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The advantages of computer assistance in total knee arthroplasty

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Objectives: The aim of this study was to compare the results of computer-assisted total knee arthroplasty (CA-TKA) and non-computer-assisted total knee arthroplasty (C-TKA).

Methods: We reviewed 175 cases of TKA and assigned them into two groups according to the use of computer assistance. Group A consisted of 50 cases (35 women, 15 men; mean age: 61.3 years), who had C-TKA and Group B consisted of 125 cases (94 women, 31 men; mean age: 70.9 years), CA-TKA. The results of the groups were compared based on the length of the incision, the duration of the surgery, the length of hospitalization and the final alignment of the prosthesis.

Results: The achievement rate of optimal alignment in the coronal plane was significantly higher in the CA-TKA group (95.2%) than the C-TKA group (74%) ($p<0.0001$). The average surgical time was 69.32 minutes in the C-TKA group (range: 45-94 minutes) and 70.21 minutes in the CA-TKA group (range: 46-98 minutes). The average surgical incision length was 15.78 (range: 11-18.4) cm in the C-TKA group and 12.6 (range: 9.2-16.6) cm in the CA-TKA group. The average hospital stay was 7.3 (range: 5-16) days for the CA-TKA group and 8.5 (range: 5-17) days for the C-TKA group.

Conclusion: Our results suggested that computer assistance provides a more accurate alignment in TKA. The reduced incision length and hospitalization time appear as two other advantages of this technique.

Key words: Alignment; navigation; total knee arthroplasty.

Total knee arthroplasty (TKA) is one of the most frequently performed procedures in modern orthopedics. There has been a marked improvement in the implantation technique with the introduction of computer-assisted TKA (CA-TKA) by Saragaglia and Picard.[1] This initial study paved the way for an advanced surgical procedure that was less susceptible to errors of the conventional instrumentation or the human imprecision. Despite developments in the navigation system, previous studies have not revealed any advantage of this technique.[2,3]

The main benefit of CA-TKA is the increased survival rate of the implants, which is due to the reduction of mechanical stress and debris produced by polyethylene wear.

In order to achieve satisfactory results, two generally accepted conditions should be fulfilled:

1- Stability in full extension and flexion at 90° by the re-establishment of the mechanical axis in the limits of 180°±3°, the placement of the femoral and tibial components at 90°±2° in a frontal plane, and the correction of ligament balancing;

2- Mobility obtained by the congruence of the prosthetic components. This congruence is obtained with the correct rotation of the implants and two equal gaps in flexion and extension.

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The aim of this study was to compare the results of computer-assisted total knee arthroplasty and non-computer-assisted total knee arthroplasty (C-TKA).

Patients and methods

We reviewed 175 cases of TKA and assigned them into two groups according to the use of computer assistance. The patients in this series had primary gonarthrosis with no ipsilateral hip and ankle problem and a flexion contracture of less than 10 degrees and a flexion of more than 70 degrees.

Group A consisted of 50 cases (35 women, 15 men; mean age: 61.3 years) who had C-TKA (25 left, 25 right) between September 1996 and December 1997, with an unconstrained PCL-retaining TKA (SearchTM, Aesculap, Germany). In 32 cases, a varus deformity was noted, while 18 cases presented with a valgus deformity.

Group B consisted of 125 cases (94 women, 31 men; mean age: 70.9 years), CA-TKA (67 right, 58 left), between October 2005 and May 2007, with an unconstrained PCL-retaining E-MOTION prosthesis and navigating system ORTHOPILOT®, (B-BRAUN AESCULAP).There was a pre-operative varus deformity in 94 cases and valgus in 31.

The groups' demographic characteristics were homogenous.

All TKA procedures were performed by the same author (FD) using a medial parapatellar arthrotomy with patellar eversion under pneumatic tourniquet control.

In Group A, the procedures were performed using standard instrumentation with an extramedullary targeting device for the tibial cut and an intramedullary guide for the distal femoral resection. Bone cuts were made using an oscillating saw, the posterior cruciate ligament was retained, and the tibial and femoral components were fixed with cement.

