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Revision Arthroplasty for the Management of Stiffness After Primary TKA

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ABSTRACT

Background: The aim of this study was to evaluate the results of revision surgery for the treatment of stiffness after total knee arthroplasty (TKA).
Methods: An IRB-approved retrospective review was performed to identify patients who were revised due to stiffness after a primary TKA. Patients were included when at least one major component had to be revised due to stiffness after primary TKA with a minimum follow-up of 2 years. Patients with history of previous infection and those treated with isolated polyethylene exchange were excluded.
Results: The study group involved 42 knees. Mean follow-up was 47 months (24-109 months). Mean flexion contracture improved from 9.7° (0°-35°) preoperatively to 2.3° (0°-20°) postoperatively ($P < .00$). Mean flexion improved from 81.5° (10°-125°) preoperatively to 94.3° (15°-140°) postoperatively (P .02). Mean range of motion improved from 72.0° preoperatively (10°-100°) to 92° (15°-140°) postoperatively ($P < .00$). Mean Knee Society knee scores improved from 43.9 points (15-67) preoperatively to 72.0 points (50-93) at latest follow-up and mean Knee Society Function scores improved from 48.7 (35-80) preoperatively to 70.1 points (30-90) postoperatively. Pain improved in 73% of the patients.
Conclusion: Revision surgery appears to be a reasonable option for patients presenting with pain and stiffness after TKA. However, the benefits may be modest as the outcomes still do not approach those achieved with primary TKA.

Stiffness after total knee arthroplasty (TKA) has been defined as an inadequate range of motion (ROM) that results in functional limitations in activities of daily living [1]. A stiff TKA is one of the most complex postoperative complications after TKA [2], in terms of pathogenesis and treatment, as it represents a frustrating problem for both the surgeon and the patient. The incidence of stiffness after TKA is generally low (1.3%-5.3%), thought its true incidence is difficult to estimate given the lack of a uniform definition [3-5]. The development of a stiff TKA is multifactorial and several preoperative, intraoperative, and postoperative risk factors have been identified [5-7]. Treatment options range from aggressive physical therapy, to manipulation under anesthesia, arthroscopic debridement, open arthrolysis, or revision of the components [8,9]. Component revision has been reported to be a reasonable option, although the reported results seem to be modest with regards to pain, function, and ROM [3,10-13]. However, because those reports several changes have been accomplished in the orthopedic field that may have had an impact in these results, these include, multimodal pain management, less invasive exposures, more anatomic component sizing options, ability to add constraint without removing primary components, faster recovery programs, etc [14,15].

The purpose of this study was, therefore, to analyze the results of revision arthroplasty for the treatment of stiffness after TKA.

Material and Methods

We retrospectively identified 559 revision knee arthroplasties performed by 1 of 4 arthroplasty surgeons at a single institution between 2007 and 2014. Operative records and office notes were reviewed to identify preoperative ROM and the reason for revision surgery, with the goal of identifying all revisions performed for

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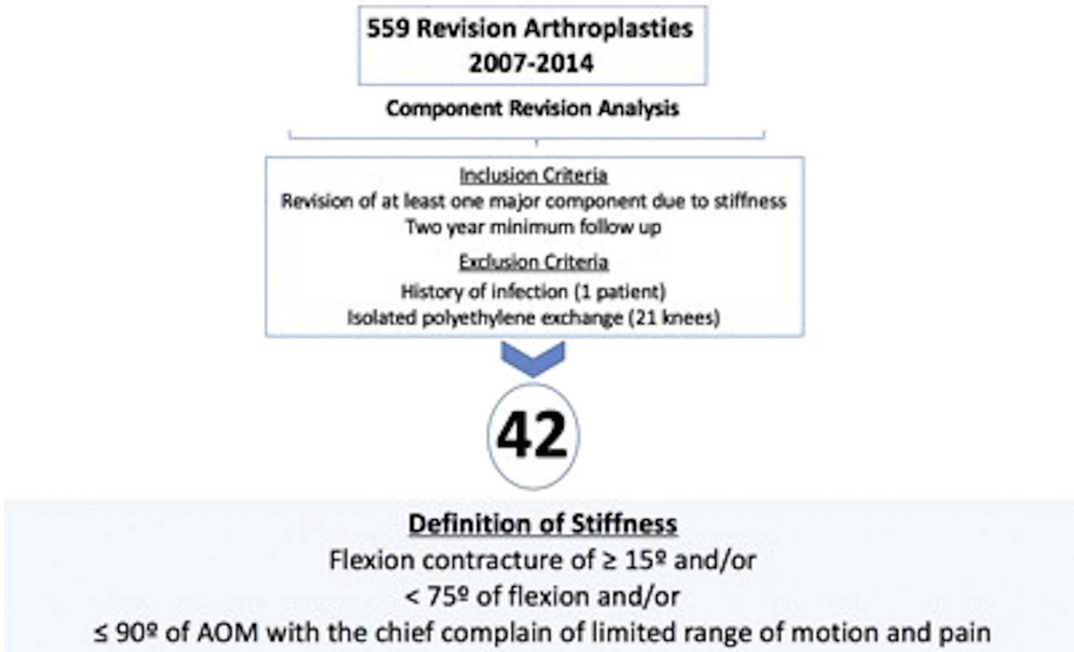

