Comparison Between Articulating vs. Fixed Spacers in Revision for Periprosthetic Knee Infection

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ABSTRACT

Introduction: Cement spacers with antibiotics can be fixed or articulating, with similar results in eradicating infection. Our objective was to compare joint range of motion (ROM) and functional outcomes after reimplantation. **Materials and Methods:** A retrospective cohort study of patients who had undergone a knee prosthetic revision due to infection in two surgical stages. Functionality was analyzed according to the Knee Society Score (KSS) one year after surgery and ROM was recorded 45 days after surgery. Bone defect, pain, satisfaction, complications, and recurrence of infection were recorded. **Results:** A total of 103 patients were included. 40 with articulating spacers and 63 with fixed spacers. The articulating spacer group presents a median of 2.5 degrees greater in final mobility (102.5 IQR 95-110 vs 100 IQR 90-105, p 0.01). The KSS functional scale and KSS of the knee did not show differences between the two groups. There were no differences concerning satisfaction, pain, and time until reimplantation. Complications were similar in both groups, with a reinfection rate without statistically significant differences. **Conclusion:** Articulating spacers have shown a benefit in ROM after prosthetic reimplantation.

Keywords: Knee arthroplasty; spacers; periprosthetic infection; joint range of motion.
Level of Evidence: III

Comparación de los espaciadores articulados vs. fijos en la revisión de la infección periprotésica de rodilla

RESUMEN

Introducción: Los espaciadores de cemento con antibiótico pueden ser fijos o articulados y se logra un resultado similar con ambos para erradicar una infección. Nuestro objetivo fue comparar el rango de movilidad articular y los resultados funcionales después del reimplante. **Materiales y Métodos:** Estudio de cohorte retrospectiva de pacientes sometidos a una revisión de la prótesis de rodilla por infección, en dos tiempos quirúrgicos**.** Se analizó la funcionalidad según el *Knee Society Score* (KSS) al año de la cirugía y se registró el rango de movilidad a los 45 días. Se registraron el grado de defecto óseo, dolor, satisfacción, las complicaciones y la recidiva de la infección. **Resultados:** Se incluyeron 103 pacientes (40 con espaciador articulado, 63 con espaciador fijo). El grupo con espaciador articulado tuvo una mediana 2,5° mayor en la movilidad final (102,5; RIC 95-110 vs. 100; RIC 90-105, p 0,01). Según el KSS funcional y el KSS de rodilla, no hubo diferencias entre ambos grupos. No hubo diferencias en el grado de satisfacción, dolor y el tiempo hasta el reimplante. Las complicaciones fueron similares en ambos grupos, con una tasa de reinfección sin diferencias estadísticamente significativas. **Conclusión:** Los espaciadores articulados proporcionaron un beneficio en el rango de movilidad después del reimplante de la prótesis.

Palabras clave: Artroplastia de rodilla; espaciadores; infección periprotésica; rango de movilidad articular.
Nivel de Evidencia: III

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How to cite this article: Nicolino TI, Astoul Bonorino J, Molina A, Costantini J, Costa Paz M, Carbo L. Comparison Between Articulating vs. Fixed Spacers in Revision for Periprosthetic Knee Infection. *Rev Asoc Argent Ortop Traumatol* 2021;86(4):493-500. https://doi.org/10.15417/issn.1852-7434.0..0.1391

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INTRODUCTION

Periprosthetic infection after total knee replacement continues to be one of the most feared complications and has consequences that can be devastating. The incidence varies between 0.7% and 2% despite improvements in surgical technique.[1]

At present, two-stage surgery to treat periprosthetic joint infection by placing an antibiotic-loaded cement spacer before prosthesis reimplantation is the most widely used treatment and the infection eradication rate is >80-90%.[2] Antibiotic cement spacers can be classified into two types: *fixed*, which do not allow knee joint mobility, and *articulating*, which maintain a certain range of motion during use (Figure 1).

The manufacture of spacers has evolved and the advantages and disadvantages of these two types of spacers are constantly being analyzed. Infection eradication rates are similar regardless of spacer type. Today the use of articulating spacers is more recommended based on a theoretical improvement in joint mobility.[3-5]

The main objective of this study was to compare the range of joint motion and functional outcomes using the *Knee Society Score* (KSS) between a group of patients treated with a fixed spacer and another with an articulating spacer.

