

Functional Outcome of Patients Undergoing Knee Arthrodesis after Infected Total Arthroplasty*

Resultado funcional dos pacientes submetidos a artrodese de joelho após artroplastia total infectada

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Abstract

Keywords

- arthrodesis
- knee
- arthroplasty, replacement, knee
- infection

Objective Retrospectively assess the functional outcome of patients undergoing arthrodesis after septic failure of total knee arthroplasty.

Methods Eighteen patients were evaluated, with a mean time of 3.7 years of follow-up. Arthrodesis surgery was performed using a narrow anterior dynamic compression plate, and medial or external fixator in two planes of the joint (Orthofix Bone Growth Therapy, Lewisville, TS, USA), at the surgeon's discretion.

Results The most frequent pathogen found was *Staphylococcus aureus* methicillin sensitive (38.9%). The mean lower limb discrepancy was 3.63 cm. The mean knee society score was 68 points. According to the visual analog scale for pain, 44% of the patients had a 0 score at the time of assessment, and 22.2% were very dissatisfied, despite the bone healing achieved. Patients were assessed for the ability to walk with or without assistance.

Conclusion Knee arthrodesis surgery was effective in controlling the infectious process and decreasing pain complaints, but satisfaction with the procedure was low.

Resumo

Objetivo Avaliar de modo retrospectivo o resultado funcional dos pacientes submetidos a artrodese após falha séptica da artroplastia total de joelho.

Métodos Foram avaliados 18 pacientes com tempo médio de 3,7 anos de seguimento. A cirurgia de artrodese foi realizada com placa do tipo *dynamic compression*

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plate (DCP) estreita, anterior e medial, ou fixador externo em dois planos da articulação (Orthofix Bone Growth Therapy, Lewisville, TS, EUA), a critério do cirurgião.

Resultados O patógeno mais frequentemente encontrado foi o *Staphylococcus aureus* sensível a metilicina (38,9%). A discrepância de membros inferiores média foi de 3,63 cm. O da *knee society score* (KSS) médio foi de 68 pontos. Segundo a escala analógica visual de dor, 44% dos pacientes apresentaram pontuação zero no momento da avaliação, e 22,2% estavam muito insatisfeitos a despeito da consolidação óssea obtida. Os pacientes foram avaliados quanto à capacidade de deambular com ou sem auxílio de apoio.

Conclusão A cirurgia de artrodese do joelho se mostrou eficiente quanto ao controle do processo infeccioso e diminuição das queixas algicas, porém a satisfação com o procedimento é baixa.

Palavras-chave

- artrodese
- joelho
- artroplastia do joelho
- infecção

Introduction

Infection after total knee arthroplasty (TKA) represents a serious complication with an incidence ranging from 0.5 to 3%. Such complication can have severe functional and psychological consequences for patients. Adequate treatment remains controversial in the literature, even today, representing a huge challenge for the orthopedic surgeon.^{1,2}

Patients with inflammatory symptoms less than 3 weeks are classified as having acute infection after TKA and are often treated with surgical debridement associated with venous antibiotic therapy. Success rates are variable, and implant retention occurs in between 44 and 84% of cases.³⁻⁶ Two-stage revision surgery is described as the gold standard for the treatment of patients with chronic infection after TKA.⁷ The success rate of the procedure varies between 80 and 90% in most series in short-term follow-up.^{2,7,8} Current studies question these results. Mahmud et al⁹ found a recurrence of infection of 22% in 10 years of follow-up of patients treated with a two-stage revision. The identification of a methicillin-resistant microbial agent may be associated with reinfection in up to 24% of cases.¹⁰ Despite the good results described with the two-stage revision procedure after septic failure of the TKA, functional changes in the limb, residual pain, and joint stiffness are described.¹¹

In patients with refractory infection after TKA, the treatment options described are amputation above the knee, resection arthroplasty, suppressive antibiotic therapy, or joint arthrodesis. Suppressive antibiotic therapy is restricted to patients infected with low-virulence bacteria sensitive to oral antibiotic therapy and high surgical risk.^{12,13} Patients undergoing knee resection arthroplasty after infected TKA evolve with healing of the infectious process in 92 to 100% of cases, but the maintenance of mild-to-moderate joint pain has been described in 64% of the cases in the largest series described in the literature.¹⁴

Knee arthrodesis surgery or amputation above the knee are the methods most used by the orthopedic surgeon in the context of refractory infection after TKA. Considering the functional limitations, and the low percentage of success in prosthesis and assisted walking in patients undergoing

amputation above the knee, arthrodesis surgery should be attempted in patients with permissive surgical risk.¹⁵ Other indications for knee arthrodesis surgery are: massive injury to the knee extensor mechanism, inadequate soft-tissue coverage after TKA failure, and severe ligament instability.^{15,16} Young patients with high functional demand with secondary or inflammatory osteoarthritis can be considered suitable for knee arthrodesis. To stabilize arthrodesis, external fixator in one or two planes, circular external fixator, double compression plate, or intramedullary nail can be used.^{16,17}

The main objective of our study was to retrospectively assess the functional outcome of patients undergoing knee arthrodesis after infected TKA using an external fixator or a double compression plate. As secondary objectives, satisfaction with the procedure, the healing capacity of the infectious process, the presence of residual pain at the end of the follow-up, and the leg length discrepancy (LLD) were evaluated.

