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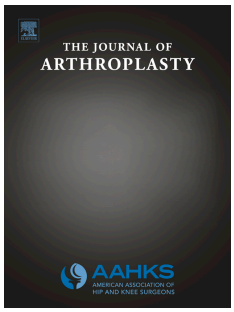

1.5-Stage Exchange Arthroplasty for Total Knee Arthroplasty Periprosthetic Joint Infections

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1.5-Stage Exchange Arthroplasty for Total Knee Arthroplasty Periprosthetic Joint Infections

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Title: 1.5-Stage Exchange Arthroplasty for Total Knee Arthroplasty Periprosthetic Joint Infections

Abstract

Introduction: Periprosthetic joint infection (PJI) in total knee arthroplasty (TKA) is a challenging problem. The purpose of this study was to outline a novel technique, to treat TKA PJI. We define 1.5-stage exchange arthroplasty as placing an articulating spacer with the intent to last for a prolonged time.

Methods: A retrospective review was performed from 2007 to 2019 to evaluate patients treated with 1.5-stage exchange arthroplasty for TKA PJI. Inclusion criteria included: an articulating knee spacer remaining in-situ for 12 months, and the patient deferring a second stage reimplantation because the patient had acceptable function with the spacer (28 knees) or not being a surgical candidate (three knees). Thirty-one knees were included with a mean age of 63 years, mean BMI 34.4 kg/m^2, 12 were female, with a mean follow-up of 2.7 years. Cobalt-chrome femoral and polyethylene tibial components were used. We evaluated progression to a second stage reimplantation, reinfection, and radiographic outcomes.

Results: At mean follow-up of 2.7 years, 25 spacers were in-situ (81%). Five knees were satisfied with their spacer (mean 1.5 years in-situ) and then underwent a second stage reimplantation; one of the five had progressive radiolucent lines, but no evidence of component migration. Three knees (10%) had PJI reoccurrence. Four had progressive radiolucent lines, but there was no evidence of component migration in any knees.

Conclusions: 1.5-stage exchange arthroplasty may be a reasonable method to treat TKA PJI. At a mean follow-up of 2.7 years there was an acceptable rate of infection recurrence and implant durability.

Keywords: total knee arthroplasty, periprosthetic joint infection, 1.5-stage exchange arthroplasty, revision, infection

Introduction

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Periprosthetic joint infection (PJI) following total knee arthroplasty (TKA) is a challenging complication to manage. As the demand for TKA increases over time the number of PJIs will also increase [1]. Periprosthetic joint infection place significant burden on the healthcare system: they are costly and often require repeat surgery [2]. The estimated incidence of PJI in the Medicare population is 1.55% within 2 years following TKA [3]. Typical treatment options for chronic PJI include 1-stage exchange arthroplasty, 2-stage exchange arthroplasty, debridement, antibiotics, and implant retention (DAIR), or in certain cases chronic suppression.

In North America, treatment for PJIs using 2-stage exchange arthroplasty has relatively good success [4-6]. However, the elapsed time between the two stages typically exceeds 12 weeks, which can be burdensome for patients. While 1-stage exchange is less common in North America, it is a popular treatment choice in Europe. However, this treatment choice is becoming increasingly popular in North America as the data seems to support satisfactory results [7, 8]. One potential downside with 1-stage exchange arthroplasty is if a patient becomes re-infected, then the revision TKA prosthesis may end up resected. This can be both costly and morbid. An alternative treatment is 1.5-stage exchange arthroplasty. In 1.5-stage exchange arthroplasty the infected knee is resected and then articulating spacer is placed with the intent to stay in-situ as long as the patient can tolerate. The theoretical advantages of 1.5-stage exchange arthroplasty are potentially avoiding a second operation, if the patient does require a second operation it is likely less costly and morbid for resection of the spacer than resection of a revision prosthesis, and last if the patient requires a second stage surgery the patient can typically choose a time that works best for their schedule while they often remain quite functional.

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To the authors' knowledge there are no prior reports evaluating the treatment of PJIs with a 1.5-stage exchange arthroplasty as described above. The purpose of this paper-was to evaluate rates of revision, infection recurrence, and radiographic outcomes, following 1.5-stage exchange arthroplasty for TKA PJI.