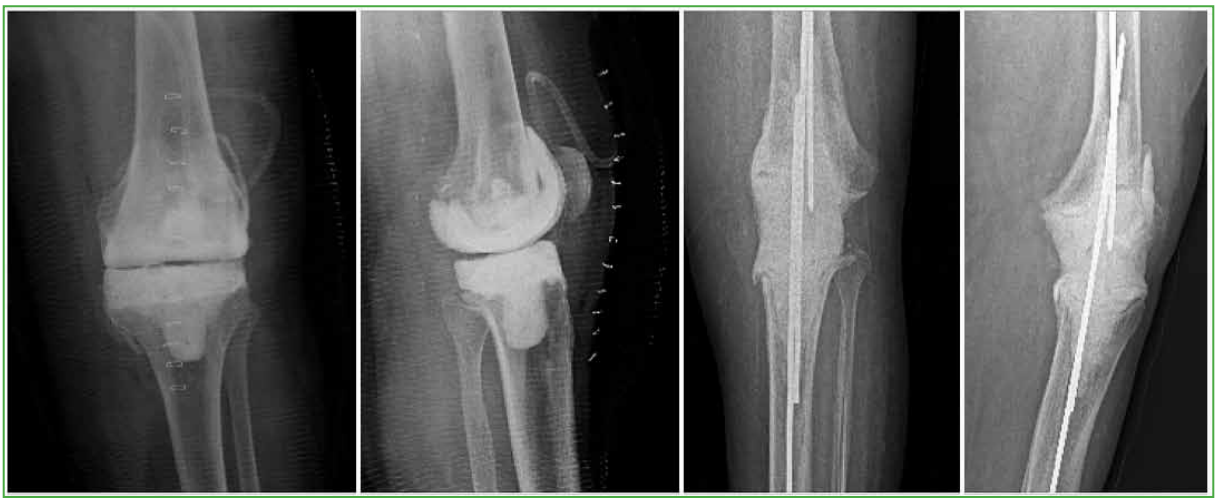

Figure 1. Articulated spacer and fixed spacer used in this series.

MATERIALS AND METHODS

Design and data collection

A retrospective cohort study of patients who underwent a revision of the knee prosthesis due to infection, in two surgical stages, in a high-complexity center.

The data obtained from the electronic medical records for the period between January 1, 2012 and January 1, 2019 were analyzed. The study start date was the date of removal of the infected prosthesis and the follow-up was carried out until the last date of remote follow-up.

All patients with periprosthetic knee infection treated by removing the prosthesis and placing a cement spacer with antibiotics were included. Patients who had undergone knee arthrodesis as a final procedure were excluded. They were classified into two groups: fixed spacer and articulating spacer.

Variables analyzed

The clinical and demographic characteristics of the series were evaluated. To assess the primary objective, functionality after reimplantation was analyzed using the *Knee Society Score* (KSS)[6] one year after surgery, and the range of joint motion was recorded with a goniometer 45 days after surgery.

Patient satisfaction during the use of the spacer was recorded using a linear percentage satisfaction scale[7] applied one day before the second surgery. Pain during the use of the spacer was recorded using the visual analog scale.[8] Bone loss was evaluated using the *Anderson Orthopedic Research Institute* (AORI) classification,[9] for which bone status was recorded after the first surgical stage and at the time of reimplantation, in the second stage. The time of use of the spacer was evaluated as weeks that elapsed from the first surgical stage to the second. Complications related to the use of the spacer (rupture, dislocation, rupture and dislocation, reinfection/replacement of the spacer, deep vein thrombosis) were recorded. As the sample was fixed, all patients who met the selection criteria during the study period were included.

Statistical analysis

The categorical variables were described with absolute number and percentage; and numerical variables, with median and percentile 25% -75%. Characteristics among patients undergoing one or the other treatment were compared with the chi-square, Fisher or Mann-Whitney tests, as appropriate. To explore the factors associated with the range of motion 45 days after reimplantation, a multiple linear regression was performed, considering the type of spacer used as an exposure variable, and age, the time elapsed until reimplantation, the degree of baseline AORI defect, and the degree of satisfaction and pain one year after surgery as potential confounding factors.

The McNemar test was used to analyze the degree of initial post-resection bone defect and its progression at the time of prosthesis reimplantation.

All tests were two-tailed, and a p value <0.05 was considered significant. The Stata v14 program was used.