For group B, we used the ORTHOPILOT® system (Aesculap, Tuttlingen, Germany), a non-image based system with intraoperative kinematic and anatomic analysis, already described in the literature by many authors.[1,4-6] The system consisted of a PC computer, a POLARIS infrared camera and three markers, two of which were fixed (one to the distal fourth of the femoral diaphysis and another to the proximal fourth of the tibia) and the third was mobile. The two fixed markers were placed using two small separate incisions. An intraoperative kinematic analysis was performed with the help of a mobile marker, placed over the anatomical landmarks of the hip, knee and ankle (HKA). By using this method, the software instantly calculated the centers of rotation for each joint and thus defined the HKA angle in both the frontal and sagittal planes. First the tibial cut was performed under control of the navigation system. To obtain a ligamentary balance, we used laminar spreaders, in full extension and in flexion. This permitted the computer to determine the thickness of the femoral resection in order to obtain two identical gaps in flexion and extension. The femoral rotational alignment should be made after performing the distal femoral resection. After gathering all the data and obtaining the ligamentary balance using laminar spreaders, the computer was capable of proposing a solution, which we could then virtually modify. Using this technique, useful information was obtained regarding the size of the tibial and femoral implants, the ligamentary balance, the rotation of the femoral implant, the thickness of the polyethylene and the position of the articular interline. The rotational alignment axis was defined according to the navigation system. In order to achieve a symmetric flexion gap, we used the ORTHOPILOT® 4.2 version which allows the rotation of the femoral component to be correlated with the ligamentary balance, while taking into account the posterior condylar axis to obtain the best possible balance in extension and flexion at 90 degrees. Ninty-five cases in this group had cementing of both the tibial and femoral components, while 10 cases had only the tibial component (hybrid) cemented and 20 cases had both components uncemented.

The patella was resurfaced in all cases and there were no complications related to the operative technique in either group.

In the first phase of our study, 3 parameters were statistically compared between the two groups: the mean HKA angle, the mean frontal femoral component angle, and the mean frontal tibial component angle. Reference values, as defined in the literature, were used: 180°±3° for the HKA angle and 90°±2° for the frontal femoral component angle and frontal tibial component angle.[2,4]