Methods

After institutional review board approval a retrospective review was performed to identify TKAs with PJI treated with 1.5-stage exchange arthroplasty. We conducted a retrospective chart review on patients at XXX University Hospital from June of 2007 to March of 2019 using an institutional database. Inclusion criteria included: 12-month clinical follow-up, spacer remaining in-situ for 12 months, documentation of patient deferring second stage reimplantation, or patient not being a surgical candidate for second stage reimplantation. Patients were excluded if they were less than 18 years of age. We identified 178 TKAs with presumed PJI that underwent operative treatment. Of those we identified 31 knees in 29 patients met inclusion criteria. The mean age at the time of surgery was 63.1 years (range, 32.0 - 85.1), mean BMI kg/m^2 was 34.4 (range, 22.3 – 51.9), 12 (38.7%) were female, with a mean clinical follow-up of 2.7 years, (range, 1.0 – 6.9). Medical records were manually reviewed for necessary covariates. Of the knees included, 28 deferred reimplantation because they felt their function with the articulating spacer was acceptable, and three did not have reimplantation because they were not deemed surgical candidates. Of the three patients who were not surgical candidates one had congestive heart failure, type-two diabetes, obesity, and lymphedema; the second patient had obesity, rheumatoid arthritis, and congestive heart failure and has since deceased; and the third patient had rheumatoid arthritis, end stage renal disease on hemodialysis, type two diabetes, obesity, and

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has since deceased. The mean time of the spacer(s) being in-situ was 2.4 years (range, 1.0 – 6.9 years). The spacer in-situ time was taken from the last clinical follow-up or date of revision. Two patients had spacer exchange for recurrent PJI (mean time to spacer exchange 19.6 weeks); in these cases, the spacer in-situ time represented the total time for both spacers.

We evaluated patients by the Musculoskeletal Infection Society (MSIS) criteria, and host and extremity status as outlined by McPherson et al. [9, 10]. Twenty-three (74.2%) knees met major criteria, six (19.4%) knees met minor but not major criteria, and two knees were thought to be infected but did not meet either major or minor criteria (Table 1). One knee who did not meet MSIS criteria had a CRP of 7.75 mg/dL, cell count of 100,913 cells/mm^3, 97% neutrophils, and no culture growth from the affected knee while on antibiotics to treat diskitis, endocarditis, and contralateral TKA enterococcus PJI. The other knee that did not meet MSIS criteria had a CRP of 2.86 mg/dL, cell count of 4,320 cells/mm^3, 93% neutrophils, no culture growth, at the time of surgery pathology was not taken, but there was purulence, as well as inflamed and thickened synovium. All but one case were chronic PJIs. One patient with uncontrolled type-two diabetes and chronic kidney disease who was two years out from their index TKA underwent arthroscopic lysis of adhesions and developed PJI. This patient underwent irrigation and debridement, became septic and underwent a resection arthroplasty approximately two weeks after their arthroscopic procedure, and we labeled this infection acute post-operative.

The average erythrocyte sedimentation rate (ESR) prior to resection was 55.8 mm/hr (range, 16 - 116) (reference 0-15 mm/hr), and the average C-reactive protein (CRP) prior to resection was

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6.94 mg/dL (range, 0.4 – 27.4) (reference ≤ 0.6 mg/dL) (Table 1 and 2). The most commons organism(s) in cases with single affecting organism type were Coagulase Negative Staphylococcus in 5 knees (16%) and Methicillin Resistant S. aureus (MRSA) in 5 knees (16%) (Table 3).

Surgical Technique

We define 1.5-stage exchange arthroplasty in TKA as placing an articulating spacer with the intent to last for a prolonged period if not indefinitely. We consider patients with major bony defects, incompetent collateral ligaments, or deficient extensor mechanism poor candidates for this procedure. Surgical technique includes removal of the existing prosthesis, including the patellar component. Implant removal is typically performed with a combination of a thin saw and osteotomes. Next, we perform a thorough debridement of all infected and devitalized tissues and typically ream the canals. Next, we thoroughly irrigate the knee with saline solution. In 29 knees there was record of irrigating with betadine solution, acetic acid solution, or both. At this point we confirm that there are not any major bone defects that would preclude using an articulating spacer. If no such defects are present, we place an appropriately sized trial femoral component and recut the femur as needed to insure proper rotation. We then place an appropriately sized trial tibia. The knee is trialed to ensure adequate stability and range of motion can be achieved. In some cases, based on surgeon preference (6 of 31 cases [31%]), we re-prep and drape the extremity and the old scrub table is moved away and a new scrub table is brought near the sterile field. We irrigate the joint again and then importantly we dry the tibial and femoral surfaces and canals for excellent cement interdigitation. If an ultra-congruent or cruciate retaining polyethylene is used, then the polyethylene tibia is cemented first followed by the femoral