Material and Methods

After approval by the teaching and research committee of the National Institute of Traumatology and Orthopedics (CAAE 71750317.8.0000.5273), 23 patients were selected from the hospital database; the patients undergoing knee arthrodesis after septic failure of the TKA in the period from January 2010 to December 2016. Two patients who refused to attend the evaluation visit, and three patients who underwent amputation after arthrodesis failure, were excluded from the study. The patients were operated via anteromedial access to the knee using a narrow anterior and medial dynamic compression plate (DCP) plate (6 cases) or external fixator in two planes of the joint (Orthofix Bone Growth Therapy, Lewisville, TS, USA) at the surgeon's discretion (12 cases).

The visual analog scale for pain was used to assess the presence of residual pain after consolidation of arthrodesis. For functional evaluation, the knee society score (KSS) scores, validated for Portuguese, were used.¹⁸ Patients were asked about their satisfaction with the procedure, ranging from: very satisfied, satisfied, dissatisfied and very dissatisfied, according to the method proposed by Mhomed et al.¹⁹ The ability to walk was evaluated between: community walker with support

assistance (crutch or cane), community walker without support assistance, household walker with support assistance (crutch, cane), and non-walker (wheelchair users).

The discrepancy of the lower limbs was assessed by the comfort in the block test method.²⁰

The germs identified in the bone fragments submitted to culture for aerobic and anaerobic bacteria were recorded as well as the number of surgeries before the knee arthrodesis procedure. Control of the infectious process was defined by the absence of local fistula or joint effusion associated with local inflammatory signs.

Statistical Analysis

The data collected from the research instruments were displayed in an electronic spreadsheet of the Microsoft Excel 2013 software (Microsoft Corp., Redmond, WA, USA), thus building the research database. The Microsoft Excel software (Microsoft Corp.) was also used to build some descriptive graphics. Any other statistical analysis of the data was done through the IBM SPSS version 22.0 (IBM Corp. Armonk, NY, USA) software.

The descriptive analysis of the data aimed to describe the characteristic profiles of the patients, and the distributions of the measures of interest. Descriptive analysis was performed based on the construction of graphs, frequency distributions, and calculation of descriptive statistics (proportions of interest for all variables and calculation of minimum, maximum, mean, median, standard deviation, coefficient of variation (CV) for quantitative variables). The variability in the distribution of a quantitative variable was considered low if $CV < 0.20$, moderate if $0.20 \leq CV < 0.40$, and high if $CV \geq 0.40$.

The correlation between two quantitative variables was assessed using the Spearman rank-order correlation coefficient. A correlation was considered strong only if its absolute value was greater than 0.7.

Results

Eighteen patients with a mean of 3.7 years of follow-up after knee arthrodesis surgery were evaluated. The frequency distributions of patients' epidemiological variables are shown in ►Table 1.

Pathogens identified through periprosthetic tissue culture after the primary TKA procedure are described in ►Table 2. The most frequently pathogen found was the *Staphylococcus aureus* methicillin-sensitive (7 cases, 38.9%), the 2nd most frequent was the *Enterobacter cloacae* (3 cases, 16.7%), and *Escherichia coli* was found in 2 cases (11.1%).

►Table 3 brings the LLD frequency distribution with the comfort in the block test. The discrepancy varied from 1.5 to 12 cm, being more frequent in the range of 1.5 to 3.5 cm (55.6%). The average was 3.63 cm. In 33.3% of the patients, a discrepancy between 3.5 and 5.5 cm was identified. The values described represent the limb shortening after the joint fusion procedure.

►Table 4 brings the frequency distribution of the KSS score. The most frequent score range was from 70 to 80 (55.6%), but the KSS scores ranged from 43 to 76, with a mean of 68.

