

Cost and Safety Evaluation of Simultaneous Bilateral Total Knee Arthroplasty versus Unilateral Knee*

Avaliação de custo e segurança da Artroplastia Total do Joelho Bilateral Simultânea versus Unilateral

José Humberto de Souza Borges¹  Paulo Lobo Júnior¹ Darlan Malba Dias¹
Miguel Fernando Ferreira da Silva¹ Anderson Freitas¹ Thaiane Araújo¹

¹Instituto de Pesquisa e Ensino (IPE) Home, Hospital Ortopédico e Medicina Especializada, Brasília, DF, Brazil

Address for correspondence José Humberto de Souza Borges, SQS 111 Bloco C Apt. 303. Brasília, DF, Brazil. CEP: 70.374-030 (e-mail: drjhumberto@gmail.com).

Rev Bras Ortop 2019;54:709–713.

Abstract

Objective To measure the cost of simultaneous total knee arthroplasty, as well as the costs of total and intensive care unit (ICU) length of stay, perioperative complications and need for blood transfusion compared to the costs of unilateral procedure in a referral hospital, in Federal District, Brazil.

Method The present article is a retrospective study analyzing the medical records of patients admitted for unilateral or bilateral total knee arthroplasty, performed between June 2011 and March 2017. Seventy-four medical records were included in the study for evaluation of data such as total cost of the procedure, comorbidities, complications, days of hospitalization, and need for blood transfusion.

Results A significantly higher incidence of deep vein thrombosis (DVT) was found in unilateral procedures. Compared to the other data, no statistically significant differences were found in the relative costs or in the need for blood transfusion.

Conclusion There was no increase in the cost or in complications when comparing the simultaneous bilateral knee joint replacement procedure with the unilateral procedure, which corroborates most of the literature.

Keywords

- ▶ knee arthroplasty
- ▶ knee
- ▶ morbidity
- ▶ costs and cost analysis
- ▶ postoperative complications

Resumo

Objetivo Medir o custo das artroplastias totais de joelho simultâneas, assim como tempo de internação total e em unidade de tratamento intensivo (UTI), complicações perioperatórias, e necessidade de hemotransfusão comparativamente ao procedimento unilateral, num hospital de referência, no Distrito Federal, Brasil.

Método Os presente artigo trata-se de um estudo retrospectivo de análise dos prontuários de pacientes admitidos para a realização de artroplastia total de joelho uni ou bilateral, no período entre junho de 2011 e março de 2017. Foram incluídos no

* Study developed at Ipe-Home, Orthopedic Hospital and Specialized Medicine, Brasília-DF, Brazil.



Palavras-chave

- ▶ artroplastia do joelho
- ▶ joelho
- ▶ morbidade
- ▶ custos e análise de custo
- ▶ complicações pós-operatórias.

estudo 74 prontuários de pacientes para avaliação de dados como custo total do procedimento, comorbidades, complicações, dias de internação, e necessidade de hemotransfusão.

Resultados Uma incidência significativamente maior de trombose venosa profunda (TVP) foi encontrada nos procedimentos unilaterais. Em relação aos outros dados, não foram encontradas diferenças estatisticamente significantes nos custos relativos, nem na necessidade de hemotransfusão.

Conclusão Não houve aumento nos custos nem nas complicações do procedimento de substituição articular bilateral do joelho num mesmo momento em relação ao procedimento unilateral, corroborando com a maioria da literatura.

Introduction

Knee osteoarthritis is an increasingly common disease that affects an ever-expanding number of people, bearing in mind the absolute growth of the elderly population in the most varied countries. It is a long-term degenerative and disabling disease, with decreased quality of life.¹

Total knee arthroplasty (TKA) has gained space as an effective treatment in the final stages of the degenerative process, due to better success rates, the greater number of indications, and the improvement of implants used.²

In the United States, the number of TKAs has been increasing, growing from 350,000 per year in the early 2000s to over 600,000 primary knee arthroplasties in the mid-2010s, showing steady growth from the year 2000.^{3,4}

In addition, bilateral involvement is increasingly common, leading to the question of whether to perform bilateral surgical procedure at the same time or staged at different times. About 5 to 6% of bilateral TKAs (BTKAs) have been carried out simultaneously in the US.⁵⁻⁷ Some reports show a higher degree of patients' satisfaction who underwent simultaneous BTKA.^{8,9}

