Journal of Orthopaedics, Trauma and Rehabilitation 24 (2018) 9–11

Contents lists available at ScienceDirect

Journal of Orthopaedics, Trauma and Rehabilitation

Journal homepages: www.e-jotr.com & www.ejotr.org

Research Paper

Bilateral Sequential Total Knee Replacement Versus Unilateral Total Knee Replacement in a High Volume Hospital
在大手術量醫院中雙側順序全膝關節置換術與單側全膝關節置換術的比較

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ARTICLE INFO

Article history:
Received 25 April 2016
Received in revised form
2 October 2016
Accepted 7 December 2016

Keywords:
Total knee replacement
Bilateral total knee replacement
Knee osteoarthritis

ABSTRACT

Background/purpose: Bilateral simultaneous or sequential total knee replacement (TKR) is performed on a portion of patients but the benefits and risks remain controversial.
Methods: A total of 89 sequential bilateral TKR (BTKR) patients were compared with 89 unilateral TKR (UTKR) patients in our total joint replacement centre from October 2011 to October 2014. The baseline parameters were matched and postoperative results were compared.
Results: The BTKR group had a shorter length of stay per knee (4.8 days vs. 6.5 days) but with a higher total drain output, higher haemoglobin drop, higher transfusion rate, and more postoperative acute retention of urine. Both groups had similar major complication rates and no 90 days mortality.
Conclusion: BTKR is a safe surgery in selected patients performed in a high volume hospital with fast-track programme.

中 文 摘 要

背景/目的：部分患者選擇進行雙側同時或順次全膝關節置換術，但益處和風險仍然有爭議。
方法：從2011年10月至2014年10月，將我們全關節置換中心的89例雙側順序全膝關節置換術（BTKR）患者與89例單側全膝關節置換術（UTKR）患者的基線參數匹配後，比較術後結果。
結果：例雙側順序全膝關節置換術組的每膝關節留院時間較短（4.8天對6.5天），但總引流量較高，血球蛋白下降較多，輸血率較高，術後急性尿瀦留較多。兩組的主要並發症發生率相似，無90天死亡率。
結論：在大手術量醫院和術後快速程序下，對於選定的患者，雙側順序全膝關節置換術是一個安全的手術。

Introduction

Due to the aging population, osteoarthritis of the knee is getting more common. The demand of total knee replacement (TKR) is increasing. Sometimes, a patient will have severe knee pain in both knees at the same time and bilateral TKR (BTKR) may be one of the ways out. BTKR can be classified in several ways (Table 1).

The advantages of BTKR over unilateral TKR (UTKR) include patient convenience, shortened hospital stay and rehabilitation,[1–4] similar mortality rate,[5] similar knee and functional score,[5] same quality of radiological results,[5] and high patient satisfaction.[6] The disadvantages of BTKR include prolonged operating time, higher chance of fat embolism,[7] higher major complications rate,[8–10] more blood loss, higher transfusion rate,[5,11] and more wound infections.[12] There is no convincing evidence to support the general use of either approach. However, selective use of BTKR may be beneficial in the setting of fast-track rehabilitation. Literature on this is scarce. The purpose of this study is to compare the results of sequential BTKR and UTKR in a selected group of patients in a fast-track rehabilitation setting.

Methods

All patients who underwent BTKR from October 2011 to October 2014 were reviewed. Patients with no significant preoperative risk, such as history of cardiovascular accident, myocardial infarction and chronic obstructive airways disease were selected for BTKR. Patients with complex surgery involving the use of constrained

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http://dx.doi.org/10.1016/j.jotr.2016.12.001

Table 1
Classification of bilateral total knee replacement (BTKR)

Single anaesthetic session	One surgical team	Sequential BTKR
	Two surgical teams	Simultaneous BTKR
Two anaesthetic sessions	Single hospital admission (days apart)	Staggered BTKR
	Single hospital admission (weeks apart)	Staged BTKR
	Two hospital admissions	Staged BTKR

implant, simultaneous removal of old fixation implants or use of bone-graft or augment were excluded.

Patients with UTKR performed in the same period with matched age, sex, and body mass index were used as control group.