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component. If a posterior-stabilized polyethylene is used, the femur is cemented first followed by the tibia. We typically use two batches of cement with antibiotics. In cases where there may be larger bony defects an additional batches(s) of cement can be used. In eight knees (26%) hand-made antibiotic dowels were placed in the canals (Figure 1). Antibiotic beads were not used in any cases.

In 20 knees (65%) an ultracongruent polyethylene was used, in 6 knees (19%) a posterior-stabilized polyethylene was used, and in 5 knees (16%) a cruciate retaining polyethylene was used (Figure 2 and 3). A polyethene tibia insert was cemented to bone in 17 knees (55%) and an all-polyethylene tibial component was cemented in 14 knees (45%). Cobalt chrome femoral components were used in all cases. Antibiotic(s) were included in cement in all knees. Typically, this included vancomycin plus tobramycin, which was mixed with plain copolymer cement powder, prior to the addition of liquid monomer.

Post-operatively patients are made either partial weight-bearing or weight-bearing as tolerated based on individual surgeon preference. Generally, if patients are partial weight-bearing and they have no issues at their 6-week post-operative visit then the weight-bearing status was advanced to weight-bearing as tolerated. In general, patients were evaluated clinically at 2 weeks, 6 weeks, 3 months, 1 year and then either annual or biannually.

The Infectious Disease (ID) service was consulted on all patients, and culture specific antibiotics were used. Patients were typically treated with intravenous (IV) antibiotics for six weeks, except

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in three knees. One patient with bilateral knee spacers was treated with three weeks of IV antibiotics. One patient was treated with linezolid alone for six weeks because of a vancomycin allergy. Six knees (19.4%) were treated with oral (PO) antibiotics following IV antibiotics for an average of 8 weeks (range, 3-12 weeks). Five knees (16.1%) were treated with chronic antibiotic suppression, as defined being on antibiotics 6 months following the procedure (Table 3). Post hospital discharge the ID team would evaluate the patients at regular intervals with laboratory assessment to assess control of infection as well as absence of complications from antibiotics.

We evaluated all knees with particular consideration for spacer loosening or reinfection. We also report a visual analogue pain score and if patients were using gait-aids, which was noted at latest follow-up or prior to any revision procedure. In addition, all TKAs with available radiographs were evaluated on anteroposterior and lateral radiographs according to the Knee Society radiographic criteria [11, 12]. All patients with a minimum of 12-months of radiographic follow-up, or revision prior to 12-months with follow-up radiographs were included in the analysis. This left 25 knees with a mean radiographic follow-up of 2.4 years (range, 1.0-5.5). For the two knees with spacer exchanges for PJI, neither had any radiolucent lines prior to revision, and in these cases, we included the second spacer in the radiographic analysis as they were in-situ longer.

Statistical Analysis

Continuous variables were reported as a mean with ranges.

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Results

At last follow-up 25 of the spacers were still in-situ (81%). Five of 31 (16%) retained their spacer(s) for some time and then underwent a second stage reimplantation at a mean 1.5 years (range, 1.2 – 2.0) following placement of their articulating spacer. One of the five had progressive tibial radiolucent lines at anterior and posterior keel, distal cement mantle, and lateral baseplate all at the bone and cement interface. Yet none of the five were reported to have loose components at the time of revision surgery.

There were three knees that had reoccurrence of PJI. One knee had a spacer exchange for recurrent PJI. The second knee had a spacer exchange for possible culture negative recurrent PJI and eventually went on to reimplantation. Following reimplantation they developed methicillin-susceptible staphylococcus aureus (MSSA) PJI, underwent a two-stage exchange, and has been reported to be infection free at latest follow-up. The third knee underwent a reimplantation complicated by signs of recurrent PJI and had a DAIR procedure for methicillin-resistant staphylococcus aureus (MRSA) approximately 2.5 months after their reimplantation. Following IV antibiotics this patient was placed on indefinite suppression with tedizolid. Of the six knees that had a re-prep and drape of the extremity before real components were placed, none had infection recurrence. In the eight knees with antibiotic dowels there were two cases with reoccurrence of PJI.