Clinical outcomes after arthroplasty are known and reported with great improvement across all assessment scales, with low perioperative morbidity.¹⁰ Postsimultaneous BTKA results show functional improvement, similar to those undergoing bilateral staged procedure.^{10,11}

Interest in this subject has motivated comparative studies regarding the cost, recovery time, complications, functional results, patient satisfaction, morbidity and mortality of these procedures, in order to clarify their real benefit.^{8,11-13}

Thus, the authors present, through a retrospective analysis, the comparison of simultaneous BTKA with unilateral total knee arthroplasty (UTKA), presenting statistical data related to cost, total and ICU length of stay, use of blood products, and complications.

Materials and Methods

Data were collected from medical records of patients undergoing BTKA, either simultaneous or unilateral, performed between 2011 and 2017, in a large specialized hospital. After evaluation, the medical records were analyzed for formatting this study, being licensed by the ethics committee under the CAAE number 79624617.0.0000.0023.

Of the 90 records analyzed, 74 were used for data extraction and production of results. Other 16 were excluded due to incomplete filling of the medical records. The 74 patients included during this period were subdivided into 2 groups, which underwent either BTKA or UTKA, composed, respectively, of 40 and 34 patients.

General characteristics of the groups, comorbidities, total and ICU length of stay, costs, and complications were analyzed. A descriptive analysis of the observed data was performed in the form of tables, expressed by frequency (n) and percentage (%) for general characteristics between groups and by the mean and its standard deviation for numerical data.

Preoperative planning - with standard anteroposterior (AP) radiographs, weight bearing profile, Rosenberg incidence, and panoramic views of the lower limbs was performed in both groups. The implants used were from manufacturer Smith & Nephew (Memphis, Tennessee, USA) of model Genesis II; all patients underwent single-dose antibiotic prophylaxis of 2 grams of cefazolin and thromboprophylaxis with 40 mg of enoxaparin in a single subcutaneous daily dose during post-operative hospitalization. At discharge, 10 mg of rivaroxabana was prescribed, once daily, for 21 days.

In the BTKA group, the following procedure was adopted regarding the use of ischemia; the first surgical procedure was performed with the use of a pneumatic tourniquet, while the second procedure was performed without the use of ischemia. However, throughout the operative period, Cell Saver (Haemonetics, Braintree, MA, USA) was used in all patients who were part of this group. The entire UTKA group had intermittent tourniquet use without the use of Cell Saver (Haemonetics). In none of the groups was tranexamic acid administered, and all patients used suction drain on the operated knee, both intra-articular and subcutaneously for 24 hours after the surgery.

The cost analysis was performed by comparing the value of each UTKA to the value of each BTKA divided by two since, in this way, we obtained an estimated value of each procedure of the BTKA group.

The inferential analysis for comparison between the BTKA and UTKA groups was composed by the chi-square test (X^2) or Fisher exact test for the general characteristics and Student t test or the Mann-Whitney test, depending on normality, after applying the Shapiro-Wilk test. The criterion

of significance determination adopted was the level of 5%. Statistical analysis was processed by SAS^R SYSTEM statistical software, version 6.04 (SAS Institute, Inc., Cary, NC, USA).

Results

The overall mean age of the patients was 73.7 years, 55 (74.3%) patients had systemic arterial hypertension (SAH), and 22 (29.7%) patients had diabetes mellitus (DM). Of the 74 patients, 58 (78.4%) were women. (► **Table 1**)

The ► **Tables 2, 3 and 4** provide the descriptive analysis of the variables under study, according to the BTKA and UTKA group and the corresponding descriptive level (*p*-value) of the statistical test, analyzing, thus, the statistical significance of the differences between the groups.

Regarding the characteristics of both groups, there is no statistical significance regarding age, gender, and comorbidities (SAH and DM) (► **Table 2**).

It was observed that there was a difference regarding the length of stay of 5 or more days (*p* < 0.0001) and ICU stay for more than 1 day (*p* < 0.0006), which was significantly longer in the BTKA group. Also, 78% of the patients who were hospitalized for 5 days or more were from the BTKA group, and 85% of the patients who were in the ICU sector for more than 1 day were also in the BTKA group. (► **Table 2**).