All patients underwent general or spinal anaesthesia. All had the same surgical protocol including prophylactic antibiotics, tourniquet during procedure, medial parapatellar approach, patella resurfacing, posterior-stabilized implants, simple cementation, haemostasis without tourniquet release, closure of quadriceps and retinaculum with continuous suture, closure of skin with subcutaneous absorbable suture and staples, and compression dressing. All patients had mechanical deep vein thrombosis prophylaxis postoperatively with calf-pump for 4–7 days until fully ambulatory. Patients with a history of thromboembolism were given chemical prophylaxis of subcutaneous enoxaparin 40 mg daily until fully ambulatory.

Sequential BTKR was performed in a single anaesthetic session by one single team in a sequential manner. Surgery of the contralateral knee started after closure of the wound on the first. The tourniquet on the first leg was released before inflation on the other side. The postoperative protocol was the same for both groups. Patients were to be discharged from hospital when the total range of motion could reach 90° and be ambulatory independently.

The primary outcome measures included tourniquet time, drain output, haemoglobin drop, blood transfusion requirement, length of stay, thromboembolic complications, central nervous system complications, cardiovascular complications, respiratory complications, total major complications, urinary tract complications, surgical site infection, and 90 days mortality. Secondary outcome measures included range of motion, knee scores, functional scores, and Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) scores at 3 months and 6 months after operation.

Statistical analysis

Statistical analysis was performed with IBM SPSS Statistics 20 (SPSS (Hong Kong) Ltd, Rm 1804, 18/F, Westlands Centre, Westlands Road, Quarry Bay, Hong Kong). Univariate analysis of numerical and categorical data was performed with the Student *t* test and Chi-square test, respectively. Fisher's exact test was used for analysis of categorical data with small sample number in any one cell.

Results

A total of 1139 patients underwent TKR in our centre; 89 patients (7.8%) underwent sequential BTKR. There was no significant difference in most baseline characteristics except range of movement (ROM), knee society score (KSS) and type of anaesthesia (Table 2). The BTKR group had a poorer ROM (102° vs. 110°), poorer KSS (45 vs. 53), and lower percentage of spinal anaesthesia (2.2% vs. 71.9%).

There were several significant differences in the outcome (Table 3). First, the BTKR group had a higher total drain output (398 mL vs. 193 mL), higher haemoglobin drop (3.7 g/dL vs. 2.2 g/dL), and higher transfusion rate (21.3% vs. 1.1%). However, the transfusion amount was similar in both groups. Second, the BTKR group had more acute retention of urine (29.2% vs. 7.9%). Third, the BTKR group had a shorter length of stay per each operated knee compared with the UTKR group (4.8 days vs. 6.5 days per knee).

There were two cases of transient confusion postoperatively in the BTKR group, but it was not statistically significant. There was one case of superficial wound infection in the BTKR group which was treated successfully with antibiotics and dressing. Otherwise, both groups had similar major complication rates. There was no 90 days mortality in both groups. Both groups had similar 3 months and 6 months ROM and knee scores.

Table 2
Baseline characteristics

	UTKR ($n = 89$)	BTKR ($n = 89$)	*p*-value for chi-square/*t*-test/ Fisher's exact test
Sex, M:F (female%)	53:36 (59.6)	52:37 (58.4)	0.879
Age (y), SD	66.1 ± 8.2	65.9 ± 8.0	0.897
BMI	28.0 ± 4.1	28.4 ± 4.1	0.544
Comorbidities (%)	88.8	87.6	0.816
Pre-Hb	13.4 ± 1.8	13.6 ± 1.7	0.528
Pre-TFA	−4.6 ± 6.3	−6.4 ± 9.4	0.139
Pre-ROM	110 ± 19	102 ± 14	0.001*
Pre-KSS	53 ± 11	45 ± 14	<0.001*
Pre-FS	46 ± 10	44 ± 13	0.453
Pre-WOMAC	46 ± 19	40 ± 21	0.090
Anaesthesia (SA %)	71.9	2.2	<0.001*
DVT Prophylaxis (%)	34.8	18	0.011

*Statistically significant.
BMI = body mass index; BTKR = bilateral total knee replacement; DVT = deep vein thrombosis; FS = functional score; Hb = haemoglobin; KSS = Knee Society Score; ROM = range of movement; SA = spinal anaesthesia; SD = standard deviation; TFA = tibio-femoral angle; UTKR = unilateral total knee replacement; WOMAC = Western Ontario and McMaster Universities Arthritis Index.

