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Original Research

Arthroscopic Lysis of Adhesions With Manipulation for Management of Late-Presenting Stiffness After Total Knee Arthroplasty

Austin M. Middleton, BS, Michael J. Ziegele, MD *, Carole S. Vetter, MD, Adam I. Edelstein, MD

Department of Orthopaedic Surgery, Medical College of Wisconsin, Milwaukee, WI, USA

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ABSTRACT

Background: Arthrofibrosis is a known complication of total knee arthroplasty (TKA). Closed manipulation is the treatment of choice for arthrofibrosis within 90 days of TKA. Treatment for arthrofibrosis that has failed prior interventions remains controversial, and the role for arthroscopic lysis of adhesions has not been examined for late-presenting arthrofibrosis.

Methods: A retrospective analysis of patients who underwent arthroscopic lysis of adhesions (LOAs) with manipulation for post-TKA arthrofibrosis was performed. Chart review included patient characteristics, time from TKA, prior interventions, and range of motion (ROM) data. Knee extension, flexion, and total ROM were recorded preoperatively, intraoperatively, and throughout follow-up. Knee ROM was compared at the different time intervals using Wilcoxon signed-rank tests.

Results: A total of 13 patients (6 male and 7 female) with a mean age of 66.3 years were included. Average time since index TKA was 57.2 months (3.7-209.5). Ten of 13 patients had undergone prior interventions for arthrofibrosis, which included closed manipulation under anesthesia, open LOA, and revision arthroplasty. The mean preoperative knee flexion and extension values for the cohort were 76.5 ± 17.4 and −4.6 ± 6.1 degrees, respectively. Postoperative improvements in knee ROM were significant at all time points, with mean improvements of 17.2 ± 16.3 degrees at 1 week ($P = .022$), 17.2 ± 13.2 degrees at 4 weeks ($P = .001$), 19.2 ± 16.0 degrees at 8 weeks ($P = .004$), and 25.2 ± 13.1 degrees at 12 weeks ($P = .005$). No complications were recorded.

Conclusions: Arthroscopic LOAs with manipulation achieves significant improvements in knee ROM for late-presenting arthrofibrosis after TKA.

Introduction

Demand for total knee arthroplasty (TKA) is predicted to rise exponentially over the coming decades as a function of an increasingly elderly population and expanding surgical indications that are beginning to include the younger and more active patients [1]. Despite TKA's long track record of success, complications are inherent risks of this procedure [2,3] and have been targeted as priorities for quality improvement [4]. Arthrofibrosis is a condition characterized by postoperative stiffness and limitation of functional range of motion (ROM), occurring in approximately 1.3%-5.2% of patients after TKA [5,6]. A number of risk factors have been associated with the development of arthrofibrosis, including limited preoperative ROM, errors in the surgical technique, poor patient motivation, the lack of patient compliance with physiotherapy, infection, patellar complications, complex regional pain syndrome, and heterotopic ossification [7].

Timing of patient presentation within the postoperative period largely dictates the treatment strategy for arthrofibrosis. When identified within the first 12 weeks after surgery, the mainstay of treatment for arthrofibrosis includes a manual manipulation under anesthesia (MUA) followed by physical therapy. This treatment strategy has been demonstrated to be effective, with significant improvements in knee ROM and patient-reported knee functional scores [8]. Patients who present outside of this 12-week window or those who have failed prior manipulations experience diminished

* Corresponding author. Department of Orthopaedic Surgery, Medical College of Wisconsin, 9200 W. Wisconsin Avenue, P.O. Box 26099, Milwaukee, WI 53226-0099, USA. Tel.: +1 262 894 9974.
E-mail address: mjziegele@gmail.com

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gains in knee ROM and functional scores with a closed MUA [8]. Furthermore, they are at a higher risk of periprosthetic fracture and patellar tendon rupture with attempts at manipulation [9]. Additional treatment options for these patients include an arthroscopic lysis of adhesions (LOAs), open LOAs, and revision arthroplasty [10,11]. No consensus exists on optimal management of late-presenting or treatment-resistant arthrofibrosis, and the role for arthroscopic LOAs has only been examined for patients within 3 years of index arthroplasty.

To fill this gap in the literature, we performed a retrospective review of patients that underwent arthroscopic LOA for treatment-refractory or late-presenting knee arthrofibrosis, with a cohort that includes patients out to 17 years from index TKA.

Material and methods

Institutional review board approval was attained, and the records of a single surgeon from 2001 onward were retrospectively reviewed. Patients who completed more than 3 months from the index TKA with a functional loss of knee ROM after total knee replacement and underwent arthroscopic LOAs with manual MUA were included. All patients were first evaluated by a fellowship-trained arthroplasty surgeon and referred for arthroscopy once other causes of stiffness had been ruled out, including malalignment, infection, or malposition. Patients were excluded if they underwent arthroscopic LOAs for an indication other than stiffness or decreased ROM after TKA. Charts were reviewed for demographic information (age, gender, body mass index, comorbidities, American Society of Anaesthesiologists (ASA) score, and smoking status) and historical information including the date of TKA, the implant type, the technique at index arthroplasty, and any prior interventions. Preoperative radiographs and inflammatory markers were reviewed to evaluate potential contributing factors to stiffness. Extension, flexion, and total ROM were recorded with the use of a goniometer preoperatively, intraoperatively, and postoperatively at intervals of 1 week, 4 weeks, 8 weeks, and 12 weeks.

All patients had initially undergone a standard period of physical therapy after their index arthroplasty. Patients were indicated for arthroscopic LOAs with manipulation if they failed to achieve adequate arc of motion for activities of daily living (ADLs) (90°) regardless of prior interventions for stiffness and if there were no other problems contributing to the limited motion (malalignment, malpositioned components, fracture, infection).

