KNEE

Fast-track surgery for bilateral total knee replacement

H. Husted, A. Troelsen, K. S. Otte, B. B. Kristensen, G. Holm, H. Kehlet

From Hvidovre University Hospital, Copenhagen, Denmark

Bilateral simultaneous total knee replacement (TKR) has been considered by some to be associated with increased morbidity and mortality. Our study analysed the outcome of 150 consecutive, but selected, bilateral simultaneous TKRs and compared them with that of 271 unilateral TKRs in a standardised fast-track setting. The procedures were performed between 2003 and 2009.

Apart from staying longer in hospital (mean 4.7 days (2 to 16) versus 3.3 days (1 to 25)) and requiring more blood transfusions, the outcome at three months and two years was similar or better in the bilateral simultaneous TKR group in regard to morbidity, mortality, satisfaction, the range of movement, pain, the use of a walking aid and the ability to return to work and to perform activities of daily living. Bilateral simultaneous TKR can therefore be performed as a fast-track procedure with excellent results.

The findings of large historical series and register-based studies with pooled data extending up to four decades on bilateral simultaneous total knee replacement (BSTKR) have suggested that the procedure may be associated with higher rates of mortality and morbidity compared with unilateral TKR (UTKR).1-4 This contrasts with recently published reports which found no difference in mortality between the procedures.5,6 A meta-analysis of patients who underwent BSTKR between 1966 and 2005 showed an increase in the incidence of pulmonary embolism,2 whereas a study on 122 385 patients operated on in the year 2000 found the risk of pulmonary embolism in BSTKRs to be equal to or less than the sum of risks associated with the two operations in a staged procedure.7

These findings may reflect changes in medical practice including the use of regional anaesthesia, opioid-sparing analgesia, early mobilisation and thromboprophylaxis. Thus, fast-track surgery based on the principle of multimodal rehabilitation approaches has led to a decrease in morbidity and the lengths of hospital stay and convalescence across surgical procedures.8

These principles of fast-track surgery (Accelerated New Optimised Rationalised Arthroplasty Koncept - Hvidore Hospital (ANORAK-HH)) were developed and implemented at Hvidore University Hospital in 2003 with a reduction in the length of stay for UTKR, high patient satisfaction and few re-admissions.9,11 The benefits of optimisation of the clinical pathway and the application of the fast-track methodology might therefore also be applicable to BSTKR,9,14 but this has not yet been reported, despite the numbers of patients who present with symptomatic bilateral osteoarthritis. Accordingly, we here report the outcome after five years in a consecutive series of BSTKRs performed according to the fast-track procedure.

Patients and Methods

In 2003 we established the fast-track procedure with optimised logistical and evidence-based clinical features.9 All patients undergoing total hip and knee replacement, including bilateral simultaneous procedures as well as revisions, were enrolled into the programme. The emphasis was on the effective management of pain and early mobilisation with improved convalescence and reduced length of hospital stay.12,13 The logistical features included a specialised joint replacement ward with regular staff, a high level of continuity of care, pre-operative information including the intended length of stay, admission on the day of surgery and functional discharge criteria. The intra-operative clinical features included regional anaesthesia, local infiltration analgesia, protocols for fluid therapy, small standardised incisions, the absence of drains, compression bandaging and regional cooling of the surgical site.14 Post-operatively, the protocol included prophylaxis for deep-vein thrombosis (DVT)
starting six to eight hours after surgery, multimodal opioid-sparing analgesia, early mobilisation and discharge when functional criteria had been met. These afforded early rehabilitation and accelerated discharge from hospital.

All patients presenting with bilateral symptomatic osteoarthritis of the knees were considered for BSTKR and were included prospectively in our study. Inclusion criteria were bilateral osteoarthritis with disabling pain in both knees and consent to bilateral simultaneous operations. Patients were excluded if they had a history or objective findings of cardiopulmonary disease. Our joint replacement ward does not have any special post-operative facilities for BSTKR patients other than the option of transfer to an intensive-care unit for a higher level of care. However, no patient required this.