Ethical considerations

This study was carried out respecting the considerations related to the care of clinical research participants under the national and international guidelines included in the Declaration of Helsinki.

FINDINGS

103 patients were included. Forty received an articulating spacer and 63 received a fixed spacer. The median age was 65 years (interquartile range [IQR] 58-73), the group with articulating spacer had a slightly younger population (60.5; IQR 53-70 vs. 68; IQR 60-73; p 0.01). The clinical and demographic characteristics are detailed in Table 1. As shown in this Table, there were no differences in the time elapsed from spacer placement to reimplantation in both groups.

Table 1. Demographic variables of the study population

Variable	All n = 103	Articulated n = 40	Fixed n = 63	p
Age, median (IQR)	65 (58-73)	60.5 (53-70)	68 (60-73)	0.01
Body mass index, median (IQR)	28 (26-31)	28.5 (26-31)	28 (26-30)	0.51
Satisfaction, median (IQR)	70 (65-80)	75 (70-85)	70 (60-80)	0.06
Pain, median, visual analog scale (IQR)	3 (2-4)	4 (3-5)	3 (2-4)	0.03
Postoperative range of motion, median (IQR)	100 (90-110)	102.5 (95-110)	100 (90-105)	0.01
Time until reimplantation - weeks, median (IQR)	10 (9-11)	10 (9-11)	10 (9-11)	0.3
Right side, number (%)	52 (50.5)	21 (52.5)	31 (49.2)	0.74
Diagnosis, number (%) Periprosthetic infection Arthrofibrosis	103 (100) 101 (98.1) 2 (1.9)	40 (100) 38 (95) 2 (5)	63 (100) 63 (100) 0 (0%)	0.07

IQR = interquartile range.

Evaluation of range of motion

When evaluating the range of joint motion 45 days after reimplantation, better outcomes were observed in the group with articulating spacers. Patients who had undergone this technique had a median of 2.5 ° more in final mobility than patients with fixed spacers (102.5; IQR 95-110 vs. 100; IQR 90-105, respectively; p 0.01).

The multivariate linear regression analysis showed that patients with a fixed spacer had, on average, 5.6 ° less mobility than those with articulating spacers, regardless of age, time until reimplantation, degree of baseline AORI defect, and the degree of satisfaction and pain one year after surgery (95% CI from -10.03 to -1.33; p = 0.011).

Evaluation of functional outcomes

The results according to the functional KSS and the knee KSS did not differ between the two groups. For the evaluation of the functional KSS, the score of the articulating and fixed spacers was 78 (IQR 65-85) vs. 78 (IQR 70-82), respectively (p 0.82).

The knee KSS was 85 (IQR 80-90) in both groups (p 0.52) (Table 2).

Table 2. Functional outcomes

Variable	All n = 103	Articulated n = 40	Fixed n = 63	p
Functional KSS, median (IQR)	78 (70-84)	78 (65-85)	78 (70-82)	0.82
KSS knee, median (IQR)	85 (80-90)	85 (80-90)	85 (80-90)	0.52

KSS = Knee Society Score, IQR = interquartile range.

When evaluating the degree of satisfaction with the different spacers used, the group of patients with an articulating spacer reported greater satisfaction (75/100, IQR 70-85) than the group with a fixed spacer (70/100, IQR 60-80), the difference was not statistically significant (p 0.06).

Table 3 and Figure 2 show the degree of bone defect after resection and its progression until reimplantation.

Tabla 3. Degree of bone defect according to post-resection AORI and evolution of the defect before reimplantation of the prosthesis.

Variable	All n = 103	Articulated n = 40	Fixed n = 63	p
Post-resection AORI, number (%)	103 (100)	40 (100)	63 (100)	0.008
1	14 (13.6)	7 (17,5)	7 (11.1)	
2	31 (30.1)	18 (45)	13 (20.6)	
3	58 (56.3)	15 (37,5)	43 (68.2)	
AORI before reimplantation, number, (%)	103 (100)	40 (100)	63 (100)	
1	6 (5.8)	2 (5)	4 (6.3)	
2	28 (27.2)	16 (40)	12 (19.1)	
3	69 (67)	22 (55)	47 (74.6)	

AORI = *Anderson Orthopaedic Research Institute*, IQR = interquartile range.