Fig. 1. Flowchart, inclusion and exclusion criteria. Definition of stiffness.

stiffness or in the presence of significantly restricted motion. Patients were included when at least one major component had to be revised due to postoperative stiffness following primary TKA with a minimum follow-up of 2 years (Fig. 1). Patients with history of previous infection, and those treated with isolated polyethylene exchange were excluded (Fig. 1). Stiffness was defined as the presence of one or more of the following criteria: (1) flexion contracture of ≥15°, (2) <75° of flexion, and/or (3) ≤90° of ROM with the chief complain of limited ROM and pain.

A retrospective chart review was performed to identify all relevant preoperative and postoperative (at final follow-up) clinical, physical examination, radiographic, and intraoperative findings (as per reported by the operating surgeon). Knee Society Scores [16] were calculated at the final preoperative visit before revision surgery and at the final follow-up visit for all knees. Radiographs were analyzed for any signs of component loosening as described by the Knee Society (KS) roentgenographic evaluation and scoring system [17]. Component alignment in coronal and sagittal planes was evaluated on standardized anteroposterior and lateral radiographs of the knee. The lateral radiograph was also used to assess posterior condylar offset of the femoral component and patellar height, as previously described [18,19]. Axial alignment was evaluated with computed tomography as described by Berger et al [20] when there were radiographic or physical examination findings to suggest malrotation. Patients were contacted by telephone when any relevant data was missing.

General, epidural, and/or regional anesthesia were performed isolated or in combination, in all patients. The anesthesiologist and the patient generally decided the type of anesthesia. All surgeries were performed using the prior skin incision, which was extended as needed to gain exposure to the extensor mechanism. All knees were exposed performing a medial parapatellar arthrotomy. Ten of the knees (23.8%) required a quadriceps snip and 3 (7.1%) a tibial tubercle osteotomy for exposure. A thorough synovectomy and excision of capsular scar tissue was then performed. Subperiosteal releases of the deep medial collateral ligament and capsule were performed to achieve external rotation of the tibia and mobilization of the extensor apparatus reducing stresses on the patellar tendon.

The posterior cruciate ligament, when present, was transected at the time of revision surgery in all patients. The components were removed carefully using a microsagittal saw, flexible osteotomes, and other hand instruments. The flexion and extension gaps were subsequently evaluated and measured performing additional bone cuts as needed. Distal femoral resection was confirmed to be within 5°-7° of valgus. Augments and/or cement were used as needed to restore the joint line and rotation of the components. Intramedullary stems were used in cases of periarticular bone loss to achieve a more stable construct. All knees were stable and able to achieve full extension and more than 90° of flexion intraoperatively.

