Total knee arthroplasty with conventional or navigated technique : Comparison of the learning curves in a community hospital

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We performed a comparative study of the short-term radiological and clinical results after implantation of an unconstrained TKA with preservation of the posterior cruciate ligament with a conventional (50 cases – group A) or navigated (50 cases – group B) technique. The primary criterion was the postoperative leg coronal alignment measured on 3-month postoperative anteroposterior long-leg radiographs by the HKA angle : the expected alignment was $180° \pm 3°$. The mean post-operative HKA angle was $180° \pm 3°$ in group A and $180° \pm 1°$ in group B (p = 0.15). Thirty-four cases in group A and all 50 cases in group B were in the desired range (p< 0.001).

The navigated system used in this study allowed for a significantly better alignment accuracy than the conventional implantation technique. Acceptable routine implantation was achieved during the time of the study (first 50 cases). We can thus hypothesise that the learning curve of the navigated technique used is not any longer than the learning curve of a conventional implantation technique.

Key words : knee arthroplasty ; computer-assistance.

INTRODUCTION

Factors influencing the short- and long-term clinical and functional outcome of total knee arthroplasty (TKA) are numerous ; correction of the femoro-tibial angle in the coronal and sagittal planes definitely appears as an important factor. Varus or valgus positioning of a total knee prosthesis may result in accelerated polyethylene wear *(1, 4)* ; the positioning of the tibial baseplate in the

sagittal plane may influence the ligament balance and eventually the risk for long-term loosening of the prosthesis *(1)*. Computer-aided systems as impartial referees independent of the surgeon's experience have been used in orthopaedics since 1992 and in total knee arthroplasty since 1996 *(8)*. We have been using a system (ORTHOPILOT®, B-BRAUN AESCULAP) developed by Picard *et al (9)* and Saragaglia *et al (10)*, which does not require pre-operative CT-Scan images and is based on real-time acquisition of the lower limb kinematics during operation *(3)*.

The goal of this study was to compare the learning curves for implantation of a TKA with either conventional or navigated instruments in a non academic community hospital.

MATERIALS AND METHODS

We performed a comparative study of the short-term radiological and clinical results after implan-

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tation of an unconstrained TKA with preservation of the posterior cruciate ligament (PCL) (Search™, Aesculap, Germany) (5) in 100 patients with primary gonarthrosis. Group A included the first 50 TKAs performed using a conventional surgical technique between September 1996 and December 1997, and Group B included the first 50 TKAs performed using the ORTHOPILOT system in similar indications between September 2000 and October 2001.

Criteria for inclusion for both groups were :

– ipsilateral hip and ankle undamaged ;
– first knee intervention ;
– primary gonarthrosis ;
– pre-operative range of motion with less than 10° flexion contracture and more than 70° flexion.

Patients

Group A included 35 women and 15 men, with an average age of 61 years ; there were 25 left knees and 25 right knees. The pre-operative mechanical femoro-tibial (HKA) angle, measured on long-leg anteroposterior radiographs, was between 161° and 179° in 32 cases with a varus deformity and between 180° and 199° in 18 cases with a valgus deformity. According to the classification of Ahlback (2) there were grade I lesions in 28 patients, grade II lesions in 15 patients and grade III lesions in 7 patients.

Group B included 31 women and 19 men, with an average age of 63 years ; there were 31 left knees and 19 right knees. The pre-operative HKA angle, measured on long-leg anteroposterior radiographs, was between 159° and 179° in 27 cases with a varus deformity and between 180° and 203° in 23 cases with a valgus deformity.
There were no significant differences between the pre-operative characteristics of both groups.

Operative Technique

Group A. Patients were operated using a conventional technique with an extramedullary targeting device for the tibial cut and an intramedullary targeting device for the femoral cut. Bone cuts

were made using an oscillating saw, with preservation of the posterior cruciate ligament ; the tibial baseplate was fixed with cement ; the patella was resurfaced in all cases.