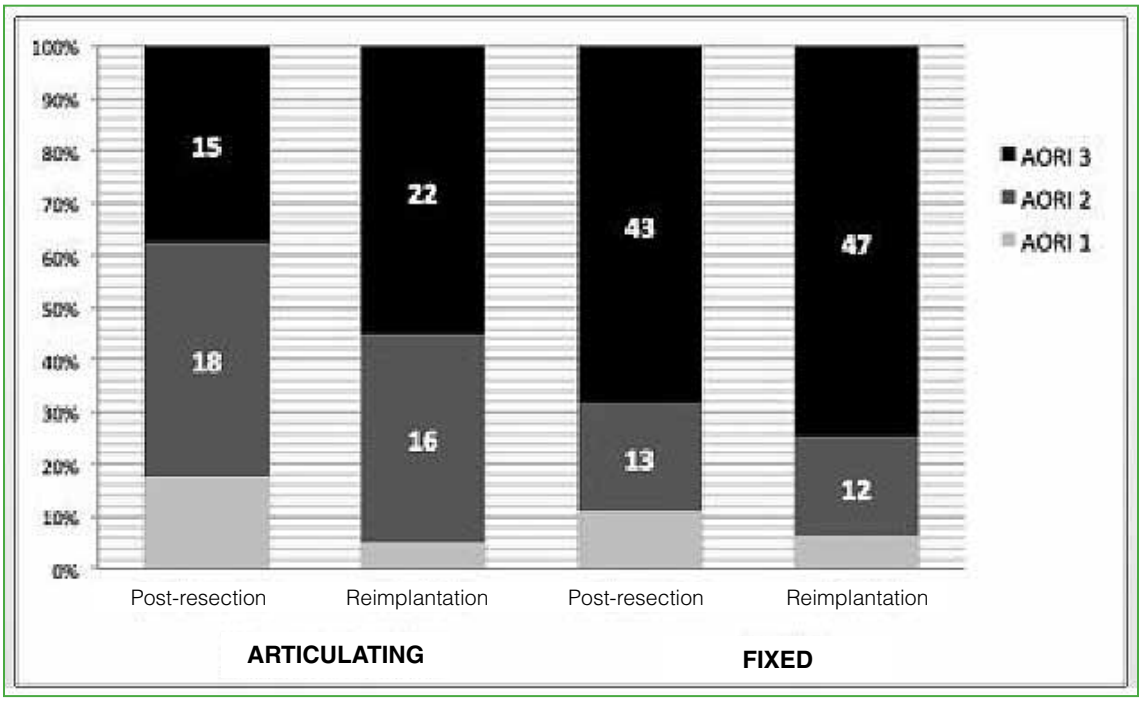

Figure 2. Degree of bone defect according to the type of spacer. Post-resection evaluation and evolution of the defect before reimplantation of the prosthesis.

Finally, no differences were observed in the frequency of complications between the two groups in terms of spacer rupture or dislocation, reinfection, or deep vein thrombosis (Table 4, Figure 3).

Table 4. Complications recorded in both groups during the use of the spacer.

Variable	All n = 103	Articulated n = 40	Fixed n = 63	p
Spacer complications (%)	15 (14.6)	7 (17.5)	8 (12.7)	0,5
Breakage	5 (33.3)	3 (42.8)	2 (25)	
Dislocation	2 (13.3)	1 (14.3)	1 (12.5)	
Breakage plus dislocation	1 (6.8)		1 (12.5)	
Infection	2 (13.3)	1 (14.3)	1 (12.5)	
Deep vein thrombosis	5 (33.3)	2 (28.6)	3 (37.5)	