Between 2003 and 2009 we performed 300 BSTKRs in 150 patients. Their clinical details are shown in Table I. There were 63 men and 87 women with a mean age of 66.0 years (37 to 85). For comparison, a group of UTKR patients was selected by registering those procedures performed most recently preceding and following our BSTKR patients, matched for gender but not for age. This method was chosen to reduce the possibility of bias and to avoid comparison with a historical group. Patients who underwent UTKR were excluded from comparative analysis if they underwent subsequent contralateral TKR. In all, 271 patients were registered as a control group of whom 111 were men and 160 women with a mean age of 69.6 years (41 to 90) (Table I). Pre-operatively, we recorded the type of operation, the age at operation, gender, the pre-operative diagnosis, the body mass index, the presence of comorbidities including heart disease, lung disease, diabetes and rheumatoid arthritis, the range of movement of the knee, the dependence on walking aids and occupational status.

Tricompartmental AGC (Biomet, Warsaw, Indiana) and LPS (Zimmer, Warsaw, Indiana) prostheses were used in every knee using a standard medial parapatellar approach under tourniquet control. The standardised operating programme was followed including fluid management, the use of tranexamic acid, the absence of drains, compression bandaging and cooling. The multimodal opioid-sparing analgesic regime included the use of non-steroidal anti-inflammatory drugs, paracetamol, gabapentin, local infiltration analgesia and opioid only upon request, permitting early mobilisation. A strict transfusion protocol was applied with blood transfusions being triggered by a decrease in the post-operative level of haemoglobin by 25% of the pre-operative value with symptoms of anaemia. The patients were returned from the post-operative recovery unit after a few hours to the ward where they attempted to mobilise. Physiotherapy was started on the first post-operative day (day 2) and took place once or twice daily until discharge. Thromboprophylaxis consisted of subcutaneous low-molecular-weight-heparin (LMWH; enoxaparin, Sanofi-Aventis Pharma, Horsholm, Denmark, 40 mg) from 2003 to 2007 and of Rivaroxaban (Bayer, Lyngby, Denmark) from 2008 onwards, starting six to eight hours post-operatively and continuing once daily until discharge. No extended prophylaxis was given and also no mechanical devices were used, including the wearing of compression stockings. No attempt was made to stratify the risk for DVT and all patients received the same regime.

The length of stay was counted in whole days as the number of post-operative nights in hospital. Patients were discharged when they met strict criteria which included being able to undertake independent personal care, to walk at least 70 m with crutches, get in and out of bed and to stand from a chair, and manage with oral analgesia. Pain was assessed on a visual analogue scale (VAS) with 10 being...
the worst score and 0 as the best. All patients were discharged directly to their homes. 9

The outcome parameters included the length of stay and duration of the operations, peri-operative anaesthesia, surgical complications and blood transfusions. Patient satisfaction with reference to 13 parameters was recorded, including their opinion on the first pre-operative visit and examination, the information provided, operating-theatre stay, recovery ward stay, nursing care, physiotherapy, occupational therapy, treatment of pain, doctor’s visits, length of stay and satisfaction with the overall experience, all measured on a VAS from 0 to 10, with 10 being the best score. At follow-up after three months the need for additional physiotherapy beyond the mandatory eight sessions and/or assistance at home was recorded as were any post-operative complications, problems with pain management, the range of movement, and the use of walking aids. The final review, the length of follow-up, the presence of any pain and its intensity recorded on a visual analogue scale (VAS) (0 to 10) at rest and with activity, occupational activity, satisfaction with the operated knee(s) and with overall outcome, any restriction of the activities of daily living attributable to each knee, and the range of movement were recorded.

All complications or deaths within 90 days from the operation were registered. In case of doubt as to whether an adverse development could be attributed to the knee replacement, the complication was included as being linked to ensure that there was no underestimation of complications. The following complications were found to be potentially linked to the knee replacement: DVT whether confirmed or suspected but not found, pulmonary embolism, infection found or suspected but not found, other sequelae including pain, delayed wound healing, limited movement, peri-prosthetic dislocation of the hip or patella, the necessity for manipulation under anaesthesia, rupture of quadriceps, myocardial infarction, cerebrovascular accident, pneumonia, peptic ulcer, pressure ulcers and infections of the urinary track. Death after re-admission and also death without re-admission were analysed.