Table 1 Frequency distributions of epidemiological variables

Variable	Frequency	
	F	%
Sex		
Female	9	50.0%
Male	9	50.0%
Knee operated side		
Left	11	61.1%
Right	7	38.9%
Age (years)		
46–53	2	11.1%
53–60	4	22.2%
60–65	6	33.3%
65–72	3	16.7%
74–81	3	16.7%
TKA indication		
Primary OA	10	55.6%
Posttraumatic	3	16.7%
RA	3	16.7%
SA sequel	1	5.6%
Posttraumatic OA	1	5.6%
Surgery prior to TKA		
None	15	83.3%
One surgery	1	5.6%
Two surgeries	2	11.1%
Comorbidities		
SAH	17	94.4%
Obesity	10	55.6%
DM	6	33.3%
RA	3	16.7%
Hypothyroidism	2	11.1%
SLE	1	5.6%
COPD	1	5.6%

Abbreviations: RA rheumatoid arthritis; SA, septic arthritis; COPD, chronic obstructive pulmonary disease; DM, diabetes mellitus; OA, osteoarthritis; SAH, systemic arterial hypertension; SLE, systemic lupus erythematosus; TKA, total knee arthroplasty.

►Table 5 brings the frequency distribution of the pain score assessed by the patient using the pain VAS. No patient had a VAS scale greater than 5, considering its variation between score 0 for complete absence of pain and 10 as the maximum score.

In all 18 cases evaluated, bone consolidation of arthrodesis occurred. Our group considers as consolidated the absence of mobility in dynamic examination by fluoroscopy and the presence of consolidation in the anterior, posterior, medial, and lateral cortical areas seen on radiograph of the knee. Three patients (16.7%) presented an active fistula at the time of the assessment, characterizing the maintenance of

Table 2 Results of culture tests for infections after primary total knee arthroplasty

Germ isolated	Frequency	%
<i>Escherichia coli</i>	2	11.1
<i>Enterobacter cloacae</i>	3	16.7
<i>K. pneumoniae</i>	1	5.6
<i>Morganella morganii</i>	1	5.6
<i>Proteus mirabilis</i>	1	5.6
<i>Pseudomonas aeruginosa</i>	1	5.6
<i>S. aureus</i> *	1	5.6
<i>S. aureus</i> **	7	38.9
Negative culture	1	5.6
Total	1	100.0

*(methicillin-resistant).

***(methicillin-sensitive).

Table 3 Frequency distribution of the lower limb discrepancy with the block test

Discrepancy	F	%
1.5–3.5 cm	10	55.6%
3.5–5.5 cm	6	33.3%
6.5 cm	1	5.6%
12 cm	1	5.6%

Table 4 Frequency distribution of the knee society score

KSS	F	%
40–50	1	5.6%
50–60	1	5.6%
60–70	6	33.3%
70–80	10	55.6%

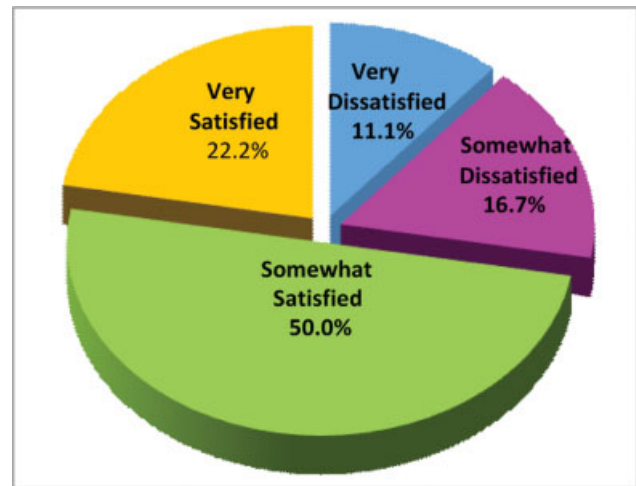
Abbreviation: KSS, knee society score.

Table 5 Frequency distribution of the pain score assessed by the patient using the visual analog scale

VAS	F	%
0	8	44.4
1	2	11.1
2	5	27.8
3	1	5.6
4	1	5.6
5	1	5.6

Abbreviation: VAS, visual analog scale.

the infectious process despite the consolidation of the arthrodesis focus. Seven patients evaluated underwent some type of microsurgical procedure for the treatment of cutaneous complications in the surgical wound: total free skin

**Fig. 1** Declaration of patient satisfaction with the treatment.

graft or pedicled flap of the gastrocnemius muscle. Among these patients, five underwent arthrodesis surgery at the time of removal of primary prosthetic implants in view of the extensive damage to the local skin cover (mentioned above).

Regarding the final walking condition, the following were observed: 10 community walking patients with support assistance (crutch or cane), one community walking patient without support assistance, five home walking patients with support assistance (crutch, cane or walker), two non-walking patients, restricted to bed.

When assessing the patients' satisfaction with the treatment, two very dissatisfied patients were found, three were somewhat dissatisfied, nine were somewhat satisfied, and four were very satisfied, as shown by the distribution of ► **Figure 1**.