Group B. Patients were operated using a computer aided technique. The navigation station contains a PC-computer, a POLARIS infrared camera and four localisers (set of six infrared light emitting diodes (LED) rigidly connected on a plastic frame). The localisers are fixed on the lower limb to be operated : one is screwed into the ipsilateral iliac crest, one is screwed into the distal fourth of the femoral diaphysis and one is screwed into the proximal fourth of the tibia. The fourth marker is mobile and can be fixed to the foot, to a calibrated stylus, to the femoral or to the tibial cutting guides according to the respective step of the procedure. The camera can track the respective movements of two adjacent localisers, and the software calculates in real time the centre of rotation of the movement, i.e. the hip, the knee and the ankle centres respectively. By extrapolation it calculates the HKA angle in both frontal and sagittal plane. Palpation of the intra-articular femoral and tibial surfaces allows calculating the cutting height and indicates the size of the tibial and femoral implant. The thickness of the polyethylene bearing will determine the ligament balance, which is left to the surgeon's judgement at the current stage in the development of the program. Bone cuts were made using an oscillating saw, with preservation of the posterior cruciate ligament.

After implantation of the trial prosthesis, the software allows to check in real time the axial correction achieved and to compare it with the pre-operative situation and the expected goal.
The tibial baseplate was fixed with cement ; the patella was resurfaced in all cases.

Data analysis

The primary criterion was the postoperative leg coronal alignment measured on 3-month postoperative anteroposterior long-leg radiographs by the HKA angle : the expected alignment was 180° ± 3°.

Secondary criteria were : coronal alignment of the femoral component according to the coronal

femoral mechanical axis (expected alignment was 90° ± 2°) ; coronal alignment of the tibial component according to the coronal tibial mechanical axis (expected alignment was 90° ± 2°), and complications related to the operative technique.

Radiological criteria were analysed in both a quantitative and a qualitative way, using respectively Student's t-test and Chi-square test for statistical comparison of both groups with a 0.05 level of significance.

RESULTS

Primary criterion

The mean post-operative HKA angle (fig. 1) was 180° ± 3° in group A and 180° ± 1° in group B (p = 0.15). Thirty-four cases in group A and all cases in group B were in the desired range (p < 0.001).

Secondary criteria

The mean anteroposterior alignment of the femoral component according to the coronal femoral mechanical axis (fig. 2) was 89° ± 2° in group A and 90° ± 1° in group B (p = 0.20). Thirty seven cases in group A and 45 cases in group B were in the desired range (p < 0.05).

The mean anteroposterior alignment of the tibial component according to the coronal tibial mechanical axis (fig. 3) was 90° ± 2° in group A and
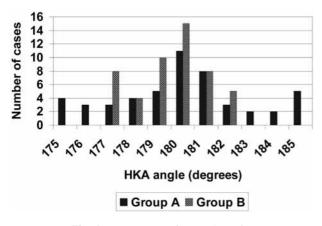

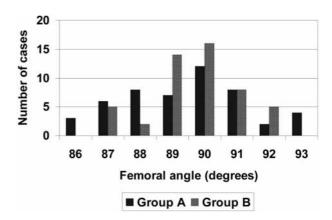**Fig. 2.** — Coronal alignment of the femoral component.

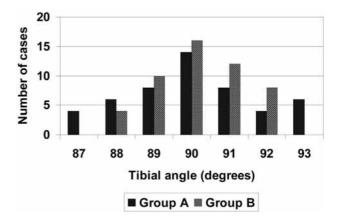**Fig. 3.** — Coronal alignment of the tibial component.

90° ± 1° in group B (p = 0.29). Forty cases in group A and all cases in group B were in the desired range (p < 0.001).

There were no complications related to the operative technique in either group.

