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Success of Different Knee Arthrodesis Techniques After Failed Total Knee Arthroplasty: Is There a Preferred Technique?

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ABSTRACT

Arthrodesis is a widely accepted treatment for failed total knee arthroplasty when further revision is contraindicated. In this study, we retrospectively review the pre-operative characteristics, operation techniques, treatment plans, and eventual outcomes in 42 consecutive patients (43 knees) who underwent knee arthrodesis at a single institution. Femorotibial fusion was achieved in 30 cases (75.0%). No cases of implant failure were recorded. Post-operative complications occurred in 20 cases (46.5%). Repeat arthrodesis was performed in 4 cases, and 2 patients eventually required above-the-knee amputation. Comparing the cases with successful vs. unsuccessful outcomes, there was a significant difference in days until hospital discharge following arthrodesis ($P = .026$), mean erythrocyte sedimentation rate prior to arthrodesis ($P = .012$), and the proportion of patients with post-operative wound complications ($P = .021$).

As the number of annual total knee arthroplasty (TKA) operations has grown tremendously over the past few decades [1,2], surgeons must address a growing number of post-operative complications, including infections and implant failures. When infection of the replaced knee joint is severe and persistent, and further revision is contraindicated, patients' options may be reduced to either above-the-knee amputation or arthrodesis. Of these, knee arthrodesis is generally considered the preferred treatment [3]. Although knee arthrodesis never reflects a truly satisfactory end goal for surgeon or patient, it can be a successful salvage procedure that provides very significant pain relief for the patient [3–8]. Furthermore relatively low recurrence of infection is reported, ranging from 0% to 21% of arthrodesis cases done with an intramedullary nail [6,7,9–12].

The most common indication for knee arthrodesis is failed TKA due to infection, which is generally due to the presence of resistant organisms [3]. Arthrodesis may also be indicated when there is substantial aseptic loosening and severe instability, the patient is immune compromised and there is a periprosthetic infection, there is inadequate soft tissue coverage of the knee, or the extensor mechanism is deficient [8,13,14]. Conversely, knee arthrodesis may be contraindicated when the ipsilateral hip or ankle has severe degenerative changes or when there is a contralateral knee amputation [13].

There are various surgical techniques that are used for arthrodesis, each with their own advantages and disadvantages. Currently, the most widely used techniques include various external fixators, long or short intramedullary nails, and internal fixation [8]. Among these, many surgeons currently regard intramedullary nails to be the most reliable in achieving bony fusion between the femur and tibia [3,6,8,13–19] (bony fusion is defined as clear observation of bony trabeculae traversing between the femur and tibia in at least 2 different radiographic views [20]). While variations of external fixation were previously the most common technique for arthrodesis [15], the technique is now mostly considered mainly as an alternative procedure when the use of an intramedullary nail or plate fixation is contraindicated, such as in the presence of active infection [4,8]. However, most authors advocate for careful selection of technique based on the patient's specific situation [4,8].

In terms of timing and management, there are two general approaches to treating a persistent knee joint infection prior to arthrodesis. The first approach is a single stage procedure, where the operation includes debridement of infected tissue in and around the joint, followed by insertion of the fixation device. The second, and most common, approach is a two-stage procedure, where the first stage includes surgical debridement, removal of components from the failed primary or revision TKA, and placement of an antibiotic impregnated cement spacer [21]. Following the first stage, the patient is generally given a 6 to 8 week course of antibiotics prior to the second stage, where fixation is achieved using the preferred technique. The goal of the two-stage procedure is to decrease or eliminate the infection of the knee prior to arthrodesis. Higher fusion rates have typically been observed when the infection has been adequately reduced or eliminated by the time of arthrodesis [20,22].

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While there has been substantial agreement in the literature regarding the general management of knee arthrodesis cases, no single technique or exact management plan has been shown to be far superior to others. Likewise, various authors have advocated for the necessity of flexible treatment plans that address the specific needs and situation of the patient [4]. Consequently, it is important to seek to elucidate which patient characteristics or treatments significantly contribute to outcomes of the operation.

In this study, we evaluated a consecutive cohort of patients where knee arthrodesis was performed. The purpose of our study is to (1) compare the results of our observed cases to other reported cases in the literature, (2) compare our patients' pre-operative characteristics to each other in order to find associations with outcomes, and (3) compare the cases where intramedullary nails were used to the rest of the cases where other arthrodesis techniques were used.

Methods

This study was conducted with the approval of our institutional review board (IRB).

We retrospectively reviewed 43 consecutive cases of knee arthrodesis that took place at our institution between January 1997 and January 2012. Arthrodesis operations were performed by five different surgeons in our department. In total, five different surgical techniques were utilized across all arthrodesis operations.

