ORIGINAL ARTICLE

Bilateral total knee arthroplasty in a one-stage surgical procedure

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Summary

Introduction: Bilateral total knee arthroplasty (TKA) in a one-stage surgical procedure has the advantage of a single hospital stay, shorter rehabilitation, and reduced patient management costs. However, until now the use of this strategy has been limited by the fear of a higher rate of perioperative complications. The hypothesis of this study was that in selected patients, this management strategy would not result in any serious complications.

Materials and methods: This prospective 24-month pilot study was performed in a continuous series of patients without a control group. Inclusion criteria were bilateral non-infectious gonarthropathy, in patients classified as American Society of Anesthesiology (ASA) 1 or 2 and presenting with a preoperative hemoglobin level of at least 13 g/dL. All patients underwent a pre- and postoperative evaluation using the International Knee Society (IKS) and Knee Injury and Osteoarthritis Score (KOOS) scores.

Results: Thirty patients were included in the study (25 women, mean age 70.3 years old [32 to 88 years]; five ASA 1 and 25 ASA 2). All patients were followed-up and evaluated for a mean 18 months (6 to 30 months). Three deep vein thromboses, one cardiopulmonary accident and three confusional states were reported, but there were no perioperative deaths, pulmonary embolisms, nosocomial infections or revision procedures. At 18 months follow-up the IKS score had improved from 98 (33–139) preoperatively to 169 (62–200) postoperatively. The five items of the KOOS score improved significantly.

Discussion: This preliminary series confirms that bilateral total knee replacement in a one-stage surgical procedure is a reliable alternative to a two-stage procedure in ASA 1 and 2 patients. Because of the savings in health costs with this strategy, public healthcare authorities should provide support by creating and sponsoring a specific group for further study.

Level of evidence: 4, prospective, no control group.

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**Introduction**

Two thirds of the patients who undergo total knee arthroplasty (TKA) have bilateral degenerative disease [1] and 20% of them will undergo surgery of the 2nd knee within 2 years after the first [2]. Moreover, when the disease is bilateral, optimal benefit is only possible when both joints are replaced [3].

The two possible surgical strategies in these patients who require tri-compartmental knee replacement are bilateral TKA performed in a one-stage surgical procedure with one session of anesthesia, or bilateral TKA performed in two separate surgical procedures, either during the same hospital stay or two hospital stays between 1 and 12 months apart. One-stage bilateral knee replacement has been evaluated in retrospective [4–20] and prospective [21] studies and throughout the world the use of one-stage surgical procedures has increased in the past 15 years. At present they represent for example, 11% of the knee replacements in New Zealand [15] and 4% in the United States [22].

Although there is no consensus, most authors indicate these one-stage procedures for American Society of Anesthesiology (ASA) 1 or 2 patients with few or no associated comorbidities [19,20]. Age is not a strict exclusion criterion [23]. Authors emphasize that the main advantages of one-stage bilateral surgery are the reduced cost and shorter hospital stay compared to two-stage surgery [24–26]. Moreover, functional recovery has been found to be satisfactory after one-stage bilateral TKA [27].

The main aim of this prospective study of a continuous series of one-stage bilateral TKAs was to evaluate perioperative complications. The hypothesis of this study was that, in selected patients, this strategy does not result in any severe complications.

**Materials and methods**

This was a 24-month prospective pilot study in a continuous series of patients without a control group (January 1, 2009 to December 31, 2010). Inclusion criteria were primary or secondary arthritis or non-infectious bilateral inflammatory arthritis, in patients classified as ASA 1 or 2 and presenting with a preoperative hemoglobin level of at least 13 g/dL. Non-inclusion criteria were patients who refused one-stage bilateral TKA. Exclusion criteria were ASA 3 or 4 patients or patients presenting with deep vein thrombosis, pulmonary embolism, severe obliterative arthritis of the lower limbs and/or revision arthroplasties.