Statistical analysis. Follow-up of 100% was not achieved for all parameters at all times; n-values are given when differing from complete follow-up. The data are presented as the mean and SD, median or as proportions expressed as percentages. For normally distributed data, comparison was performed using a two-sample t-test. Those data which were not normally distributed were compared using a two-sample Wilcoxon rank-sum (Mann-Whitney U) test. Proportions were compared using the Pearson chi-squared test. Fisher’s exact test was used instead of Pearson chi-squared test when small sample sizes were compared. Analyses were performed using stata version 10.1 software (StataCorp LP, College Station, Texas). A p-value ≤ 0.05 was considered to be statistically significant.

Results

Both groups were very similar, the only exceptions being that the series of BSTKR patients was significantly younger (t-test, p < 0.001), had greater independence walking (Pearson chi-squared, p = 0.009) and had exclusively spinal anaesthesia (Pearson chi-squared, p = 0.02) (Table I).

The patients undergoing BSTKR had a mean length of stay of 4.7 days (2 to 16) compared with those with UTKR who had a mean stay of 3.3 days (1 to 25; Mann-Whitney, p < 0.001). Both groups had few peri-operative and anaesthetic complications (Table II). Blood transfusions were given to 68 (45.3%) of the BSTKR patients compared with 31 (12.1%) of the UTKR patients (pearson chi-squared, p = 0.001). Patient satisfaction was uniformly high with a median of 10 on all parameters in both groups.

Clinical findings at three months. At the follow-up at three months extra physiotherapy exceeding the eight mandatory sessions after discharge was required in 17 patients (11.3%) in the BSTKR group, but only in 16 patients (6.2%) in the UTKR group (Pearson chi-squared, p = 0.06).

Post-operative complications within the first three months occurred in 21 (14.6%) of the BSTKR patients and in 38 (15.2%) UTKR patients (Pearson chi-squared, p = 0.87). The incidence of specific complications between the BSTKR (n = 144) and UTKR (n = 250) groups were as follows: no patients (0%) vs two (0.8%) for DVT, four (2.8%) vs six (2.4%) for deep infection, seven (4.9%) vs three (1.2%) for superficial infection, one (0.7%) vs one (0.4%) for urinary-track infection, one (0.7%) vs none (0.0%) for pulmonary embolism, none (0.0%) vs

### Table II. Details of the operative findings in the bilateral simultaneous total knee replacement (BSTKR) and unilateral total knee replacement (UTKR) groups

<table>
<thead>
<tr>
<th></th>
<th>BSTKR</th>
<th>Number</th>
<th>UTKR</th>
<th>Number</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean operating time (mins, range)</td>
<td>111.8 (54 to 228)</td>
<td>147</td>
<td>61.6 (31 to 169)</td>
<td>255</td>
<td>&lt; 0.001*</td>
</tr>
<tr>
<td>Peri-operative complications (%)</td>
<td>1 (0.7)</td>
<td>149</td>
<td>5 (1.9)</td>
<td>261</td>
<td>0.42†</td>
</tr>
<tr>
<td>Anaesthetic complications (%)</td>
<td>3 (2.0)</td>
<td>149</td>
<td>5 (1.9)</td>
<td>261</td>
<td>1.00*</td>
</tr>
</tbody>
</table>

* t-test
† Fisher’s exact test
one (0.4%) for each of cardiopulmonary complications, pressure ulcers and peptic ulcers, two (1.4%) vs three (1.2%) for manipulation under anaesthesia, two (1.4%) vs four (1.6%) for re-operation, one (0.7%) vs ten (4.0%) for suspected but not found DVT, one (0.7%) vs none (0.0%) for stroke, and two (1.4%) vs five (2.0%) for other sequelae, respectively. There were no cases of pneumonia or suspected but not found infection in either group.

Within 90 days two patients in the BSTKR group died. In one patient this occurred after 27 days following gastrointestinal bleeding and in the other after 75 days because of sepsis from an unknown focus outside the operated knees. No post mortem was performed. Two patients in the UTKR group died, both from pneumonia in the presence of pre-existing lung disease after 25 and 88 days, respectively (Pearson chi-squared, p = 0.62).

No difference was found between the groups regarding pain at follow-up at three months, with 89 patients (64%) in the BSTKR and 140 (57%) of the UTKR reporting no pain (Pearson chi-squared, p = 0.22). The range of movement was similar in both groups at three months, except for significantly better flexion of the right knee in the BSTKR group (p < 0.001; Table III). Only seven patients (7%) in the BSTKR group used walking aids compared with 32 patients (20.9%) in the UTKR group (Pearson chi-squared, p = 0.003).