Discussion

Refractory infection after TKA represents the main indication for knee arthrodesis. The most used fixation methods are the use of nail, external fixator, and double plate fixation. Stabilization with intramedullary nail reduces the discrepancy in the length of the lower limb, presents a higher percentage of consolidation, but has a higher rate of recurrence of the infectious process. The use of an external fixator avoids the maintenance of a metallic implant in the infected joint and allows joint stabilization in multiple planes.^{21,22}

Amputation above the knee represents a treatment option in the event of arthrodesis failure or in patients not candidates for the arthrodesis procedure after refractory infection after TKA—ipsilateral hip or ankle joint disease, extensive bone loss, contralateral lower limb amputation and disease in the other knee joint.¹³ Sierra et al²³ identified only 20% of patients able to walk with assistance after amputation above the knee for the treatment of refractory infection after TKA. De Paula et al²⁴ evaluated the outcome of patients amputated after TKA failure and identified that only 37.5% were able to walk with assistance for a distance greater than a block. Such results make amputation above the knee an option in case of failure of bone consolidation with the knee arthrodesis procedure or in patients with infection refractory to arthrodesis surgery.

Complete joint fusion represents a method of controlling the infectious process as well as the patient's pain complaints. In the group of patients evaluated, despite bone consolidation of arthrodesis, 83.3% had pain between 0 and 2 in the evaluation using the VAS scale. Three patients had an active low-output fistula at the time of assessment. When the patients were asked about their satisfaction at the time of assessment, 27.8% were dissatisfied. Despite this fact, 61.2% of patients reported being able to walk in the community at the time of assessment. There was no correlation between the control of pain symptoms and the degree of satisfaction after consolidation of arthrodesis.

Shortening of the limb represents a common concern for the patient and the surgeon after the arthrodesis procedure, after septic failure of the TKA. However, in the studied group, the LLD assessed by the comfort in the block test was 3.63 cm. Balci et al²⁵ evaluated the result of knee arthrodesis in the treatment of refractory infection after TKA using an external fixator in 17 patients. The authors obtained a mean discrepancy between the lower limbs of 2.9 cm. Robinson et al²⁶ evaluated 23 patients who underwent knee arthrodesis after two-stage review after septic failure of the TKA. After bone fusion, the mean lower limb discrepancy (LLD) was 4.85 cm and the KSS obtained was 44 points. Conway et al²⁷ consider performing femoral bone elongation during the period of bone healing of arthrodesis in cases with lower limb discrepancies greater than 5.0 cm. The authors argue that the time taken to consolidate the regenerated bone is less than the time to consolidate arthrodesis.

Balato et al,²⁸ in a literature review and meta-analysis, compared the results of knee arthrodesis with an external fixator or intramedullary nail in the treatment of septic failure of TKA. Patients treated with an external fixator had a shortening of the larger limb, but a lower percentage of reinfection (5.4%) than patients treated with an intramedullary nail (10.6%). The analysis of the VAS scale of 49 patients in 3 studies identified an average score of 2.9 in the patients treated with an external fixator, and the discrepancy between the lower limbs presented a mean of 4.04 cm after evaluating seven studies and 108 patients.

Rohner et al²⁹ retrospectively assessed the functional outcome of patients undergoing arthrodesis with an intramedullary nail covered with antibiotic cement after septic TKA failure. In the evaluated group, reinfection was diagnosed in 50% of the patients. The average KSS score was 40, and 73% of patients described pain above 3 on the VAS scale. The authors do not recommend the use of an intramedullary device to perform knee arthrodesis in the context of septic failure after TKA. In our study group, the average score obtained by the KSS assessment was 68 out of 100 possible points.

In our case series, the most frequently identified germ was the *S. aureus* sensitive to methicillin, corresponding to 38.9% of cases. The need to perform a skin flap is associated with a higher incidence of reinfection after the two-stage review in the treatment of septic failure after TKA.³⁰ In our institute, such complications after TKA surgery are associated with worse functional results in patients with infection after

primary TKA or revision and prolongation of hospital stay. The choice between using a double plate or external fixator was based on the patient's skin condition, implant availability, and surgeon's expertise.

The limitations of the present study are related to the small number of cases evaluated, the retrospective characteristic of the study and the absence of comparative analysis. The blocks discrepancy test performed represents a subjective method of assessment but used in clinical practice. The follow-up time is considered short considering the biomechanical changes to which the hip and ankle joints were subjected after knee arthrodesis surgery. The distance that patients were able to walk after surgery was not objectively assessed. Finally, the KSS score used has the limitation of having been designed to assess patients with joint mobility; however, there is no description in the literature of a specific score for patients undergoing knee arthrodesis, with no consensus on which would be the ideal method for the functional assessment of these patients.

Conclusion

Knee arthrodesis surgery was effective in controlling the infectious process and reducing pain complaints in the operated limb. Most patients were able to walk at home after the evaluated follow-up, but satisfaction with the procedure is low. Arthrodesis surgery provides a functional limb, being an option in cases of refractory infection after TKA.

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Conflict of interests

The authors declare that have no conflict of interests.

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