**Anesthesia methodology**

A systematic anesthesia consultation took place one month before surgery with a standardized work-up including full blood count, electrolyte test, coagulation test, chest X-ray, a recent dental examination (less than 6 months old), a Cytobacteriological examination of urine (CBEU) and a cardiac examination (electrocardiogram ± echocardiography). The anesthesiologist then determined whether the patient was apt for surgery (ASA score, pre-existing comorbidities) and prescribed treatment with erythropoietin [EPO] if necessary, to obtain hemoglobin level greater or equal to 13 g/dL on the day of surgery, which was the threshold for inclusion in our study. All patients signed an informed consent form then a joint decision was made by the orthopedic surgeon and the anesthesiologist to decide whether the patient would be managed with bilateral one-stage TKA.

Two types of anesthesia were used: epidural nerve block with placement of an epidural catheter for 72 hours (as well as systematic placement of a urinary catheter) or general anesthesia with a perineural femoral catheter and a "single shot" sciatic nerve block.

**Surgical procedure**

Prophylactic intravenous antibiotics: 2 g of cefazolin (1st generation cephalosporin) were administered to all patients during induction of anesthesia then 1 g every 8 hours for 24 hours.

Either an anteromedial approach (varus knee) or an anterolateral approach (valgus knee) was used. A cemented polyethylene fixed posterior stabilized implant (Nexgen® LPs – Zimmer) with patellar resurfacing was systematically used.

A bilateral sequential pneumatic tourniquet was used in all cases. The surgical procedure, performed by the principle surgeon and investigator in the study, began when the tourniquet was inflated. Once the implant was cemented, the 2nd tourniquet was inflated (double tourniquet period). While the surgeon incised the 2nd knee, assistants closed the 1st knee and the tourniquet was released. All operated knees underwent postoperative draining with two Redon drains in the knee, connected to the perioperative recovery system Orthopath®. The recovered blood was filtered and washed in the recovery room then retransfused into the patient within 6 hours. Two splints were placed on the legs in the operating room. Preventive anticoagulant therapy with low weight heparin was begun within 12 hours after surgery and continued for 15 days.

**Rehabilitation program**

Immediate passive mobilization was begun on a Kinetec® device. The goal was to achieve complete extension and 90° flexion by the 7th day. Patients with an epidural catheter got up for the first time 3 days after surgery. Those with general anesthesia and a femoral catheter got up on the 2nd day. The splint was worn for 15 days. All patients were then managed in a rehabilitation center.

**Pre-, peri- and postoperative evaluation**

Assessment of clinical function was based on the International Knee Society (IKS) score, the index of patient satisfaction [28]. Assessment of quality of life was based on the subjective Knee Injury and Osteoarthritis Score (KOOS [29]). Radiological assessment was based on bilateral AP and lateral X-rays of the knee, a 30° and 60° tangential view and long leg weight bearing X-Rays.

An objective clinical assessment was performed preoperatively and at 1 month, 3 months, 6 months and 12 months
postoperatively. Evaluation criteria were the mean duration of surgery, pre- and postoperative hemoglobin levels, homologous (allogenic) transfusions and immediate postoperative autologous retransfusion, total estimated postoperative blood loss and any use of recombinant erythropoietin (rHU-EPO). Mortality, pulmonary embolism and nosocomial infection, and surgical revision rates as well as any other complications were recorded. Duration of the hospital stay and in the rehabilitation center was recorded for each patient.

**Results**

Thirty patients were included (11 patients refused one-stage knee replacement and 16 patients accepted but were excluded after the anesthesia consultation because they were ASA 3 in 12 cases and ASA 4 in four cases). During the same period 366 unilateral total knee arthroplasties were performed in our unit, nine unicompartmental arthroplasties, nine revision unicompartmental arthroplasties, four revision TKAs for mechanical failure and 21 for infections.

There were 25 women and five men, mean age 70.3 years old (32–88); five were classified as ASA 1 and 25 ASA 2. The preoperative diagnosis was primary arthritis in 23 patients, secondary arthritis in five and rheumatoid arthritis in two. Twenty-five patients received epidural nerve block with a catheter and five patients received general anesthesia with femoral catheters and sciatic nerve block. Preoperative injections of rHU-EPO were prescribed in 11 patients to reach the threshold of 13 g/dL of hemoglobin necessary for surgery (a subcutaneous injection of 600 UI/kg rHU-EPO per week; the first injection was performed 3 weeks before the planned date of surgery). An iron supplement (200 to 300 mg per os if there was no deficiency) was systematically associated with EPO to promote erythropoiesis.