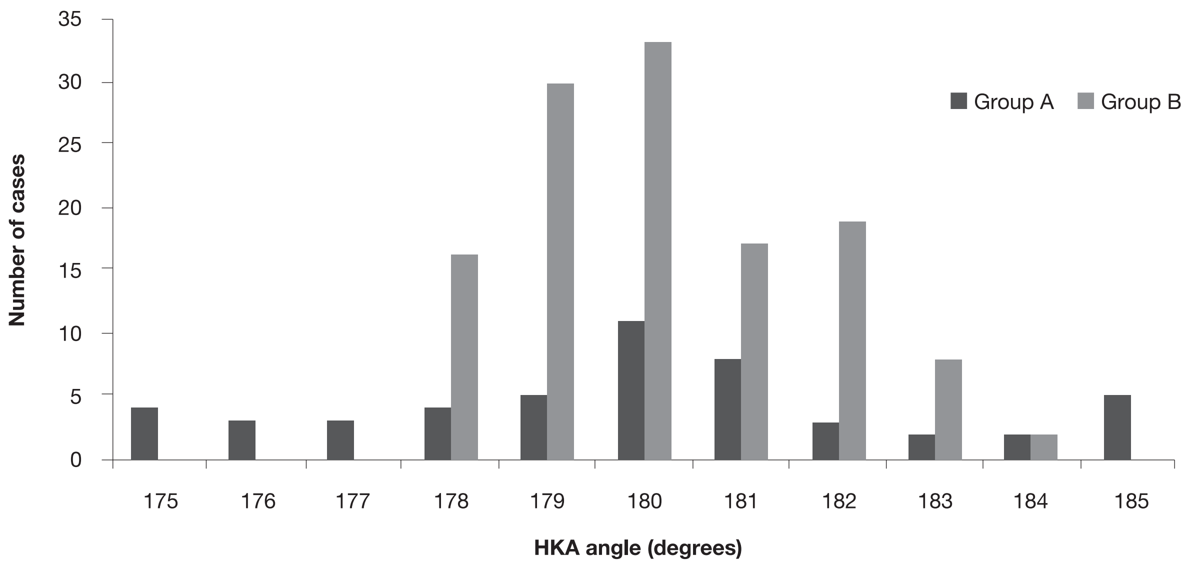

Fig. 1. The postoperative HKA angle.

The duration of the surgical procedure was measured between the inflation and deflation of the pneumatic tourniquet.

The incision length was evaluated for both groups in full extension at the end of the surgical procedure.

The postoperative hospital stay was the period in which the patient was treated in the department of orthopedic surgery.

The analysis was performed using SPSS (version 16.00, Chicago, IL, USA). For quantitative items, either the Student t-test or the Mann-Whitney U test

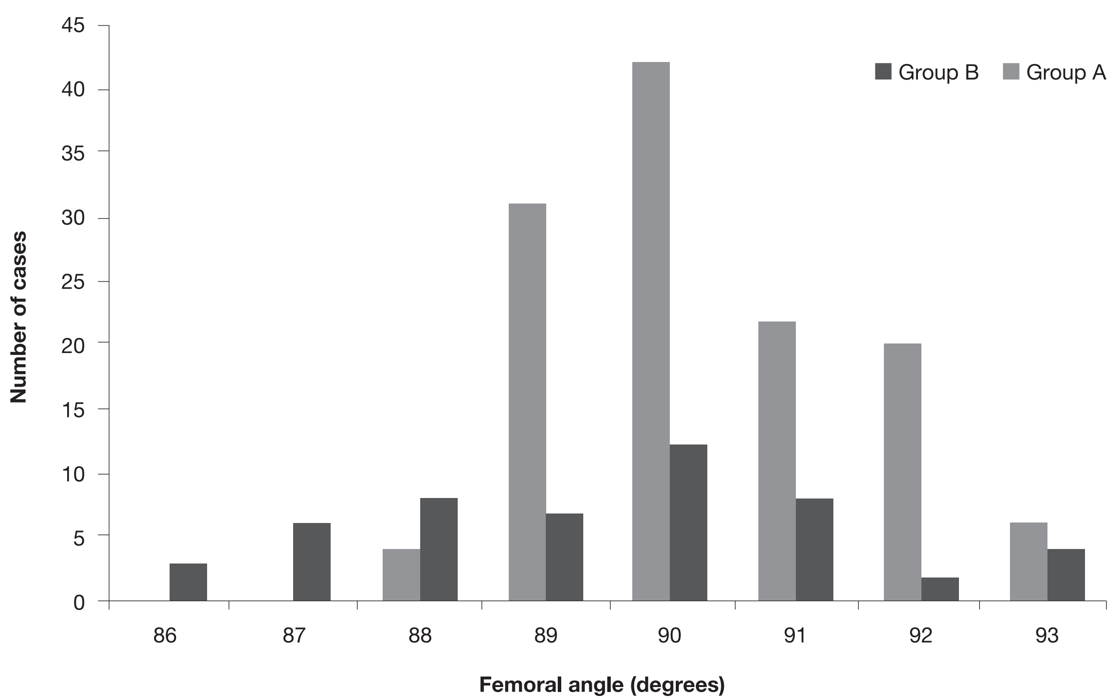

Fig. 2. The final frontal femoral component angle.

was used and qualitative items were evaluated using the chi-square test.

Results

There were no reported intraoperative complications for patients in either group.

The average postoperative frontal HKA angle for Group A was 180°±3° (range: 175-185) and was considered to be optimal in 36 (72%) of the cases (Fig. 1). The average angle for Group B was 180.2°±1.5° (range: 178-184) which was within optimal limits for 123 (98.4%) of the cases (p<0.0001).