Of 25 knees that were included in the radiographic analysis, 17 knees had radiolucent lines, 15 of 17 had tibial radiolucent lines, and six of 17 had femoral radiolucent lines. Four of 17 knees had

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progressive radiolucent lines, four had progressive tibial radiolucent lines, and two had progressive femoral radiolucent lines. One knee with progressive tibial radiolucent lines went on to reimplantation. Of note no components had evidence of migration on serial radiographs (Table 4).

At latest follow-up in 25 knees (81%) there was no gait aid used, in three knees a wheelchair was used, in two knees a walker was used, in one knee a cane was used. In the three patients using a wheelchair: one patient had a hip Girdlestone for hip PJI, one patient with a BMI of 56 kg/m^2 had a chronically dislocated hip antibiotic spacer trying to get her weight down to undergo further hip surgery, and one patient had rheumatoid arthritis, end stage renal disease on hemodialysis, type two diabetes, obesity, and was minimally ambulatory prior to her TKA infection surgery.

At latest clinical follow-up, the post-operative pain score was rated 3.3/10 (range, 0/10 - 8/10). Two patients reported their pain score as an eight, with one patient having significant lumbar spine disease and the other having significant arthritis in the contralateral knee.

Discussion

There continues to be debate regarding the best way to treat chronic TKA PJI. We evaluated the results of 1.5-stage exchange arthroplasty in TKAs with PJI. We found at a mean 2.7 years follow-up that 16% went on to a reimplantation. We had a PJI success rate of 90%, three knees

(10%) had PJI recurrence requiring reoperation. Four knees had progressive radiolucent lines on post-operative x-rays, but there was no evidence of component migration or catastrophic failure in any cases.

There are multiple options to treat chronic TKA PJI, with two-stage exchange arthroplasty being common in North America. Martazavi et al. [5] evaluated 117 patients who underwent two-stage exchange for PJI, and at a mean 3.4 years follow-up 28% had reoperation for infection. Fehring et al. [4] looked at 45 patients who underwent repeat two-stage exchange for periprosthetic knee infection and found that at a mean six years follow-up 49% of patients had another revision for infection and 62% had another revision for any reason. Tan et al. [6] evaluated 570 patients who underwent resection arthroplasty and found that 458 were reimplanted. At a mean 39.3 months, Tan et al. [6] found 70.1% success with no other unintended surgeries other than reimplantation. The results from these studies indicates that two-stage exchange is a viable option to treat chronic TKA PJI. The downside with two-stage exchange arthroplasty is that patients typically must wait at least 12 weeks before undergoing reimplantation. Undergoing a second stage reimplantation adds a second hospitalization, increased possible time away from work, may increase the time one is disabled. Thus, one-stage exchange arthroplasty is an attractive option because the infection surgery is taken care of in one operation.

One-stage exchange arthroplasty for TKA PJI is less common in North America but in appropriately selected patients has had reasonable results [7, 8]. Singer et al. [13] evaluated 63 patients undergoing one-stage exchange for septic knee prostheses, and excluded MRSA,

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Methicillin-resistant Staphylococcus epidermidis, or unknown microorganisms; at a mean follow-up of 36 months there were three cases of infection recurrence. Tibrewal et al. [14] looked at 50 single-stage revision TKAs for PJI, at a mean 10.5 years follow-up one patient had an additional revision surgery for PJI, three other patients had infection not requiring revision, and nine patients had revision for aseptic loosening. Haddad et al. [15] looked at 102 chronic TKA infections, with 28 treated with single-stage exchange and 74 treated with two-stage exchange. At a mean 6.5 years follow-up they found no reinfections in the single-stage group and five reinfections in the two-stage exchange group [15]. While the results of one-stage exchange seem satisfactory, it is not appropriate for all patients. Some potential contraindications to single-stage exchange are poor soft tissues/sinus tract, resistant microorganism(s), unknown organism(s), sepsis, and significant bone loss. In the current study we also found an acceptable reinfection rate (10%), albeit this was a short-term follow-up study. 1.5-stage exchange may be a viable option in many cases where single-stage exchange would be contraindicated.