A retrospective chart review was conducted using knee arthrodesis CPT code (27580) to identify all knee arthrodesis cases conducted during the study time period. All identified cases were reviewed and patients' demographic and clinical data were collected; all radiographic data were reviewed by two of the senior authors. Fusion was determined when bony trabeculae was observed crossing the femorotibial joint in at least two views of the knee.

In order to analyze factors that may contribute to successful outcomes or failures, we separated patients into two groups: one representing successful cases, and the other unsuccessful cases. We defined "successful cases" as cases where bony fusion and eradication of infection were achieved without further surgical operations. We defined "unsuccessful cases" as those where fusion was not achieved, required any further surgery, or failed to adequately eradicate the infection. For comparison of these two groups, the student's t-test was used for numerical data, measuring significance when the P value was less than 0.05. For categorical data, the Pearson's chi-squared test was used with a significance level of 0.05. For each variable tested, if the 2×2 table formed had an expected count of less than 5.0 (an expected count is determined by multiplying the row total by the column total and dividing this product by the total samples — it is generally accepted that a count less than 5 violates the standard assumptions of a Pearson's chi-squared test), then the Yates Continuity Correction was applied (all reported values have this correction applied when appropriate).

For all categorical data compared between "successful cases" and "unsuccessful cases," odds ratios were also calculated for each variable. The odds ratio represents the odds of a "successful" outcome when a certain variable is present over the odds of a "successful" outcome when the same variable is not present.

Results

There were a total of 42 patients and 43 knees studied (1 patient had bilateral knee fusion, with separate operations for each knee). The average age of the patients at the time of arthrodesis was 66.2 years old (range: 40.2–89.8). Sixteen patients were male (38.1%) and 26 were female (61.9%). The average BMI at the time of operation was 36.44 (range: 23.5–59.1). The average time of follow-up was 2.5 years. Of the 42 patients in the study, 3 were lost to long-term follow-up after arthrodesis.

Reasons for TKA and Timeline

All 43 knees originally had a TKA operation and 42 of them had subsequent secondary surgery due to TKA failure (1 patient had fusion directly following a failed TKA). The most common primary reason for failure of the TKA in the patient set was infection (76.2% of knees); the second most common reason was aseptic failure (9.5%). The average time between the original TKA and arthrodesis was 6.53 years (range: 0.3–29.6) (Table 1).

Reasons for Fusion

The most common reason for arthrodesis was current infection or a history of infection (together accounting for 90.7% of fusion operations — some knees experienced a failed TKA due to reasons other than infection, but after revision operations developed chronic infections). Two knees underwent arthrodesis due to arthrofibrosis, 1 knee due to attenuation of the infrapatellar tendon, and another knee due to shortening of the lower limb caused by knee flexion deformity (Table 1).

Table 1
General Characteristics of Arthrodesis Cases.

	Cases of Non-Intramedullary Arthrodesis (13 Cases)	Cases of Intramedullary Nail Surgery Only (30 Cases)
	Mean or Percentage w/ Variable	Mean or Percentage w/ Variable
Average Age at Time of Fusion (years)	65.94 (SD = 12.53)	66.3 (SD = 12.73)
Gender	5 Males (38.5%), 8 Females (61.5%)	11 Males (36.7%), 19 Females (63.3%)
BMI	34.24 (SD = 9.19)	36.99 (SD = 10.28)
Reason for Primary TKA:		
Osteoarthritis	8 (61.5%)	23 (76.7%)
Rheumatoid Arthritis	2 (15.4%)	0
Trauma	2 (15.4%)	1 (3.3%)
Post-traumatic Osteoarthritis	0	4 (13.3%)
Juvenile Rheumatoid Arthritis	0	2 (6.7%)
Osteoarthritis Post-Hip Arthroplasty	1 (7.7%)	0
Primary Reason for Failure of Primary TKA:		
Infection	9 (69.2%)	23 (76.7%)
Aseptic Failure	2 (15.4%)	2 (6.7%)
Arthrofibrosis	1 (7.7%)	2 (6.7%)
Extensor Mechanism Failure	1 (7.7%)	1 (3.3%)
Trauma	0	1 (3.3%)
Soft Tissue Compromise	0	0
Secondary Procedure Following Failed TKA:		
Incision and Drainage	2 (15.4%)	10 (33.3%)
Incision and Drainage/ Antibiotics Spacer Placed	5 (38.5%)	9 (30.0%)
Revision	5 (38.5%)	10 (33.3%)
Fusion	1 (7.7%)	0
Intra-Operative Culture Results (during secondary Sx):		
No Growth	0	3 (10.0%)
MSSA	1 (7.7%)	4 (13.3%)
MRSA	4 (30.8%)	6 (20.0%)
Pseudomonas	1 (7.7%)	1 (3.3%)
Enterococcus	1 (7.7%)	1 (3.3%)
Corynebacterium	0	1 (3.3%)
Enterobacter	0	1 (3.3%)
Group B Strep	0	2 (6.7%)
Coagulase Negative Staph	1 (7.7%)	0