The femoral and tibial components were revised in 39 knees (92%). The patellar component thickness and symmetry were evaluated in all patients and revised only in one case. Two patients had an isolated tibial component exchange (5%) due to malrotation of the tibial component and one patient (2%) had an isolated femoral component exchange due to an oversized component (as per surgeon operative report). The decision whether to exchange one or both components was made based on component compatibility issues and the ability to balance the flexion and extension gaps. Revision implants used included the NexGen LCCK in 27 knees (64%) (Zimmer, Warsaw, IN), the Press Fit Condylar TC3 prosthesis in 9 knees (21.4%) (De Puy [Johnson and Johnson]), the Legion revision prosthesis in 5 knees (11.9%) (Smith & Nephew, Memphis, TN) and the Triathlon TS in one knee (2.3%) (Stryker Howmedica Osteonics, Allendale, NJ). Pain was managed perioperatively with a combination of patient-controlled analgesia, epidural catheters or regional blocks, oral narcotics, and/or anti-inflammatory agents. Postoperatively all patients underwent a standard course of physical therapy beginning within 24 hours after surgery that was continued after discharge for approximately 3-6 months.

Descriptive statistics, including mean, range, and standard deviation, were performed to report patient demographics, diagnoses, and treatments. Paired *t* tests were used for continuous variables to determine statistical significance between groups and to compare the findings at the preoperative visit and at final

Table 1
Patient Baseline Demographics.

	Demographics
Study sample	42 knees (3 bilateral)
Male knees	14 (33%)
Female knees	28 (66%)
Age, y	61 (range 48-80)
BMI, kg/m^2	33 (range 21-58)
Mean follow-up, mo	47 (range 24-109)

BMI, body mass index.

follow-up visit. Chi-square tests were used for categorical variables. Data analysis was performed using SPSS for Windows statistical software (version 18.0; SPSS, Chicago, IL). $P < .05$ was considered statistically significant.

Results

The study group involved 42 knees, of which, 28 corresponded to women knees (1 bilateral) and 14 to men knees (2 bilateral). Mean follow-up was 47 months (range 24-109 months) after revision surgery. The mean age of the cohort was 61 years (range 48-80 years) at the time of the index procedure. Other baseline demographics and comorbidities, as well as, significant preoperative and intraoperative findings are described in Tables 1-4. The diagnosis before the primary TKA had been osteoarthritis in 39 (93%) of the 42 knees and post-traumatic osteoarthritis in 3 knees (7%). All knee arthroplasties were in between 5° and 10° of valgus alignment before revision surgery. All patients had a negative work-up for periprosthetic joint infection as recommended by guidelines published by the Workgroup of the Musculoskeletal Infection Society [21]. The original TKAs were posterior stabilized in 35 knees, cruciate retaining in 4 knees, and constrained in 3 knees (Table 3). The ROM before knee replacement was not known in most patients given the referral nature of our practice. Interventions performed in the attempt to improve stiffness before revision surgery included physical therapy in all patients (100%), manipulation under anesthesia in 10 knees (23.8%), and arthroscopic debridement in 5 knees (11.9%).

Significant functional and clinical improvements were observed postoperatively ($P < .05$; Table 5). The mean flexion contracture improved from 9.7° (range 0°-35°) preoperatively to 2.3° (range 0°-20°) postoperatively. The mean flexion improved from 81.5° (range 10°-125°) preoperatively to 94.3° (range 15°-140°) postoperatively. Mean ROM improved from 72.0° preoperatively (range 10°-100°) to 92° (range 15°-140°) postoperatively. Thirty-three knees (80%) had an improvement in their ROM postoperatively. Twenty-seven knees (64.3%) improved their level of flexion, whereas 37 knees (88%) improved their level of extension. The mean KS knee score improved from 43.9 points (range 15-67) preoperatively to 72.0 points (range 50-93) at latest follow-up, whereas the mean KS Function score improved from 48.7 points (range 35-80) preoperatively to 70.1 points (range 30-90) postoperatively. The level of pain improved in 73% of the patients; however, 4 patients (9.5%) continued to have severe pain at latest follow-up (Table 5). Two knees underwent manipulation under anesthesia within 3 months after the revision and gained at least 10° in the ROM. Two knees required re-revision arthroplasty at a mean of 10 months after the first revision both of them due to recurrent pain and stiffness. There were 2 additional complications requiring surgical intervention. One knee had a hematoma that required surgical drainage and one patient had persistent drainage from the wound and required a vacuum-assisted closure and oral antibiotics.

