



Original article

Range of motion predictability after total knee arthroplasty with medial pivot prosthesis[☆]



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ABSTRACT

Objective: To assess whether there the final range of motion (ROM) results achieved by patients undergoing total knee arthroplasty (TKA) with prosthesis using Medial Pivot design are predictable.

Methods: Between January and August of 2014, 155 patients with primary osteoarthritis of knee who underwent TKA using the prosthesis ADVANCE[®] Medial Pivot were prospectively assessed. All ROM measures were made and recorded before, during, and after surgery. All patients were clinically assessed preoperatively and postoperatively (15, 45 days, three months, six months, one year, and annually thereafter after surgery); their functional status was assessed using the WOMAC questionnaire.

Results: Significant differences ($p < 0.001$) were observed between the means and medians of ROM in the preoperative when compared with those during the perioperative; the perioperative values, when compared with those after six months postoperative, were also different ($p < 0.001$). No significant differences were found between the means and medians ROM between the intraoperative period and at the 45-day assessment (ns) and between the means and medians ROM between the preoperative period and at the six-month evaluation (ns).

Conclusion: The final ROM achieved by patients that underwent TKA with medial pivot prosthesis can be predicted. The perioperative ROM correlates with that at 45 days after surgery. The final ROM is correlated with that of the pre-operative period.

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Previsibilidade da amplitude de movimento após artroplastia total do joelho com prótese medial pivot

R E S U M O

Palavras-chave:

Amplitude de movimento articular
Artroplastia do joelho
Desenho de prótese

Objetivo: Avaliar se há previsibilidade da amplitude de movimentos alcançada por pacientes submetidos a artroplastia total do joelho com prótese que usa desenho medial pivot.

Métodos: Entre janeiro e agosto de 2014 foi feita avaliação prospectiva de 155 pacientes com osteoartrose primária do joelho submetidos a artroplastia total do joelho com o uso da prótese Advance[®] Medial Pivot. Todas as medidas da amplitude de movimentos foram feitas antes, durante e após a cirurgia. Todos os pacientes foram avaliados clinicamente no pré- e pós-operatório (15, 45 dias, três meses, seis meses, um ano e depois anualmente após a cirurgia) para a análise de seu estado funcional. O questionário Western Ontario and McMaster Universities Osteoarthritis Index (Womac) foi usado.

Resultados: Diferenças significativas ($p < 0,001$) foram relatadas entre as médias e medianas da amplitude de movimentos no pré-operatório em comparação com as medidas obtidas no período intraoperatório. As medidas do pré-operatório também se mostraram diferentes quando comparadas com aquelas após seis meses de pós-operatório ($p < 0,001$). Não foram encontradas diferenças significativas entre as médias e medianas da amplitude de movimento na comparação do intraoperatório e as medidas feitas aos 45 dias (*ns*) e entre as médias e medianas das medidas pré-operatórias e aquelas observadas aos seis meses (*ns*).

Conclusão: Há previsibilidade da amplitude de movimentos obtida por pacientes submetidos a artroplastia total do joelho com prótese medial pivot. A amplitude aos 45 dias é semelhante àquela observada nas medidas intraoperatórias. A amplitude final está relacionada à amplitude pré-operatória.

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Introduction

Osteoarthrosis of the knee is a common cause of pain, disability, and decreasing quality of life, affecting 41.1% of certain population groups, especially women over 70 years.¹⁻³ Total knee arthroplasty (TKA) is a well-established procedure associated with good clinical outcomes, particularly regarding functional improvement.⁴⁻⁶

Although different results may be related to TKA, range of motion (ROM) recovery is essential for functional outcome.^{7,8} Several factors may influence the post-TKA ROM, including pre- and perioperative ROM, surgical technique, posterior cruciate ligament (PCL) resection, prosthesis design, and post-operative rehabilitation.⁸⁻¹¹ In some groups and in certain situations, even ROM loss has been described after TKA.^{9,11-14} Some studies also discuss the importance of the perioperative ROM as an indicator of the final movement; to the best of the authors' knowledge, there are no studies using medial pivot prostheses.^{12,13,15}

Medial pivot prostheses were introduced in 1998 as a revolutionary concept in relation to the other prostheses then available.¹⁶ By sacrificing both cruciate ligaments, stability was based on the conformation of the condyle and medial plateau, making this region a spherically stable center of rotation, and allowing greater movement in the lateral compartment.^{5,17,18} This asymmetry attempts to ensure the reproduction of the combined movement of rotation/translation normally observed in human knees.^{16,18-20}

It is assumed that a higher perioperative ROM can positively influence the ROM observed after TKA using the ADVANCE[®] Medial-Pivot prosthesis, which could result in better functional results. This study aimed to assess whether it is possible to predict final ROM achieved by patients submitted to TKA with a medial-pivot design prosthesis.