The mean duration of surgery was 98 minutes (70 to 145 minutes). All patients received immediate postoperative retransfusion (330 ± 157 mL), six patients received a homologous transfusion and 15 patients received postoperative EPO. The mean hemoglobin level went from 14.4 g/dL (13–16) preoperatively to 9.7 g/dL (6.6–11.8) postoperatively. Total estimated postoperative blood loss was 2713 mL (± 967 mL).

The mean hospital stay in the orthopedic surgery unit was 10 days (7 to 16 days) and the mean stay in the rehabilitation center was 40 days (21 to 120 days).

Three patients presented with deep vein thrombosis (at one, four and eight postoperative weeks) and one with a cardiopulmonary complication (hyperventilation syndrome with a 24-h stay in intensive care). Three confusional states occurred in the first postoperative week, and a bedsore on the heel. No other early or late complications (death, pulmonary embolism, infection or myocardial infarction)

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**Table 1** Perioperative complications according to age and American Society of Anesthesiology (ASA) score.

<table>
<thead>
<tr>
<th>Age</th>
<th>&lt; 70 years old</th>
<th>70–80 years old</th>
<th>&gt; 80 years old</th>
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</thead>
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<tr>
<td>Gender</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Woman</td>
<td>9</td>
<td>9</td>
<td>7</td>
</tr>
<tr>
<td>Man</td>
<td>4</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>ASA Score</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ASA 1</td>
<td>1</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>ASA 2</td>
<td>12</td>
<td>8</td>
<td>5</td>
</tr>
<tr>
<td>Complications</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PE</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>DVT</td>
<td>1 (ASA 2)</td>
<td>1 (ASA 1)</td>
<td>1 (ASA 2)</td>
</tr>
<tr>
<td>Cardiac</td>
<td>0</td>
<td>1 (ASA 2)</td>
<td>0</td>
</tr>
<tr>
<td>Confusion</td>
<td>1 (ASA 2)</td>
<td>1 (ASA 2)</td>
<td>1 (ASA 2)</td>
</tr>
</tbody>
</table>

PE: pulmonary embolism; DVT: deep vein thrombosis.

**Table 2** Objective and subjective functional results at 18 months of follow-up (6–30).

<table>
<thead>
<tr>
<th>IKS score</th>
<th>Preoperative</th>
<th>Postoperative</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knee score</td>
<td>39</td>
<td>91</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>Functional score</td>
<td>52</td>
<td>77</td>
<td>0.0034</td>
</tr>
<tr>
<td>KOOS score</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Symptom score</td>
<td>56</td>
<td>88</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>Pain score</td>
<td>37</td>
<td>93</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>Function score</td>
<td>36</td>
<td>87</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>Activity, sports and leisure activities score</td>
<td>5</td>
<td>38</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>Quality of life score</td>
<td>2</td>
<td>91</td>
<td>&lt; 0.0001</td>
</tr>
</tbody>
</table>

IKS: International Knee Society Score; KOOS: Knee Injury and Osteoarthritis Outcome Score.
occurred (Table 1). None of the patients had undergone revision surgery at follow-up, but two of them presented with a patellar subluxation and two others with frontal laxity without instability.

The objective and subjective results are summarized in Table 2. All patients were satisfied or very satisfied with the surgical procedure. None of them regretted being treated with the one-stage procedure.

Discussion

This study confirms that there are no serious complications in selected patients who undergo bilateral total knee arthroplasty with a one-stage procedure [16,19]. No cases of early revision surgery, pulmonary embolism, cardiac complications, acute infection, severe bleeding or death were observed. Three cases of deep vein thrombosis and three transient confusional states were recorded. At the final follow-up none of the patients had undergone revision surgery. Based on these preliminary results, the authors are continuing this strategy with the same inclusion criteria, either in ASA 1 or 2 patients presenting with preoperative hemoglobin levels of at least 13 g/dL.