Table 3
Outcome measures

	UTKR ($n = 89$)	BTKR ($n = 89$)	*p*-value for chi-square/*t*-test
Tourniquet time (min)	94 ± 19	87 ± 18 (×2)	0.013*
Drain (mL)	193 ± 91	398 ± 164	<0.001*
Hb drop (g/dL)	2.2 ± 2.0	3.7 ± 1.3	<0.001*
Transfusion (%)	1.1	21.3	<0.001*
Transfusion unit	2.0	2.2	0.813
Length of stay (d)	6.5 ± 1.7	4.8 ± 2.6 (×2)	<0.001*
CNS Cx (%)	0	2.2	0.497
CVS Cx (%)	0	0	—
Respiratory Cx (%)	0	0	—
Wound infection (%)	0	1	>0.99
Proximal DVT (%)	0	2.2	0.497
AROU (%)	7.9	29.2	<0.001*
UTI (%)	1.1	1.1	1
Major complication (%)	0	2.2	0.497
90 d mortality (%)	0	0	—
3 mo ROM	102 ± 13	101 ± 11	0.350
3 mo KSS	87 ± 8	83 ± 13	0.110
3 mo FS	54 ± 15	49 ± 20	0.162
3 mo WOMAC	76 ± 15	72 ± 15	0.259
6 mo ROM	108 ± 13	106 ± 12	0.327
6 mo KSS	91 ± 6	88 ± 16	0.076
6 mo FS	63 ± 17	63 ± 20	0.848
6 mo WOMAC	77 ± 15	79 ± 13	0.533

*Statistically significant.
AROU = acute retention of urine; BTKR = bilateral total knee replacement; Cx = complications; CNS Cx = central venous system complications; CVS Cx = cardiovascular system complications; DVT = deep vein thrombosis; FS = functional score; Hb = haemoglobin; KSS = Knee Society Score; ROM = range of movement; UTI = urinary tract infection; UTKR = unilateral total knee replacement; WOMAC = Western Ontario and McMaster Universities Arthritis Index.

Discussion

BTKR is beneficial to patients in several ways. Patients only need a single waiting time for surgery for BTKR. It is very important especially in our city, Hong Kong; because of the aging population, the waiting time for joint replacement can be as long as 8 years in public hospitals. Patients only need a single surgery and a single anaesthetic exposure.[13] Also patients only need a single rehabilitation period. In patients suffering from bilateral knee pain, after UTKR of one side, contralateral knee pain sometimes can hinder the rehabilitation progress.

There are social and economic advantages of BTKR in hospitals and society. Firstly, by performing BTKR, we can achieve higher theatre utilization by shortening theatre turnaround time. For example, we can perform BTKR for two patients in a single whole day session, but it is difficult to perform UTKR for four patients in the same period of time. Secondly, BTKR patients have a shorter overall length of stay[2,3] compared with two UTKR. In our study, the length of stay of BTKR is 4.8 days per knee, which means 9.6 days per patient. The length of stay of UTKR is 6.5 days, which means 13 days in two UTKR. So there is a 3.4 day difference. Thirdly, BTKR can lower the cost of hospitals and society in terms of length of stay, rehabilitation,[1–4] follow up, and waiting time.

However, not every patient suitable for TKR is suitable for BTKR. Firstly, patient selection is very important. BTKR need a longer operating time and creates higher physiological stress to the body. The rates of blood loss and transfusion requirements in BTKR are greater than in UTKR.[5] The mortality risk for BTKR is reported to be higher in patients with pre-existing cardiopulmonary disease[14] or advanced age,[12] therefore younger patients with both knee pain and relatively low cardiovascular risk are better candidates. Secondly, high volume surgeon is essential to achieve a shorter overall operating time to lower the overall risk of surgery. Thirdly, intramedullary alignment rod can cause fat embolism,[15–17] so computer-assisted navigation is advised in BTKR in order to avoid intramedullary reaming and reduce the chance of fat embolism.[18] Finally, a fast-track rehabilitation programme is needed to shorten the rehabilitation time. In our total joint replacement centre, total joint replacement patients are nursed in several specialized cubicles in the general ward. They are taken care of and followed up by nurses who are specialized in joint replacement. There are also teams from physiotherapy and occupational therapy who will closely follow up the patients pre- and postoperatively.