There are several potential advantages of 1.5-stage exchange compared to other treatment options for chronic TKA PJI. This can be used in patients when there is uncertainty of the organisms, resistant organisms, sepsis, and soft-tissue compromise. The contraindications are the same as for any articulating spacer: extensor mechanisms disruption, significant bone loss, and collateral-ligament insufficiency leading to gross instability. Also, patients can potentially avoid a second operation as the spacer is cemented with good technique to increase durability. Adding antibiotics to the cement may decrease the mechanical strength, but there are mixed results on this, and often antibiotics are used in cement at reimplantation for two-stage exchange [16, 17]. We found only five symptomatic patients went onto a reimplantation, no components showed

radiographic evidence of migration or were reported to be loose at the time of reimplantation. This may show that these spacers can be durable. Importantly with 1.5-stage exchange we do not consider going on to reimplantation a treatment failure. The procedure is still presented to the patient as the first stage of a two-stage procedure for PJI. If the patient's function is good, the longer time between stages allows muscle rehabilitation. We were not able to validate function and activity levels in this study, and this is an area for future research. When patients elected to have a second stage, this was not for catastrophic failure but rather progressive pain or instability, so this could be scheduled electively when it worked best for the patient's schedule. As such this second hospitalization may be less burdensome than if it were for a two-stage exchange. Another important consideration is cost. Although we did not do a cost analysis in our study, at our institution using an articulating spacer is cheaper than using a revision knee prosthesis that would be used in a single-stage exchange or reimplantation of a two-stage exchange. Further using a cobalt chrome femoral component at our institution is cheaper than using a pre-formed cement articulating spacer and may provide increased durability.

This study had several limitations. This study evaluates short-term follow-up of a novel technique. Although the results are acceptable in the short-term, longer follow-up will be important to evaluate for reinfection and for durability of implants that have been left in-situ. While it is our experience that patients seem to function well with these spacers, we did not report any clinical outcome scores. This will be an important area for future studies.

Conclusions

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Our two-stage treatment using an articulating spacer has evolved into what we call "1.5-stage exchange arthroplasty for TKA PJI". This is largely due to the wishes of the patient after counseling them on the treatment options available. Failure of surgical treatment of PJI of the knee is traumatic to both the surgeon and patient. Presenting the 1.5 spacer idea to the patient gives them the concept that if the first operation does not eradicate the infection, that a second procedure will be done. The short-term results show that this is associated with a competitive treatment result as defined as no recurrent reoperation for PJI and implant durability similar to other clinical studies of one and two-stage treatment of PJI. Future studies will need to evaluate the long-term durability of these components when left in-situ.

Take Home Message:

- 1.5-stage exchange arthroplasty for TKA PJI is defined as placing an articulating spacer with the intent to last for a prolonged time if not indefinitely
- At short-term follow-up there was an acceptable rate of infection recurrence and implant durability
- 1.5-stage exchange arthroplasty may be a reasonable method to treat TKA PJI

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Figure Legend

Figure 1. AP and Lateral of Ultra-Congruent Articulating Spacer with Hand-Made Dowels In-Situ at 1.7 Years

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338 Figure 2. AP and Lateral of Posterior-Stabilized Articulating Spacer In-Situ at 1.3 Years