However, the results in the literature are controversial. The complications described in the series in the literature are summarized in Table 3. For certain authors the risk of complications is increased with bilateral TKA. In particular the rate of deep vein thrombosis, pulmonary embolism, cardiac complications and death is higher [20,22,26]. In 2007, Restrepo [30] compared 16,419 bilateral TKA to 10,930 unilateral TKA and found that morbidity-mortality was higher in the bilateral group. In 2011, Memtsoudis [20] analyzed 206,573 bilateral TKA performed between 1998 and 2007 in the United States and concluded that extremely elderly patients and ASA 3 or 4 patients, have a major risk of severe complications. Therefore bilateral TKA should be contraindicated in these patients. Restrepo and Memtsoudis are the two authors who have analyzed the greatest number of cases of bilateral TKA. However, their statistics compare bilateral and unilateral TKA. Neither of these authors compared one-stage bilateral TKA to two-stage procedures. Other authors have performed this comparison [11,15,16]. In 2004, Ritter [11] evaluated more than 2000 patients, in 2009, Hooper [15] more than 1000 patients and in 2009, Kim [16] more than 2300 patients who underwent bilateral TKA. These were single center studies and all three concluded that there was no additional risk in the one-stage bilateral TKA groups than in the two-stage bilateral TKA groups.

Our study only included ASA 1 and 2 patients. According to Memtsoudis, ASA 3 and 4 patients have a higher risk of severe complications [20]. In a single center study Yoon [19] reached the same conclusion and found that the complication rate in ASA 3 and 4 patients was 20% compared to 0% in ASA 1 and 2 patients. It therefore seems logical not to include ASA 3 and 4 patients in the bilateral TKA group. Thus, the decision to operate is made after the anesthesia consultation and once the ASA score has been determined.

The two main disadvantages of a one-stage surgical procedure are longer surgery and increased bleeding. Although the procedure is indeed longer (98 minutes in our study) it is always less than the sum of two arthroplasty sessions.

Most available studies insist upon the amount of bleeding in one-stage bilateral procedures. Certain studies have compared the mean amount of bleeding between simultaneous and staged TKA, with respectively 1299 mL versus 1302 mL [19] and 1701 mL versus 896 mL [31]. Nevertheless it is difficult to compare these studies because the method of calculating blood loss was not standardized and the standard deviations were significant. Thus the sum of blood loss for each intervention in two-stage bilateral TKA may be greater than that in one-stage TKA [19]. However, whatever the

![Table 3 Complications in one-stage bilateral total knee arthroplasty (TKA) series.](image-url)
study, the level of blood loss is high, between 1300 and 2700 mL. Thus blood loss must be anticipated, because the need for transfusion in one-stage bilateral TKA is high.

The blood saving strategy was the following: the level of hemoglobin in the blood was increased preoperatively to reach the threshold of 13 g/dL. [32] thanks to injections of recombinant erythropoietin [33,34] associated with oral iron supplements. An injection of EPO increases the hemoglobin level by approximately 1 g/dL. Preoperative tranexamic acid can reduce the need for homologous transfusion without increasing thrombotic side effects [35,36]. Moreover by connecting the cell saver [37] to the Redon drains, blood collection and an autologous retransfusion can be performed within 6 hours. Finally, patients can receive an injection of erythropoietin associated with oral iron supplements.

This study was limited by the small size of the patient group, the lack of control group, and the lack of cost-analysis. Other studies including much larger groups, a multicenter study with the same inclusion criteria, or a case control study would help confirm our conclusions. The absence of a control group limits the level of evidence of our study, but it should be noted that although there are comparative studies in the literature, there are no prospective randomized studies of bilateral TKA comparing 1 stage and 2 stage surgical procedures [38]. Because there is no cost-analysis study, the healthcare savings could not be determined for this strategy in France, although this has been evaluated in other studies [25,26,39].

Conclusion

This study shows that in selected patients (ASA 1 and 2) bilateral TKA in a one-stage procedure does not result in severe complications. The main disadvantage of this strategy is the increase in blood loss that must be planned and compensated for. Based on these results, the public health-care authorities should provide support by creating a specific group of patients to facilitate further studies.

Disclosure of interest

The authors declare that they have no conflicts of interest concerning this article.

References