As for postoperative complications, need for blood transfusion, number of transfused bags, infection and wound dehiscence, there is no difference between the groups studied. Deep vein thrombosis (DVT) was observed in four

patients in the UTKA group and none in the BTKA group, showing a statistically significant difference (*p* < 0.040) (► **Table 3**).

The total cost from admission to discharge was assessed and compared between the two groups. We used the value of 35 thousand Brazilian Reais (R\$ 35,000.00) as the cutoff point, because it is the approximate value of the median of the two groups. In absolute terms, 95% (38 of 40) of the patients in the BTKA group had a total cost exceeding 35 thousand Brazilian Reais, a statistically higher difference (*p* < 0.0001) than the UTKA group, in which 52.9% (18 out of 34) of the patients had a total cost above this value (► **Table 4**). However, this was an expected difference, as in the BTKA procedure there is the duplicity of implants.

This same analysis was performed again considering half of the cost of the BTKA group (adjusted value, since two UTKAs are performed in each patient in this group) in order to enable the comparison between the groups. Using this adjusted value for the BTKA group, the difference between the groups did not show statistical significance (*p* > 0.05) (► **Table 4**).

Discussion

Simultaneous BTKA has gained more supporters around the world in view of more recent reports of lower cost coupled

Table 2 Comparison between the variables of groups (BTKA x UTKA)

Variable	BTKA		UTKA		<i>p</i> -value
Age (y.o.)					
Mean ± SD	73.1 ± 7.9		74.5 ± 7.4		0.58
Gender – n (%)					
Masculine	9	22.5	7	20.6	0.84
Feminine	31	77.5	27	79.4	
SAH – n (%)					
Yes	28	70.0	27	79.4	0.36
No	12	30.0	7	20.6	
DM – n (%)					
Yes	12	30.0	10	29.4	0.96
No	28	70.0	24	70.6	
Hospitalization ≥ 5 days – n (%)					
Yes	32	80.0	9	26.5	< 0.0001
No	8	20.0	25	73.5	
ICU > 1 DAY – n (%)					
Yes	18	45.0	3	8.8	0.0006
No	22	55.0	31	91.2	

Abbreviations: BTKA, bilateral total knee arthroplasty; DM, diabetes mellitus; ICU, intensive care unit; SAH, systemic arterial hypertension; SD, standard deviation; UTKA, unilateral total knee arthroplasty; y.o., years old.

The characteristics of groups were expressed by frequency (n) and percentage (%); and compared by Fisher exact test (X²), age was expressed by mean ± standard deviation and compared by Student *t* test.

Table 1 Description of variables, total sampling

Variable	n	%
Arthroplasty		
Bilateral	40	54.1
Unilateral	34	45.9
Age (y.o.)		
Mean ± SD	73.3 ± 7.7	
Age ≥ 75 years – n (%)		
Yes	35	47.3
No	39	52.7
Gender – n (%)		
Masculine	16	21.6
Feminine	58	78.4
SAH – n (%)		
Yes	55	74.3
No	19	25.7
DM – n (%)		
Yes	22	29.7
No	52	70.3

Abbreviations: DM, diabetes mellitus; SAH, systemic arterial hypertension; SD, standard deviation. General data expressed by frequency (n) and percentage (%); and age expressed by the mean ± standard deviation.

Table 3 Comparison between groups considering blood transfusion and complications

Variable	BTKA		UTKA		p-value
Hemotransfusion – n (%)					
Masculine	10	38.5	5	16.1	0.057
Feminine	16	61.5	26	83.9	
RCC volume – n (%)					
One bag	2	20.0	1	20.0	0.76
Two bags	6	60.0	4	80.0	
Three bags	2	20.0	0	0	
DVT/PE – n (%)					
Yes	0	0	4	11.8	0.040
No	40	100	30	88.2	
Infection – n (%)					
Yes	3	7.5	3	8.8	0.58
No	37	92.5	31	91.2	
Dehiscence – n (%)					
Yes	0	0	0	0	DNA
No	40	100	34	100	

Abbreviations: BTKA, bilateral total knee arthroplasty; DNA, not applicable; DVT, deep vein thrombosis; PE, pulmonary embolism; RCC, red cells concentrate; UTKA, unilateral total knee arthroplasty. Variables were expressed by frequency (n) and percentage (%); and compared by Fisher's exact test (X^2).