339 Figure 3. AP and Lateral of an Ultra-Congruent Articulating Spacer In-Situ at 5.2 Years

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Table 1. MSIS details

Meets Major	Meets Minor (3/5)	Major				Minor				
		Major: Sinus Tract	Major: Two + cultures with identical organisms	Elevated ESR (> 30) & CRP (> 10)	Elevated synovial WBC Count (greater 1100 cells/mm3)	Cell Count	Greater than 64% PMN for knees	PMN %	At least one + culture	Acute Inflammation
Yes	Yes	No	Yes	No	Yes	90116	Yes	87	Yes	No
Yes	Yes	No	Yes	No	Yes	67074	Yes	95	Yes	N/A
Yes	Yes	Yes	Yes	Yes	Yes	38250	Yes	97	Yes	N/A
No	Yes	No	No	Yes	Yes	53937	Yes	97	No	N/A
Yes	Yes	No	Yes	No	Yes	73650	Yes	73	Yes	N/A
No	Yes	No	No	N/A	Yes	210600	Yes	95	Yes	N/A
Yes	Yes	No	Yes	Yes	Yes	52325	Yes	92	Yes	N/A
Yes	Yes	No	Yes	Yes	Yes	43800	Yes	96	Yes	N/A
No	No	No	No	No	Yes	4320	Yes	93	No	N/A
Yes	No	No	Yes	No	No	Clotted	Yes	96	Yes	N/A
Yes	Yes	No	Yes	Yes	Yes	108076	Yes	97	Yes	N/A
Yes	Yes	No	Yes	No	Yes	27159	Yes	95	Yes	N/A
Yes	Yes	No	Yes	No	Yes	50490	Yes	75	Yes	N/A
Yes	Yes	No	Yes	No	Yes	84490	Yes	90	Yes	N/A
Yes	Yes	No	Yes	Yes	Yes	47300	Yes	76	Yes	N/A
No	Yes	No	No	No	Yes	26400	Yes	87	Yes	N/A
No	Yes	No	Yes	No	Yes	6240	No	44	Yes	N/A
Yes	No	Yes	No	No	No	609	No	18	No	N/A
No	Yes	No	No	Yes	No	Clotted	Yes	89	Yes	N/A
Yes	Yes	No	Yes	No	Yes	55375	Yes	94	Yes	N/A
Yes	Yes	No	Yes	No	Yes	37500	Yes	98	Yes	N/A
Yes	Yes	Yes	Yes	No	N/A	N/A	N/A	N/A	Yes	N/A
Yes	Yes	No	Yes	No	Yes	30100	Yes	94	Yes	N/A
Yes	Yes	No	Yes	N/A	Yes	136050	Yes	100	Yes	N/A
Yes	Yes	No	Yes	No	Yes	33264	Yes	93	Yes	N/A

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No	Yes	No	No	Yes	Yes	11975	Yes	85	Yes	N/A
Yes	No	No	Yes	No	No	0	No	N/A	Yes	N/A
No	No	No	No	No	Yes	100913	Yes	97	No	N/A
Yes	No	No	Yes	N/A	N/A	N/A	N/A	N/A	Yes	Yes
Yes	Yes	No	Yes	No	Yes	57460	Yes	94	Yes	N/A
Yes	Yes	No	Yes	No	Yes	87450	Yes	88	Yes	N/A

MSIS – musculoskeletal infection society. ESR – erythrocyte sedimentation rate. CRP – C-reactive protein. PMN – neutrophils. N/A – not available.

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Table 2. Patient and infection details

PJI Type	Host Grade	Extremity Status	BMI	ASA Score
Chronic	A	2	41.6	3
Chronic	C	1	23.8	3
Chronic	B	2	32.0	2
Chronic	B	2	22.3	3
Acute	B	2	31.4	4
Chronic	C	1	37.5	4
Chronic	A	2	30.2	2
Chronic	C	1	41.4	3
Chronic	A	1	34.8	2
Chronic	C	2	43.7	3
Chronic	A	1	34.1	3
Chronic	A	2	28.7	1
Chronic	C	2	39.8	2
Chronic	A	2	26.0	2
Chronic	C	2	36.3	2
Chronic	A	2	30.3	2
Chronic	A	2	30.3	2
Chronic	A	2	38.8	2
Chronic	B	2	36.3	3
Chronic	B	2	51.8	3
Chronic	B	2	42.1	3
Chronic	B	3	50.5	3
Chronic	C	1	30.0	3
Chronic	B	2	35.4	3
Chronic	B	2	40.0	4
Chronic	B	1	36.4	3
Chronic	B	2	31.1	4
Chronic	A	1	34.0	3
Chronic	B	2	26.6	2

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Chronic	A	1	25.0	1
Chronic	B	2	30.1	2

Acute – Acute Post-operative. PJI – periprosthetic joint infection. BMI – body mass index.