DISCUSSION

Computer assistance for TKA implantation has been shown to improve the accuracy of the surgical procedure, assessed on postoperative radiographs (6, 10). We were able to confirm that the navigated system used in this study allowed for a significantly better accuracy in alignment than the conventional implantation technique.

However, all currently published series were performed in highly experienced university knee

Fig. 1. — Post-operative HKA angle.

centres *(6, 7, 10, 11, 12)*, and the results might be different in community hospitals with less experienced knee surgeons and smaller surgical volume. One can hypothesise that the learning curve of a sophisticated procedure such as a navigated TKA implantation might be much longer in a community hospital than in a university centre.

Group A included the first 50 cases where we implanted the chosen knee prosthesis with the conventional technique. However, the prosthesis itself is a very conventional gliding, PCL preserving prosthesis with few, if any, relevant design differences in comparison to the implants we used previously. This group can consequently be regarded as our learning curve for the specific operative technique. Acceptable routine implantation was achieved during the time of the study (first 50 cases).

Group B included the first 50 cases in which we implanted the same prosthesis with the navigated technique ; it can be regarded as our learning curve for this specific operative technique. Acceptable routine implantation was achieved during the time of the study (first 50 cases). We can thus hypothesise that the learning curve of the navigated technique used is not any longer than the learning curve of a conventional implantation technique.

Even in our unexperienced hands, we observed neither specific technical difficulties nor postoperative complications related to the navigation system, which can be regarded as safe.

CONCLUSIONS

The ORTHOPILOT system allows significant improvement in the accuracy of implantation of a TKA. The learning curve for the procedure cannot be considered longer than for the conventional procedure, even in a community hospital. The use of this system might be enlarged to the whole orthopaedic community without major technical difficulties.

REFERENCES

1. **Aglietti P, Buzzi R.** Posteriorly stabilized total condylar knee replacement : 3 to 8 years follow up of 85 knees. *J Bone Joint Surg* 1988 ; 70-B : 211-216.
2. **Ahlback S.** Osteoarthrosis of the knee. A radiographic investigation. *Acta Radiol Diagn* 1968, 277, 7-72.
3. **Delp S, Stulberg S, Davies B, Picard F.** Computer assisted knee replacement. *Clin Orthop* 1998 ; 345 : 49-56.
4. **Jeffery RS, Morris RW, Denham RA.** Coronal alignment after total knee replacement. *J Bone Joint Surg* 1991 ; 73-B : 709714.
5. **Jenny JY, Jenny G.** Preservation of anterior cruciate ligament in total knee arthroplasty. *Arch Orthop Trauma Surg* 1998 ; 118 :145-148.
6. **Jenny JY, Boeri C.** Computer-assisted implantation of a total knee arthroplasty : a case-controlled study in comparison with classical instrumentation. *Rev Chir Orthop* 2001 ; 87 : 645-652.
7. **Jenny JY, Clemens U, Kohler S** *et al*. 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 : 832-839.
8. **Nizard R.** Computer assisted surgery for knee arthroplasty. *Acta Orthop Belg* 2002 ; 68 : 215-230.
9. **Picard F, Leitner F, Saragaglia D, Cinquin P.** Computer assisted implantation of a total knee prosthesis. About 7 cadaver implantations. *Rev Chir Orthop* 1997 ; 83 : 31.
10. **Saragaglia D, Picard F, Chaussard C** *et al.* Computer-assisted knee arthroplasty : comparison with a conventional procedure. Results of 50 cases in a prospective randomized study. *Rev Chir Orthop* 2001 ; 87 : 18-28.
11. **Sparmann M, Wolke B, Czupalla H, Banzer D, Zink A**. Positioning of total knee arthroplasty with and without navigation support. A prospective, randomised study. *J Bone Joint Surg* 2003 ; 85-B : 830-835.
12. **Victor J, Hoste D**. Image-based computer-assisted total knee arthroplasty leads to lower variability in coronal alignment. *Clin Orthop* 2004 ; 428 : 131-139.