An attempt to define the reason for stiffness was performed by evaluating the most relevant preoperative and intraoperative findings (Tables 3 and 4). Most of the stiff knees (83.3%) were posterior-stabilized, 12% of the population presented heterotopic ossification in the preoperative radiographs and 20 knees (47%) had a patella baja (Table 3). A total of 39 knees (92.8%) were documented to have abundant intra-articular and extra-articular scar tissue during revision surgery; 13 patients (30.9%) were reported to have oversized components on the operative report (based on component overhang), and 11 knees had component loosening (28.5%). Other less frequent but not less relevant intraoperative findings are reported in Table 4.

Table 2
Patient Baseline Comorbidities.

	Comorbidities (39 Patients), %
Obesity (BMI >30 kg/m^2)	59.3
Hypertension	58.9
Diabetes mellitus	28.2
Hypercholesterolemia	20.5
Respiratory disease	10.2
Osteoporosis	10.2
GI disease	7.6
Anemia	2.5
Angina	2.5
Heart disease	2.5
Steroid treatment	2.5

BMI, body mass index; GI, gastrointestinal.

Table 3
Significant Preoperative Findings.

	Component Revision
Number of knees	42
Preoperative findings	
Level of constraint	
CR	4 (9.5%)
PS	35 (83.3%)
Semiconstrained	3 (7.1%)
Mean polyethylene size	11 mm (9-21)
Heterotopic ossification	5 (11.9%)
Negative workup for infection[a]	42 (100%)
Patella baja	20 (47%)

CR, cruciate retaining; PS, posterior-stabilized.
[a] Following the MSIS criteria.

Table 4
Significant Intraoperative Findings.

	Component Revision
Number of knees	42 (100%)
Intraoperative findings	
Arthrofibrosis	34 (80.9%)
Malrotation	8 (19.0%)
Oversized implants	13 (30.9%)
F/E gap mismatch	7 (16.6%)
Polyethylene wear	8 (19.0%)
Loose components	12 (28.5%)
Patellar maltracking	6 (14.2%)
Level of constraint	
PS	4 (9.5%)
Semiconstrained	38 (90.4%)
CR/hinge	0 (0%)
Mean polyethylene size, mm	13 (range 8-23)
Mean patellar thickness, mm	24 (range 15-32)
Augments distal femur	
Medial	15 (35.7%)
Lateral	14 (33.3%)
Augments posterior femur	
Medial	9 (21.4%)
Lateral	9 (21.4%)
Augments tibia	5 (11.9%)

CR, cruciate retaining; PS, posterior-stabilized.

Table 5
Overall Functional and Clinical Results.

	Component Revision	*P* Value
Number of knees	42	
Preoperative flexion contracture	9.7° (0°-35°)	
Postoperative flexion contracture	2.3° (0°-20°)	
Change in flexion contracture	**7.4° (0°-15°)**	***<.00***
Preoperative flexion	81.5° (10°-125°)	
Postoperative flexion	94.3° (15°-140°)	
Change in flexion	**12.8° (5°-15°)**	***.02***
Preoperative AOM	72.0° (10°-100°)	
Postoperative AOM	92.0° (15°-140°)	
Change in AOM	**20° (5°-40°)**	***<.00***
Preoperative KS Knee Score	43.9 (15-67)	
Postoperative KS Knee Score	72.0 (50-93)	
Change in KS Knee Score	**28.1 (35-36)**	***<.00***
Preoperative KS Function Score	48.7 (35-80)	
Postoperative KS Function Score	70.1 (30-90)	
Change in KS Function Score	**21.4 (5-10)**	***<.00***
Severe pain before TKA revision	11 (26.1%)	
Severe pain at final follow-up	4 (9.5%)	***.04***
Need for re-revision	2 (4.76%)	

Italicized bold denotes statistically significant differences.
AOM, arc of motion; KS, Knee Society; TKA, total knee arthroplasty.

Discussion

This study reviewed our experience performing the revision arthroplasty in patients who developed stiffness after TKA. Our results revealed that component revision seems to be a reliable option for the management of this condition. Significant improvements were observed with regards to clinical and functional outcomes at a mean of 47 months after the procedure.