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Table 3. Organism and antibiotic details

Organism: Pre-operative Aspirate	Organism: Intra-operative	IV and/or PO Antibiotic(s) Following Surgery	Antibiotic duration (weeks)	PO Antibiotic following IV Antibiotic(s)	Chronic Suppression
GBS	GBS	Ceftriaxone	6	No	No
Streptococcus virdans	Streptococcuss virdans/anginosus	Ceftriaxone	6	No	No
Peptostreptococcus	Peptostreptococcus	Penicillin G	6	No	No
Negative	Negative	Vancomycin, Ciprofloxacin	6	No	No
MRSA	MRSA	Vancomycin	6	No	Doxycycline
MSSA	Negative	Cefazolin	6	No	No
MSSA	MSSA, Pseudomonas aeruginosa	Cefazolin, Ciprofloxacin	6	Ciprofloxacin	No
MSSA	MSSA	Cefazolin	6	No	No
Negative	Negative	Ertapenem	6	no	No
MSSA	Coag Neg S. epidermidis	Cefazolin	6	no	No
Negative	Enterococcus	Ceftriaxone, Ampicillin	6	no	No
MSSA	MSSA	Cefazolin	6	Cephalexin	No
MRSA	MRSA	Daptomycin	6	Doxycycline	No
MRSA	MRSA	Vancomycin	6	No	No
MRSA	MRSA	Daptomycin	6	No	TMP-SMX
Coag Neg S. lugdunensis	Negative	Vancomycin	3	TMP-SMX	No
Negative	Coag Neg S. lugdunensis	Vancomycin	3	TMP-SMX	No
Negative	Negative	Vancomycin, Ceftriaxone	6	No	No
MSSA	Negative	Cefazolin	6	No	No
Coag Neg S. caprae	Coag Neg S. caprae	Vancomycin	6	No	No
GBS	GBS	Ceftriaxone	6	No	Amoxicillin
Corynebacterium striatum	Corynebacterium striatum	Vancomycin, Cefepime	6	No	No
Coag Neg S. epidermidis	Coag Neg S. epidermidis, Finegoldia magna	Vancomycin, Ciprofloxacin, Clindamycin	6	No	No
MRSA	MRSA	Vancomycin, Ertapenem	6	No	Doxycycline
Coag Neg S. epidermidis	Coag Neg S. epidermidis	Vancomycin, Cefepime	6	No	Doxycycline

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N/A	C. acnes, Coag Neg S. warneri	No	0	Linezolid	No
Negative	Enterococcus faecalis	Ampicillin	6	Amoxicillin	No
Negative	Negative	Vancomycin, Piperacillin/Tazobactam	6	No	No
N/A	Coag Neg S. epidermidis	Vancomycin	6	No	No
Negative	Prevotella intermedia, C. acnes	Ertapenem	6	No	No
GBS	GBS	Ceftriaxone	6	No	No

IV – Intravenous. PO – oral. N/A – not available.

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Table 4.

Radiographic Findings	Reimplanted
Stable partial line at medial keel and medial baseplate of tibia, bone and cement interface	N
Progressive radiolucent line at lateral keel of tibia at bone and cement interface	N
Progressive radiolucent lines at anterior and posterior keel, distal cement mantle, and lateral baseplate of tibia at bone and cement interface	Y
Stable partial radiolucent lines at lateral keel and lateral baseplate of tibia at bone and cement interface	N
Stable partial radiolucent lines at anterior and posterior baseplate and keel of tibia at bone and cement interface	N
Stable complete radiolucent line at lateral baseplate, partial radiolucent line at medial and posterior baseplate of tibia, at the bone and cement interface	Y
Progressive radiolucent lines at bone and cement interface at anterior keel of tibia and anterior flange of femur	N
Stable partial radiolucent line at anterior to keel of tibia at bone and cement interface	N
Stable partial radiolucent line at anterior flange of femur at bone and cement interface	N
Stable radiolucent line at medial baseplate of tibia at bone and cement interface	N
Stable partial radiolucent line at anterior flange of femur at bone and cement interface	N
Stable partial line at medial keel of tibia at bone and cement interface	N
Stable partial lines at lateral baseplate of tibia and anterior flange of femur at bone and cement interface	N
Stable partial radiolucent lines anterior, medial, and lateral to tibial keel at bone and cement interface	Y
Stable partial line at anterior baseplate of tibia at bone and cement interface	N

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Stable partial radiolucent lines at bone and cement interface around medial and lateral baseplate as well as keel of tibia, as well at proximal end of cement mantle on the femoral side, at bone and cement interface	Y
Progressive radiolucent lines at anterior and medial keel of tibia, and anterior flange of femur at bone and cement interface	N

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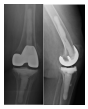

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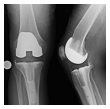

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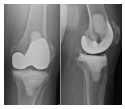

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