The frontal femoral component angle for Group A averaged 89°±2° (range: 86°±93°), with 37 (74%) of the cases in the optimal limits (Fig. 2). The average for Group B was 90.3°±1.2° (range: 88°±93°), with 119 (95.2%) of the cases in the reference limit of 90°±2° (p<0.0001).

The average for the frontal tibial component angle was 90°±2° in Group A, where 40 (80%) of the cases aligned within 2 degrees of 90° in the frontal plane (Fig. 3). Group B averaged 89.8°±0.8° with all implants aligned within 2 degrees of an ideal angle of 90° (p<0.001).

The surgical time for the TKA averaged 69.3 minutes in Group A (range: 45-94 minutes) and 70.2 minutes (range: 46-98 minutes) in Group B.

The incision length averaged 15.78 cm for Group A (range: 11-18.4 cm) and 12.4 cm (range: 9.2-16.6 cm) for Group B patients.

The average length of the hospital stay was 7.3 days for CA-TKA (range: 5-16 days) and 8.5 days for C-TKA (range: 5-17 days) patients.

Discussion

The quality of the adjustment of the frontal long-leg axis was significantly better in Group B compared with Group A. The adaptivity of the implantation remains high for the frontal tibial component angle and the frontal femoral component angle. This may be due to the experience of our team, having used the ORTHOPILOT® navigation system for the past 7 years.

The results of our study are consistent with previous studies which also examined the efficiency of the navigation system in obtaining a correct alignment in a frontal plane.[2,5,6] The accuracy of the system is ±1°.[7]

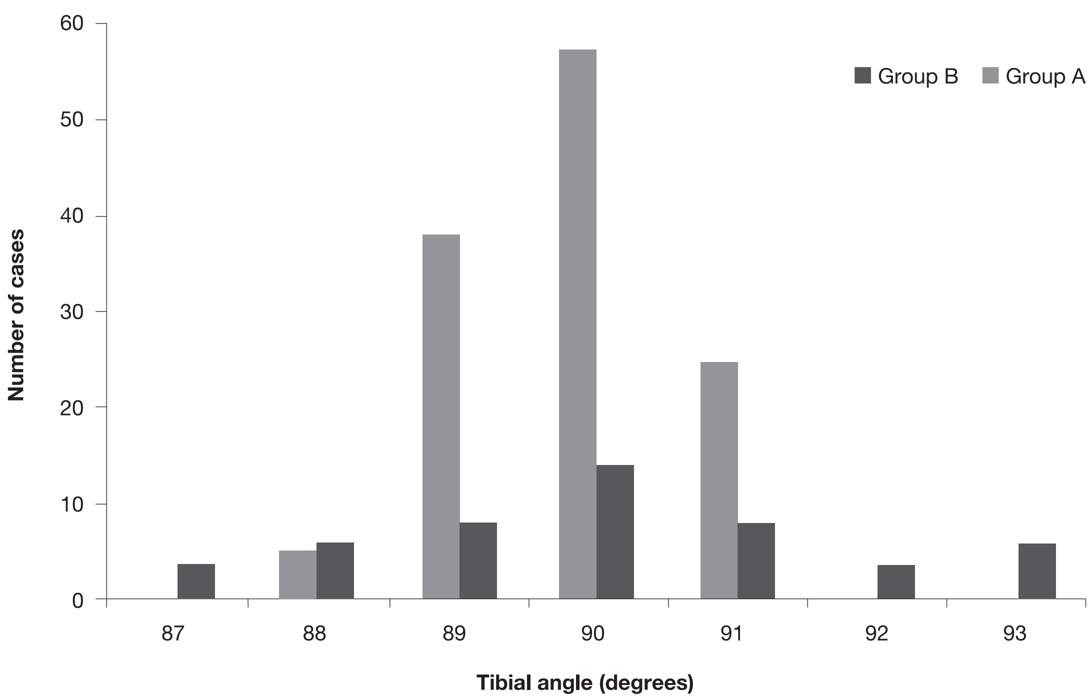

Fig. 3. The final frontal tibial component angle.