Material and methods

Between January and August 2014, 210 TKAs were performed; in 162 of these, the ADVANCE[®] Medial-Pivot prosthesis (Micro-Port Orthopaedics Inc., Arlington, TN, United States) was used. A prospective assessment of 155 patients (95.7%) with primary knee osteoarthrosis submitted to TKA using this prosthesis was made. All patients with TKA indication were considered for inclusion. Patients who had previously undergone surgical procedures in the knee, those with active infection, those who had difficulty in understanding and completing the questionnaires, and those who had undergone TKA on the opposite side within less than six months were excluded from the study due to the possible functional influence. A total of 119 patients (76.77%) were female and 36 (23.23%) were male. The patients' age ranged from 51 to 88 years, with a mean of 70.71. The right knee was operated on in 94 patients. Body mass ranged from 54 to 113 kg, with a mean of 78 kg. Height ranged from 1.40 m to 1.88 m, with a mean of 1.62 m. BMI ranged from 27.55 to 31.97, with a mean of 27.64.

All patients underwent spinal anesthesia associated with femoral and sciatic nerve blocks, with the use of pneumatic tourniquet, anterior longitudinal cutaneous access, and medial parapatellar arthrotomy. In all cases, the femoral and tibial components were cemented in one stage. The patellar component was not used; however, peripatellar neurectomy was performed in all patients. The posterior cruciate ligament (PCL) was resected in all procedures.

The patients were evaluated in the orthopedic clinic in the postoperative period. The prevention of thromboembolic events was performed with mechanical and pharmacological prophylaxis. Prophylactic anticoagulation drugs were administered to the third postoperative day at the hospital, and for 12 days at home, totaling 15 days. Patients were encouraged to walk soon after recovery from peripheral nerve blocks. Weight bearing was allowed as tolerated with a cane or walker on the first postoperative day, under the supervision of a physiotherapist. Passive ROM exercises were performed daily from the first postoperative day onwards. Patients underwent at least two hours of daily physical therapy, consisting of isometric exercises, passive ROM, active assisted ROM, quadriceps and hamstring strengthening, and gait training, which included stair climbing. The mean hospital stay was 54 h. All patients were referred to rehabilitation centers for continuing the rehabilitation program.

Clinical assessments were conducted at 15, 45, 90, 180, and 365 days after surgery, and annually thereafter. All ROM measurements were recorded before, during, and after surgery. All patients were clinically evaluated preoperatively and at the 12-month postoperative evaluation using the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC).²¹ All ROM measurements were obtained in the supine position (Fig. 1). Flexion measurements were performed with the hip at 90° of flexion, passively, under maximal gravitational flexion and using a standard goniometer (Prestige Medical Goniometer, 2013, Northridge, United States) as described by Lee et al.^{12,22} The preoperative ROM was measured immediately before surgery. The perioperative measurements were obtained under maximum passive gravitational flexion with the hip at 90° of flexion, after the arthrotomy was closed and the pneumatic tourniquet was deflated (Video 1.0). ROM was measured at the 45-day and six-month postoperative assessments. To minimize variation among observers, all measurements were made by a single, previously trained observer.

The study was approved by the Ethics Committee under CAAE n° 38474114.2.0000.5127. All participants signed the informed consent prior to enrollment. No financial incentive to participate was offered to the participants.

Statistical analysis

All data were presented as medians, means, and standard deviations. Statistical analysis was performed with SPSS 20® (IBM Corp. Released in 2011. IBM SPSS Statistics for Windows, version 20.0, Armonk, NY: IBM Corp.). The significance level was set at 0.05. Over time, the data was tested for normal distribution using the D'Agostino-Pearson test, and when necessary, the difference between the means was calculated using



Fig. 1 – Assessment of knee range of motion during the process of total knee arthroplasty. (A) preoperative, (B) perioperative, (C) postoperative.

Student's t-test or Wilcoxon's test for those data in which the normality assumption was not applicable.

Results

The ROM throughout the analyzed period is shown in Table 1. Significant differences ($p < 0.001$) were reported between the mean and median preoperative ROM compared to those observed in the perioperative period. Disparity was found between ROM measurements in the postoperative period compared with those six months postoperatively. There were no significant differences between the mean and median perioperative ROM and those obtained 45 days later (*ns*). However, there was a mean loss of 10° when compared with the preoperative ROM. No significant differences were observed between the mean and median preoperative ROM and those obtained

Table 1 – Range of motion during total knee arthroplasty.

	ΔExtension	Mean extension	ΔFlexion	Mean flexion
<i>Preoperative</i>				
General	0°–20°	–1	45°–140°	111°
Male	0°–15°	3°	95°–140°	115°
Female	0°–20°	1°	45°–140°	111°
<i>Perioperative</i>				
General	0°–5°	0.05°	86°–125°	101°
Male	0°	0°	101°	100°
Female	0°–5°	0.01°	86°–120°	101°
<i>45 days postoperatively</i>				
General	0°–10°	1°	80°–130°	102°
Male	0°	0°	90°–130°	104°
Female	0°–10°	1°	80°–120°	102°
<i>Six months postoperatively</i>				
General	0°–10°	1°	90°–130°	111°
Male	0°–5°	0.3°	90°–130°	113°
Female	0°–10°	1°	90°–130°	110°

after six months. There was no statistical difference between genders, although a shorter ROM was observed during the perioperative period in men, which did not imply a shorter ROM in the postoperative period.