Table 4 Comparison between groups considering total cost and relative cost (BTKA/2) of each procedure

Variable	BTKA		UTKA		p-value
Bill value (R\$)					
≥ 35,000.00	38	95.0	18	52.9	< 0.0001
< 35,000.00	2	5.0	16	47.1	
Bill value (R\$) Bilateral/2					
≥ 35,000.00	14	35.0	18	52.9	0.12
< 35,000.00	26	65.0	16	47.1	

Abbreviations: BTKA, bilateral total knee arthroplasty; UTKA, unilateral total knee arthroplasty. Total cost, above or below R\$ 35,000.00, was expressed by frequency (n) and percentage (%); and compared between the two groups by Fisher exact test (X^2).

with lower complication rates compared to bilateral staged procedure.^{1,5,11,14}

The aging of the population and the growing need for health care funding due to rising costs have promoted the debate on performing knee replacement by BTKA at a single moment, because studies show a reduction in spending by half, when compared to staged BTKA,^{5,15} which corroborates the results described here, since there was no increase in costs.

Authors like Restrepo et al¹⁶ and Fu et al¹⁷ warn about increased risk of complication in simultaneous BTKA, and

report increased risk of DVT, pulmonary thromboembolism, fat embolism, cardiac events, infection, and even death; complications that are evaluated and differ from the results found in our study.

Despite the increase in ICU days and length of stay, we did not observe an increase in the incidence of postoperative complications, and there was also a lower rate of DVT in the simultaneous BTKA group, which contradicts the current literature.^{16,17}

One of the most highlighted complications after simultaneous BTKA has been the need for blood transfusion up to the 30th postoperative day,^{1,11,12,14,16} This information was confirmed by our results, since there was a greater use, in absolute numbers, in the BTKA group, but without statistical significance when compared to the UTKA group.

The use of tranexamic acid has been decreasing the need for blood transfusion in TKA in general.^{18,19} In our study, it was not used in any of the groups, but we used autotransfusion system (Cell Saver, Haemonetics) in bilateral procedures as a way to minimize blood loss, which may have been a bias in relation to blood transfusion results.

Another factor that influences the incidence of complications related to this procedure is the degree of specialization of the team involved, given that the lowest rates are observed in referral centers.¹⁴

A fact that should be taken into consideration regarding morbidity and mortality is that the literature shows that patients undergoing BTKA present better health than those who undergo UTKA, and these latter usually require greater care.¹ In our research, there was no difference between age, gender, and comorbidities in the groups presented.

Although this study did not find a reduction in total costs with statistically significant data, the lower costs of bilateral intervention in a single moment are practically settled in medical reports.^{5,10,13}

Simultaneous BTKA data that were not statistically significant, such as total adjusted hospital cost, need for blood transfusion, number of transfused pockets, infection, and wound dehiscence, when compared to unilateral. allow us to ratify the safety of this procedure.

Conclusion

Bilateral total knee arthroplasty does not increase relative costs compared to UTKA. for In the case of patients undergoing simultaneous BTKA, prolonged length of stay and stay in the ICU does not cause, in relative terms, increase in the total costs of the procedure, nor does it increase the complication rate, when compared with patients undergoing UTKA

Conflicts of Interest

The authors declare that there is no conflict of interest.

References

- Lindberg-Larsen M, Jørgensen CC, Husted H, Kehlet H. Early morbidity after simultaneous and staged bilateral total knee arthroplasty. *Knee Surg Sports Traumatol Arthrosc* 2015;23 (03):831–837