**Outcome at the final review.** The mean follow-up in the BSTKR group was 23.6 months (3 to 62) compared with 24.1 months (3 to 62) in the UTKR group (t-test, p = 0.83). Two patients in the BSTKR group and 15 in the UTKR group could not attend for review but participated in a telephone interview.

At the final review 70 (70%) of patients in the BSTKR group had no pain, 20 (22%) had only slight pain with eight (8%) complaining of moderate/severe pain. By comparison, in the UTKR group 112 (73%), 27 (18%) and 15 (9%), patients had no pain, slight pain and moderate/severe pain respectively (Pearson chi-squared, p = 0.64). The proportion of patients in each group who had returned to employment was similar (20 BSTKR (20%) vs 26 UTKR (17%), Pearson chi-squared, p = 0.54).

Satisfaction with the operated knee(s) and the overall outcome was similar between the groups as was the lack of restriction in activities of daily living for most patients in each group. The ranges of movement were similar for both knees in the BSTKR group and significantly better than in the UTKR group for the left knee whereas there was no difference regarding the right knee (Table IV).

**Discussion**

In the BSTKR group only patients with no evidence of cardiopulmonary disease were included. Since cardiopulmonary disease tends to increase with age, the patients in the BSTKR group as a consequence were younger, although advanced age itself was not an exclusion factor. Other studies have shown similar findings.4,17

Age over 75 years has been found to be a predictor for in-hospital mortality18 and an earlier study identified age above 80 years as being related to an increased number of complications.19 The two patients in the BSTKR group who died were both elderly, aged 80 years and 87, respectively, they died after 27 days and 75 days. Although male gender

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**Table III.** Details of ranges of movement at three months after bilateral simultaneous total knee replacement (BSTKR) and unilateral total knee replacement (UTKR). The results are presented as number (%) and mean value (range) as appropriate.

<table>
<thead>
<tr>
<th></th>
<th>BSTKR Number</th>
<th>UTKR Number</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full extension left knee (%)</td>
<td>113 (89.0)</td>
<td>127 (86.8)</td>
<td>0.96†</td>
</tr>
<tr>
<td>Median flexion left knee (*)</td>
<td>115 (82 to 144)</td>
<td>126 (70 to 136)</td>
<td>0.27†</td>
</tr>
<tr>
<td>Full extension right knee (%)</td>
<td>113 (89.7)</td>
<td>126 (86.4)</td>
<td>0.43*</td>
</tr>
<tr>
<td>Median flexion right knee (*)</td>
<td>119 (90 to 144)</td>
<td>126 (55 to 140)</td>
<td>&lt; 0.001†</td>
</tr>
</tbody>
</table>

* Pearson chi-squared test
† Mann-Whitney U test

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**Table IV.** Comparison of the outcome of bilateral simultaneous total knee replacement (BSTKR) and unilateral total knee replacement (UTKR) at the final review.

<table>
<thead>
<tr>
<th></th>
<th>BSTKR Number</th>
<th>UTKR Number</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Satisfaction with left knee</td>
<td>9 (95)</td>
<td>10 (73)</td>
<td>0.59†</td>
</tr>
<tr>
<td>Satisfaction with right knee</td>
<td>9 (98)</td>
<td>10 (87)</td>
<td>0.18†</td>
</tr>
<tr>
<td>Satisfaction with overall outcome</td>
<td>9 (99)</td>
<td>10 (143)</td>
<td>0.23</td>
</tr>
<tr>
<td>No restrictions in activities of daily living, left knee (%)</td>
<td>37 (77%)</td>
<td>48 (69)</td>
<td>0.24†</td>
</tr>
<tr>
<td>No restrictions in activities of daily living, right knee (%)</td>
<td>39 (78%)</td>
<td>50 (70)</td>
<td>0.93†</td>
</tr>
<tr>
<td>Full extension, left knee (%)</td>
<td>69 (80)</td>
<td>86 (32)</td>
<td>0.01†</td>
</tr>
<tr>
<td>Median (range) flexion, left knee (*)</td>
<td>120.0 (80 to 140)</td>
<td>115.0 (73.7)</td>
<td>0.02†</td>
</tr>
<tr>
<td>Full extension, right knee (%)</td>
<td>64 (72.7)</td>
<td>88 (49)</td>
<td>0.96†</td>
</tr>
<tr>
<td>Median (range) flexion, right knee (*)</td>
<td>120.0 (95 to 146)</td>
<td>115.0 (55 to 139)</td>
<td>0.24†</td>
</tr>
</tbody>
</table>