The WOMAC index ranged from 21.87 to 80.24, with a mean of 49.63 in the preoperative period. In the postoperative analysis (12 months), the mean WOMAC score was 73.71, ranging between 53.12 and 88.54 ($p < 0.0001$).

Discussion

The most important finding of this study was the relationship between the perioperative ROM measurements and those obtained at 45 days postoperatively. This finding may represent the marker for those patients who would benefit from greater attention and care during the rehabilitation process. It can also be used as a goal to be achieved postoperatively or as a marker of normality in patients evolution. No relationship was observed between the perioperative measures and the ROM achieved six months after surgery. For this period, the preoperative measurements were shown to be reliable and allowed the prediction of the final ROM. It is important to note that the postoperative ROM and that at 45 days after surgery were significantly shorter than in the preoperative period, which reinforces the importance of surgical aggression, pain, and the healing process in ROM recovery.^{8,23,24}

Several authors analyzed ROM after arthroplasty with the use of the medial-pivot design and found a relationship between preoperative ROM and that obtained after surgery.^{4,5,23,25–27} Shakespeare et al.²⁸ compared 261 knees undergoing arthroplasty with medial-pivot prosthesis with 913 cases in which TKA with PCL sacrifice was performed. They found no difference between their ROMs obtained after 12 months of follow-up. Karachalios et al.²⁵ analyzed 284 TKA with medial-pivot design and found improved ROM (101° preoperatively and 117° in the final evaluation). Anderson et al.²³ described 298 primary TKA in five centers. Flexion improved from 107° preoperatively to 121° at the last follow-up exam. In the present study, maintenance of preoperative ROM was

observed, although with lower values than those observed in other studies. When stratifying by gender, a similar ROM progression was observed, with higher absolute values among men, demonstrating no final repercussion on the measured values.

Few studies have examined the importance of perioperative ROM.^{12,13,15} Lee et al.¹² observed that the final flexion measurement observed in patients with poor preoperative flexion (<85°) could be provided by intraoperative measurement (gravitational measurement), rather than by the preoperative value. Ritter et al.¹⁵ observed that the perioperative and postoperative flexion were related, and that the perioperative ROM was the best predictor of postoperative ROM. Kotani et al.¹⁰ found a positive correlation between preoperative ROM and those observed at three months and one year postoperative, but no clear correlation was observed two years after surgery. In the present study, the relationship between perioperative ROM and that observed at 45 postoperative days were not related to the measurements performed at six months. The fact that the perioperative ROM was measured passively, using gravity and without active muscle contraction, may explain the difference between its values and the measurements at six months postoperatively, in which rehabilitation and recovery of muscle strength could have contributed to the improvement in ROM.^{10,13,29}

Recovery after TKA is associated with decreased pain and consequent functional improvement. These achievements can be measured when analyzing the WOMAC questionnaire. Pritchett et al.²⁰ assessed the clinical impression of patients after TKA; 76% of the patients preferred pivotal medial prostheses compared to those in which the PCL was sacrificed, and 61% preferred those with medial-pivot design when compared with prostheses with mobile platform. Anderson et al.²³ examined 204 knees with 5.4 years of follow-up and reported a significant improvement in functional outcomes compared to the preoperative period. Bae et al.²⁴ compared two groups of patients (with and without PCL sacrifice) after TKA with medial-pivot design. A significant functional outcome improvement was found in both groups, with no difference between them.²⁴ Karachalios et al.²⁵ described 284

arthroplasties with 6.7 years of follow-up. Significant improvements were observed in the WOMAC (30.8 preoperative; 79.2 final), SF-12 (26.6 preoperative; 47 final), and Oxford scores (44.4 preoperative; 22.6 final). In the present study, functional outcome improvement was observed after 12 months, despite the maintenance of the same preoperative ROM.

The present study had some limitations. The evaluation of different prosthesis designs could determine if the ROM would follow the pattern observed in the present study. Further studies are needed to assess the reproducibility of ROM measures and whether there is functional and ROM improvement in the comparison of prostheses with medial-pivot design with the other designs. Another limitation of the present study is the fact that ROM was measured with a standard goniometer, rather than with radiographic measurements, which may have resulted in less reliable values. The fact that all the evaluations were performed with the same instrument and by the same researcher, previously validated in a pilot study, reduces the significance of this limitation.²²

This study is important for informing orthopedic surgeons to be alert to the ROM during TKA recovery. Patients with ROM loss after surgery (within 45 days) should be counseled regarding their progression. Those who recover ROM, but at a lower than expected rate, should be considered for greater attention and care in the rehabilitation process, even serving as an alert for possible manipulation under anesthesia.

Conclusion

It is possible to predict the final range of motion obtained by patients submitted to total knee arthroplasty with medial-pivot prosthesis. The preoperative range of motion is correlated with the final postoperative range of motion. The perioperative range of motion is correlated with that observed 45 days after surgery.

Conflicts of interest

Only L.H.C. Jr has made paid presentations and acts as a paid consultant at Microport Orthopedics. The other authors declare no conflicts of interest.

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