- 2 Panzram B, Bertlich I, Reiner T, Walker T, Hagmann S, Gotterbarm T. Cementless unicompartmental knee replacement allows early return to normal activity. *BMC Musculoskelet Disord* 2018;19(01):18
- 3 Kurtz SM, Ong KL, Lau E, Bozic KJ. Impact of the economic downturn on total joint replacement demand in the United States: updated projections to 2021. *J Bone Joint Surg Am* 2014;96(08):624–630
- 4 Bullock DP, Sporer SM, Shirreffs TG Jr. Comparison of simultaneous bilateral with unilateral total knee arthroplasty in terms of perioperative complications. *J Bone Joint Surg Am* 2003;85(10):1981–1986
- 5 Odum SM, Troyer JL, Kelly MP, Dedini RD, Bozic KJ. A cost-utility analysis comparing the cost-effectiveness of simultaneous and staged bilateral total knee arthroplasty. *J Bone Joint Surg Am* 2013;95(16):1441–1449
- 6 Ekinci Y, Oner M, Karaman I, Kafadar IH, Mutlu M, Argün M. Comparison of simultaneous bilateral with unilateral total knee arthroplasty. *Acta Orthop Traumatol Turc* 2014;48(02):127–35. 24747618
- 7 Cahill CW, Schwarzkopf R, Sinha S, Scott RD. Simultaneous bilateral knee arthroplasty in octogenarians: can it be safe and effective? *J Arthroplasty* 2014;29(05):998–1000
- 8 Bagsby D, Pierson JL. Functional outcomes of simultaneous bilateral versus unilateral total knee arthroplasty. *Orthopedics* 2015;38(01):e43–e47
- 9 Bohm ER, Molodianovitch K, Dragan A, et al. Outcomes of unilateral and bilateral total knee arthroplasty in 238,373 patients. *Acta Orthop* 2016;87(Suppl 1):24–30
- 10 Jenny JY, Trojani C, Prudhon JL, et al; Hip and Knee Surgery French Society (SFHG). Simultaneous bilateral total knee arthroplasty. A multicenter feasibility study. *Orthop Traumatol Surg Res* 2013;99(02):191–195
- 11 Romagnoli S, Zacchetti S, Perazzo P, Verde F, Banfi G, Viganò M. Onsets of complications and revisions are not increased after simultaneous bilateral unicompartmental knee arthroplasty in comparison with unilateral procedures. *Int Orthop* 2015;39(05):871–877
- 12 Yoon HS, Han CD, Yang IH. Comparison of simultaneous bilateral and staged bilateral total knee arthroplasty in terms of perioperative complications. *J Arthroplasty* 2010;25(02):179–185
- 13 Bolognesi MP, Watters TS, Attarian DE, Wellman SS, Setoguchi S. Simultaneous vs staged bilateral total knee arthroplasty among Medicare beneficiaries, 2000–2009. *J Arthroplasty* 2013;28(8, Suppl):87–91
- 14 Niki Y, Katsuyama E, Takeda Y, Enomoto H, Toyama Y, Suda Y. Comparison of postoperative morbidity between simultaneous bilateral and staged bilateral total knee arthroplasties: serological perspective and clinical consequences. *J Arthroplasty* 2014;29(03):504–509
- 15 Hart A, Antoniou J, Brin YS, Huk OL, Zukor DJ, Bergeron SG. Simultaneous Bilateral Versus Unilateral Total Knee Arthroplasty: A Comparison of 30-Day Readmission Rates and Major Complications. *J Arthroplasty* 2016;31(01):31–35
- 16 Restrepo C, Parvizi J, Dietrich T, Einhorn TA. Safety of simultaneous bilateral total knee arthroplasty. A meta-analysis. *J Bone Joint Surg Am* 2007;89(06):1220–1226
- 17 Fu D, Li G, Chen K, Zeng H, Zhang X, Cai Z. Comparison of clinical outcome between simultaneous-bilateral and staged-bilateral total knee arthroplasty: a systematic review of retrospective studies. *J Arthroplasty* 2013;28(07):1141–1147
- 18 Chen X, Cao X, Yang C, Guo K, Zhu Q, Zhu J. Effectiveness and Safety of Fixed-Dose Tranexamic Acid in Simultaneous Bilateral Total Knee Arthroplasty: A Randomized Double-Blind Controlled Trial. *J Arthroplasty* 2016;31(11):2471–2475
- 19 Zhang H, Chen J, Chen F, Que W. The effect of tranexamic acid on blood loss and use of blood products in total knee arthroplasty: a meta-analysis. *Knee Surg Sports Traumatol Arthrosc* 2012;20(09):1742–1752