There were two major problems encountered in BTKR according to our results. The rate of acute retention of urine was higher in the BTKR group, but it was just transient and had no long term consequences. The transfusion rate was also significantly higher in the BTKR group. However, it did not affect the infection rate and overall length of stay. In our study, we used a navigation system in all BTKR patients in order to avoid massive blood loss and thromboembolic events.

There are limitations of our study. Firstly, it is a retrospective study. Secondly, there are no objective comorbidity scores. Thirdly, computer-assisted navigation was used in all BTKR patients, but only in 15% of UTKR patients. Finally, all BTKRs were performed by experienced surgeons, but 28.4% of UTKRs were performed by trainee surgeons.

Conclusion

BTKR is a safe surgery in selected patients performed in high volume hospitals with a fast-track programme.

Financial support

No financial support was received for this study.

Conflicts of interest

The authors have no conflicts of interest relevant to this article.

References

1. Cohen RG, Forrert CJ, Benjamin JB. Safety and efficacy of bilateral total knee arthroplasty. *J Arthroplasty* 1997;**12**:497–502.
2. Jankiewicz JJ, Sculco TP, Ranawat CS, et al. One-stage versus 2-stage bilateral total knee arthroplasty. *Clin Orthop* 1994;**309**:94–101.
3. Ritter MA, Harty LD, Davis KE, et al. Simultaneous bilateral, staged bilateral, and unilateral total knee arthroplasty: a survival analysis. *J Bone Joint Surg Am* 2003;**85-A**:1532–7.
4. Soundry M, Binazzi R, Insall JN, et al. A successive bilateral total knee replacement. *J Bone Joint Surg Am* 1985;**67-A**:573–6.
5. Kim YH, Chiu YW, Kim JS. Simultaneous bilateral sequential total knee replacement is as safe as unilateral total knee replacement. *J Bone Joint Surg Br* 2009;**91**:64–8.
6. Leonard L, Williamson DM, Ivory JP, et al. An evaluation of the safety and efficacy of simultaneous bilateral total knee arthroplasty. *J Arthroplasty* 2003;**18**:972–8.
7. Barrett J, Baron JA, Losina E, et al. Bilateral total knee replacement: staging and pulmonary embolism. *J Bone Joint Surg Am* 2006;**88**:2146–51.
8. Restrepo C, Parvizi J, Dietrich T, et al. Safety of simultaneous bilateral total knee arthroplasty: a meta-analysis. *J Bone Joint Surg Am* 2007;**89-A**:1220–6.
9. Lane GJ, Hozack WJ, Shah S, et al. Simultaneous bilateral versus unilateral total knee arthroplasty. Outcomes analysis. *Clin Orthop Relat Res* 1997;**345**:106–12.
10. Oakes DA, Hanssen AD. Bilateral total knee replacement using the same anesthetic is not justified by assessment of the risks. *Clin Orthop Relat Res* 2004;**428**:87–91.
11. Lombardi AV, Mallory TH, Fada RA, et al. Simultaneous bilateral total knee arthroplasties: who decides? *Clin Orthop* 2001;**392**:319–29.
12. Gradillas EL, Volz RG. Bilateral total knee replacement under one anesthetic. *Clin Orthop Relat Res* 1979;**140**:153–8.
13. Hutchinson JR, Parish EN, Cross MJ. A comparison of bilateral uncemented total knee arthroplasty: simultaneous or staged? *J Bone Joint Surg Br* 2006;**88**:40–3.
14. Parvizi J, Sullivan TA, Trousdale RT, et al. Thirty-day mortality after total knee arthroplasty. *J Bone Joint Surg Am* 2001;**83-A**:1157–66.
15. Kolettis GT, Wixzon RL, Peruzzi WT, et al. Safety of 1-stage bilateral total knee arthroplasty. *Clin Orthop Relat Res* 1994;**309**:102–9.
16. Peltier LF. Fat embolism following intramedullary nailing; report of a fatality. *Surgery* 1952;**32**:719–22.
17. Caillouette JT, Anzel SH. Fat embolism syndrome following the intramedullary alignment guide in total knee arthroplasty. *Clin Orthop Relat Res* 1990;**251**:198–9.
18. Church JS, Scadden JE, Gupta RR, et al. Embolic phenomena during computer-assisted and conventional total knee replacement. *J Bone Joint Surg Br* 2007;**89**:481–5.