femoral and tibial cuts. Regarding the femur, it seems that a consensus that intramedullary guides should be used has been reached, considering that the local soft-tissue envelope makes it difficult to correctly identify the bone.[6] On the other hand, for the tibial cut, uncertainties regarding the best orientation still exist.[5,6,8]

Both the intramedullary and the extramedullary guide present advantages and disadvantages. Regarding the intramedullary guide, not only is there an increased risk of fatty embolism,[12] but also there are great limitations on its use, or even impossibility, in cases of bone deformity, sequelae of trauma or presence of osteosynthesis material that obliterates the medullary canal. Regarding the extramedullary guide, it becomes more difficult to use it in cases of great obesity or increased soft-tissue volume around the tibia.

We conducted the present study with the aim of identifying the precision of these two options for guides for the tibial cut, and also whether one of them might be superior to the other. Thus, two demographically, radiologically and clinically comparable groups were randomized such that one of the two guides available would be used in each case. However, in our study, we did not find any difference regarding precision or superiority of one guide over the other.

As mentioned earlier, some patients present absolute or relative contraindications against using one or other of the guides. However, for the other cases, neither of the guides was superior to the other. On the other hand, we believe that proper preoperative planning and meticulous implementation of the plan that has been established are more important, irrespective of which guide is used for the tibial cut.

Although most authors have considered that seeking adequate alignment is a crucial element in the success of TKA procedures,[2–9,11,13] other factors may be as determinant as the alignment, or more so, for the long-term results. Parratte et al.[9] followed up 398 knees that underwent TKA, over a 15-year period and analyzed the long-term results. According to these authors, there were no statistically significant differences in relation to the survival of the implants, between the groups that presented postoperative mechanical axes at angles of $0 \pm 3°$, less than $-3°$ and greater than $3°$. Therefore, it seems that there are other factors as determinant as the alignment, or even more important than this, for the success of TKA procedures.

Conflicts of interest

The authors declare no conflicts of interest.

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