Literature data suggests that the navigation system produces a better adjustment of the rotation of the femoral component, with the possibility of malrotation associated with an incorrect balance in flexion, poor patella tracking, abnormal mobility in the femoropatellar joint, pronounced wear of the polyethylene or the reduction of the longevity of the implant.[8-10]

The operative time was similar in both groups. Thus, the navigation system does not significantly prolong the surgical procedure. However, a well-trained team and good preoperative planning is paramount.

A reduction in the average length of the incision in full extension in the CA-TKA was observed, even without using minimaly invasive instruments. It is possible that this reduced incision length influenced patient outcomes and hospital stays.

The average hospital stay after CA-TKA was over one day shorter than that of C-TKA.

Other studies also suggest that CA-TKA is associated with a lower chance of thromboembolic events or the need for blood transfusion, and a smaller risk of intraoperative or postoperative blood loss.[11,12] However, these parameters have not been analyzed in the present study.

Our results suggest that computer assistance provides a more accurate alignment in TKA. The reduced incision length and hospitalization time appear as two other advantages of this technique.

Conflicts of Interest: No conflicts declared.

References

1. Picard F, Leitner F, Saragaglia D, Cinquin P. Computer assisted implantation of a total knee prosthesis. About 7 cadaver implantations. [Article in French] Rev Chir Orthop 1997;83(Suppl II):31.
2. Jenny JY, Clemens U, Kohler S, Kiefer H, Konermann W, Miehlke RK. Consistency of implantation of a total knee arthroplasty with a non-image-based navigation system: a case-control study of 235 cases compared with 235 conventionally implanted prostheses. J Arthroplasty 2005;20:832-9.
3. Jenny JY, Boeri C. Low reproducibility of the intra-operative measurement of the transepicondylar axis during total knee replacement. Acta Orthop Scand 2004;75:74-7.
4. Daubresse F, Vajeu C, Loquet J. Total knee arthroplasty with conventional or navigated technique: comparison of the learning curves in a community hospital. Acta Orthop Belg 2005;71:710-3.
5. Saragaglia D, Picard F, Chaussard C, Montbarbon E, Leitner F, Cinquin P. Computer-assisted knee arthroplasty: comparison with a conventional procedure. Results of 50 cases in a prospective randomized study. [Article in French] Rev Chir Orthop Reparatrice Appar Mot 2001;87:18-28.
6. Jenny JY, Boeri C. Computer-assisted implantation of total knee prosthesis: a case-control comparative study with classical instrumentation. Comput Aided Surg 2001;6:217-20.
7. Delp SL, Stulberg SD, Davies B, Picard F, Leitner F. Computer-assisted knee replacement. Clin Orthop Relat Res 1998;(354):49-56.
8. Katz MA, Beck TD, Silber JS, Seldes RM, Lotke PA. Determining femoral rotational alignment in total knee arthroplasty. J Arthroplasty 2001;16:301-5.
9. Akagi M, Matsusue Y, Mata T, Asada Y, Horiguchi M, Iida H et al. Effect of rotational alignment on patellar tracking in total knee arthroplasty. Clin Orthop Relat Res 1999;(366): 155-63.
10. Wasielewski RC, Galante JO, Leighty RM, Natarajan RN, Rosenberg AG. Wear patterns on retrieved polyethylene tibial inserts and their relationship to technical considerations during total knee arthroplasty. Clin Orthop Relat Res 1994;(299):31-6.
11. Kalairajah Y, Simpson D, Cossey AJ, Verrall GM. Spriggins AJl. Blood loss after total knee arthroplasty: effects of computer-assisted surgery. J Bone Joint Surg Br 2005;87:1480-2.
12. Roy N, Smith M, Anwar M, Elsworth C. Delayed release of drain in total knee replacement reduces blood loss: a prospective randomised study. Acta Orthop Belg 2006;72: 34-8.