These results are similar to those reported by previous studies (Table 6) [3,10-13] showing improvements in clinical and functional scores as well as pain levels. Hartman et al [13], however, reported a significant reoperation rate as 49% of their patients required a further intervention for stiffness or postoperative complication. This is in contrast with our data that shows that only 4 patients (9.1%) required a further intervention for stiffness or sustained a complication. The lack of a standard definition for stiffness after TKA makes difficult to compare results from different studies. This issue was addressed by Kim [3] who reported that none of the proposed previous definitions included patients who were restricted by a flexure contracture alone. Therefore, they defined stiffness after TKA as a flexion contracture ≥15° and/or <75° of flexion. These end points were selected on the basis of gait analysis studies indicating an increased difficulty in walking with increasing flexion contracture and that 67° of flexion is required for normal gait [22]. This definition, however, is purely objective, and because stiffness is also a symptom that the patient can experience it should include the patient perception in its own definition. For this reason, we decided to add a third component to the definition of stiffness proposed by Kim [3]: patients with ≤90° of ROM with the chief complain of limited ROM and pain (Fig. 1). We, therefore, propose to use this definition for future studies evaluating patients with stiffness after TKA so that standard populations can be created and proper comparisons made. In addition, since the study of Hartman [13], several milestones have been accomplished in the orthopedic field that may explain our lower complication rate. These include but are not limited to: the use of tranexamic acid, better pain control, shorter hospital stays, and faster recovery programs [14,15].

Although multiple treatment methodologies have been recommended for the treatment of stiffness after TKA, revision of the components is sometimes necessary, and has been proven to be a good option for the management of this condition, especially when other less invasive treatment options have not succeeded [8,9,23]. The reported results are modest, however, with an existing wide margin toward better clinical and functional outcomes. Scuderi [1] suggested that the best treatment option for the management of stiffness after TKA is prevention. This requires identifying patient risk factors, providing patient education, aggressive postoperative rehabilitation, and avoidance of technical errors.

When performing revision arthroplasty in a patient who developed stiffness after TKA, it is important to know the reason for failure and loss of motion because the failure to identify the cause of stiffness may result in recurrence of the problem [8,9,23,24]. In an attempt to identify some of the reasons leading to revision arthroplasty, we collected significant preoperative, intraoperative, and postoperative findings that included, a significant amount of comorbidities, such as, obesity, hypertension, and diabetes mellitus (Table 2), presence of heterotopic ossification (11.9%), patella baja (Table 3), arthrofibrosis (80.9%), and oversized implants (30.9%). All these factors seemed to contribute to the development of stiffness after TKA; however, further studies will have to determine their exact impact on the development of this condition, as this study was not intended to evaluate that.

The limitations of this study include that it is a retrospective chart review and many of the index TKAs were referred to the senior surgeons for revision; several surgeons were involved in the revision surgery and several implant designs were evaluated. However, we do not feel that these shortcomings undermine the important findings of this study.

In summary, stiffness after TKA is a complex, multifactorial issue that often involves a combination of patient-related and mechanical factors associated with component placement and pathologic soft tissue scarring. When required, component revision is a reasonable treatment option that provides significant improvements in clinical and functional outcomes with a low incidence of complications. There is still, however, a need to use a standard definition for stiffness in all studies, as well as, to implement measures to prevent and decrease the incidence of this disabling problem.

Table 6
Main Series Reporting Results of Component Revision for the Treatment of Stiffness After TKA.

	N	χF/U	χAge, y	↑ROM, °	↑KSS	↑KSF	Reoperation, %
Christensen et al [10], 2002	11	37.6	62	43.5	44.5	53.6	36
Kim et al [3], 2004	56	43.0	69	27.6	48.2	18.4	10.7
Haidukewych et al [11], 2005	16	42.0	67	33.0	37.0	13.0	25
Keeney et al [12], 2010	11	36.7	59	17.0	3.6	−1.0	NR
Hartman et al [13], 2010	35	54.5	62	44.5	28.7	14.7	49
Current study 2016	42	47.0	61	20	28.1	21.4	9

χF/U, mean follow-up (mo); ↑KSF, change in Knee Society Function score; ↑KSS, change in Knee Society knee score; ↑ROM, change in range of motion; NR, not reported.

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