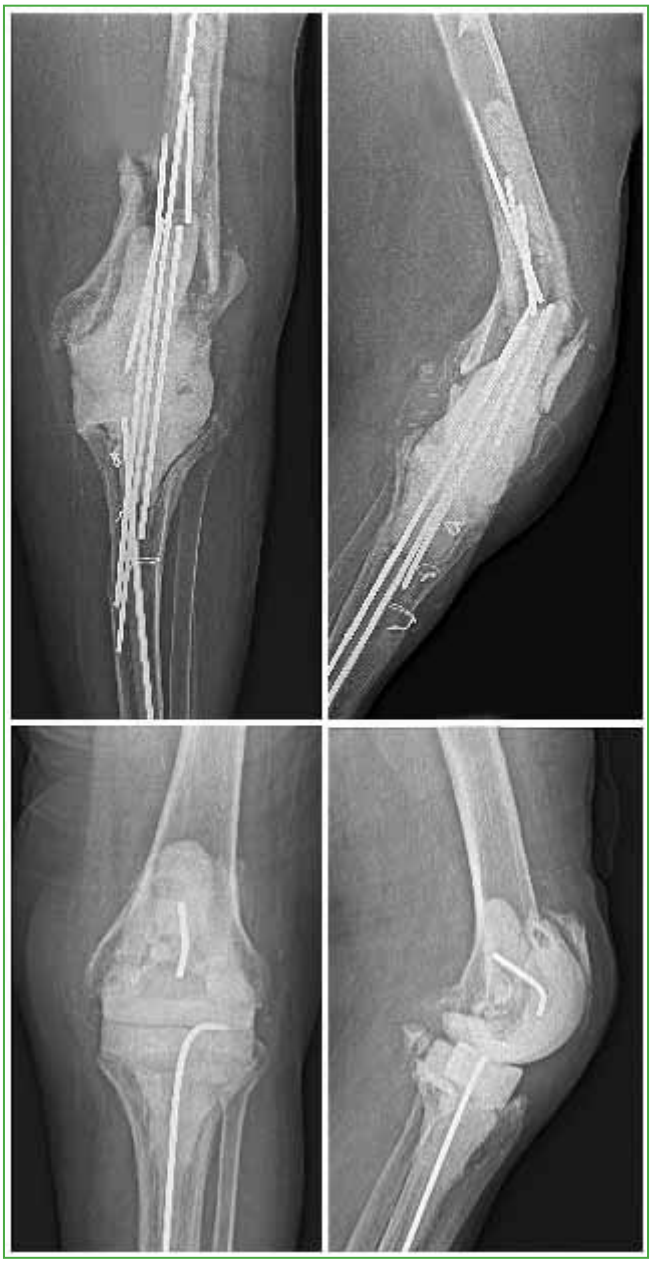

Figure 3. Complications recorded in our series. Articulating spacer dislocation and fixed spacer breakage.

DISCUSSION

Given the increase in the world population, in life expectancy, and, therefore, in the number of joint replacements performed,[10] periprosthetic infections associated with total knee replacement are a great challenge for which we must be prepared.

When the therapeutic choice is a two-stage revision, the prosthesis removal surgery and the placement of a spacer are of great importance. The spacer used must meet the conditions to facilitate the second surgical stage and above all provide adequate treatment to eradicate the infection and achieve the expected functional outcomes after reimplantation.

The role played by the type of spacer in the outcome after reimplantation, both in range of motion and in functional outcomes, has been a subject of debate. Current evidence has supported a recommendation towards the use of articulating spacers because they favor postoperative mobility.[11] Pivec et al. reported that the final average range of motion in a population of 962 patients with articulating spacers was higher than in another 707 patients with fixed spacers. Our findings confirm what was stated in this study; furthermore, they agree with the fact that no difference was demonstrated in terms of functional assessment according to the KSS.[4] This recommendation to use articulating spacers when surgical conditions allow it was even established during the Philadelphia consensus in 2013.[12]

The correct selection of the spacer must consider, among other factors, the intraoperative conditions during the first surgical stage, specifically the degree of bone defect. Therefore, in our population of patients with severe bone defects (AORI 3), the indication of a fixed spacer prevailed over that of an articulating one. However, the progression of AORI 1 and 2 bone defects up to the time of reimplantation was similar in both groups.

Finally, published systematic reviews, such as that by Voleti et al., where 1526 patients were analyzed in studies with levels of evidence III and IV, revealed that there are no differences in reinfection rates depending on the type of spacer used (12% fixed spacers vs. 8% articulating, p 0.01).[13,14] Our findings agree with this statement; in turn, there were no significant differences in complications related to the type of spacer used between the two groups.

A weakness of this study is its retrospective nature; the indications for one spacer or another may depend on the treating surgeon, the type of defect, and the patient. As a strength, this is a series with more than 100 patients treated by the same team, with no losses to follow-up.

CONCLUSIONS

In the treatment of prosthetic knee infections, articulating spacers have provided a benefit in joint range of motion after prosthetic reimplantation. The functional outcomes according to the KSS, the degree of satisfaction and pain, and the recurrence of the infection one year after surgery did not differ between the two groups.

Conflict of interests: The authors declare they do not have any conflict of interests.

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