* Mann-Whitney U test
† Pearson chi-squared test
has also been identified as a predictor of in-hospital death in our study the deaths were equally distributed between the genders in both groups. In a recent Korean study involving women and comparing BSTKRs with UTKRs there were no deaths in either group.

One extensive report found significantly higher mortality rates after BSTKR than after UTKR. In a study from the Swedish Knee Arthroplasty Register the mortality risk was 3.77 times higher for BSTKRs, with pulmonary embolism being the main cause of death. However, this contrasts with our findings of no cases of DVT and only one of non-fatal pulmonary embolism, but the Swedish study included patients between 1985 and 2004 with differing antiembolism regimes and a multitude of post-operative care plans. Other studies have found no increase in the mortality rate for BSTKR compared with UTKR or for BSTKR compared with a staged bilateral procedure. However, the latter found an increased risk of in-hospital mortality and complications associated with the bilateral procedure itself and recommended abandonment of the procedure until proper conditions had been identified under which a bilateral procedure could be safely performed. Based on our findings, fast-track surgery with optimisation of all components and selection of patients may be the answer. In the BSTKR group the mean length of stay was 4.7 days which was significantly longer than that in the UTKR group by approximately 1.5 days. Nevertheless, the length of stay for the BSTKR patients in our study was shorter than in previous studies on BSTKR, which report a range from 5.1 to 15.3 days. Both groups in our series had few perioperative and anaesthetic complications as compared with earlier studies in which BSTKR patients had more perioperative complications than UTKR patients. This might have been a reflection of the fact that our patients received epidural anaesthesia with careful fluid replacement.

The transfusion rate of 45.6% (68 patients) in the BSTKR group is high compared with the UTKR requirement of 12.1% (31 patients). An increased transfusion requirement in BSTKR patients has been noted elsewhere. This association may partly explain the longer length of stay found in our BSTKR group. Patient satisfaction was high in both groups of patients.

We did not distinguish between in-hospital complications and complications outside hospital since the decreasing length of stay rendered such a distinction to be meaningless. Instead, complications within three months were registered and were similar for the groups. This finding has been noted in another series, but a further staged bilateral TKR group had significantly more complications than the patients undergoing BSTKR. This conflicts with the findings by Chan et al that complications were more common in patients undergoing bilateral simultaneous unicompartmental knee replacement than those undergoing bilateral staged unicompartmental replacement.

The follow-up at three months showed that the BSTKR group was at least as good as the UTKR group in all parameters as follows: pain (no difference); range of movement (no difference or better) and the use of walking aids (better). This mirrors the functional capacity measured as the ability to rise independently from a chair (sit-to-stand test) reported in another series in which 94% of BSTKR patients compared with 75% of UTKR patients were able to perform the task successfully. Again there are conflicting data since the only other study to compare physical ability between BSTKR and UTKR found that patients in the former group required 24 weeks to achieve independence compared with just ten weeks for the UTKR group.

At follow-up at two years the outcome was similar in both groups. One study found increased difficulty in the ability to kneel in BSTKR compared with the UTKR patients, but we did not specifically investigate this issue.

A recent review of BSTKR concluded that most of the evidence supported the use of BSTKR and found the procedure to be “suspect, only if a complication is more than twice as common as with a comparable group of UTKR patients”. This was found only for superficial infection in our study but the relevance remains unclear since this diagnosis was not supported by the identification of bacteria. A previous report attributed a similar finding to the longer operating time with the same instruments, allowing thereby a greater opportunity for contamination.

In conclusion, our study found that fast-track BSTKR for appropriately selected patients was safe and afforded an excellent outcome. However, optimisation of both logistical and clinical features copying basic elements of our fast-track system are mandatory as well as confirmatory data from other fast-track centres to allow general recommendations for BSTKR.