Patients had a peripheral nerve block performed before the initiation of surgery. Three standard arthroscopic portals were made: the superolateral portal was used for outflow, with medial and lateral parapatellar portals used for arthroscope and arthroscopic instruments.

A systematic resection of scar tissue was performed starting with the release and resection of tissue in the suprapatellar pouch, including the release of any adhesions between the extensor mechanism and the femur. This was followed by debridement of the medial and lateral gutters and the intercondylar notch, as well as the posterior knee if indicated and accessible. Once the arthroscopic debridement was deemed concluded, arthroscopic instruments were removed and the knee was manually manipulated into flexion and extension by the surgeon. A 10-French drain was then placed in the knee, the portals were closed, and a dressing and compressive stocking were placed on the knee.

All patients were then placed in a continuous passive motion machine in the postanesthesia care unit at settings of 0°-110°. This machine was used for the first week in addition to attendance at physical therapy daily for the first 5 days postoperatively. After the first follow-up visit at approximately 1 week, physical therapy was continued 3 times per week until the patient reached a plateau in knee motion.

Statistical analysis was performed using SAS, version 9.4 (SAS Institute, Cary, NC). Knee extension and flexion after arthroscopic LOAs with manipulation were compared at different time intervals using paired-sample t-tests. A general linear (regression) model was used for multivariate analysis to determine predictors of changes in flexion and extension. All results were considered significant at the 0.05 level.

Results

A total of 13 patients (6 male/ 7 female) with a mean age of 66.3 years met inclusion criteria (Table 1). There were 8 patients with cruciate-retaining knees, 4 patients with posterior-stabilized knees, and 1 patient with a varus/valgus constrained knee. Measured resection was used in 8 of the patients, whereas gap balancing was used for 3, and the records of 2 patients were unable to be obtained from their outside institutions. The mean time since the index TKA was 57.2 months (range 3.7-209.5 months). Seven of 13 patients were more than 3 years from the index TKA. Ten of the 13 patients had undergone prior interventions for arthrofibrosis, which included closed MUA (8), open LOAs (1), and revision arthroplasty (3) in the case of stiffness with loosening. For the patients who had undergone prior interventions, the mean time since the most recent intervention was 19.4 months (range: 1.8-80.9 months). Mean preoperative knee flexion and extension values for the cohort were 76.5 ± 17.4 and 5.4 ± 6.5 degrees, respectively, and the total mean ROM was 71.9 ± 21.5 degrees. The mean intraoperative knee extension was 0.6 ± 1.7 degrees, and knee flexion was 101.5 ± 19.2 degrees, with the mean total ROM of 105.6 ± 12.9 degrees. These were all significantly improved compared with preoperatively. Postoperative improvements in knee ROM were significant at all time points compared with preoperative values, with mean improvements of 17.2 ± 16.3 degrees at 1 week ($P = .022$), 17.2 ± 13.2 degrees at 4 weeks ($P = .001$), 19.2 ± 16.0 degrees at 8 weeks ($P = .004$), and 25.2 ± 13.1 degrees at 12 weeks ($P = .005$) (Table 2). Improvements in knee flexion were also significantly improved compared with preoperatively at all time points, with changes of 14.7 ± 15.5 degrees ($P = .005$) at 1 week, 14.4 ± 14.3 degrees ($P = .005$) at 4 weeks, 17.0 ± 14.9 degrees ($P = .006$) at 8 weeks, and 24.2 ± 13.2 degrees ($P = .006$) at 12 weeks (Fig. 1). There was no significant difference in knee extension at any time point postoperatively ($P > .05$). There was a general trend in the initial postoperative period toward a decrease in ROM from that obtained intraoperatively. At week 1, patients experienced a mean −7.1 (±12.6) degree decrease in the ROM and mean −7.5 (±11.0) degree decrease at 4 weeks. These differences, however, were not statistically significant with P values of .130 and .094, respectively (Table 2). There were no complications recorded. No associations

Table 1
Patient characteristics.

Parameter	Value
Sex, male (%)	6 (46.2%)
Smoker, n (%)	3 (23.1%)
Previous interventions, median (min-max)	1 (0-3)
Time since TKA (months), mean ± SD	57.2 ± 58.1
Age at scope (years), mean ± SD	61.7 ± 9.1
BMI, mean ± SD	28.0 ± 2.5
ASA status, median (min-max)	2 (2-3)
Charleston comorbidity, median (min-max)	2 (0-4)
Preoperative extension, mean ± SD	−4.6 ± 6.1
Preoperative flexion, mean ± SD	76.5 ± 17.4

BMI, body mass index.

Table 2
Follow-up ROM vs preoperative and intraoperative ROM.

Time post-op	△ROM vs preoperative Mean ± SD	*P*	△ROM vs intraoperative Mean ± SD	*P*
1 Week	17.2 ± 16.3	.002[T1]	−7.1 ± 12.6	.130[T1]
4 Weeks	17.2 ± 13.2	<.001[T1]	−7.5 ± 11.0	.094[T1]
8 Weeks	19.2 ± 16.0	.004[T1]	−2.1 ± 5.6	.320[T1]
12 Weeks	25.2 ± 13.1	.005[T1]	−1.0 ± 10.8	.841[T1]

[T1], One-sample *t*-test.

were found between patient demographics, prior interventions, implant design or knee balancing technique, or time from the index TKA and improvements in knee ROM. Two patients underwent subsequent revision arthroplasty after arthroscopic LOAs, one for stiffness and one for loosening.

Discussion

Arthrofibrosis is a well-known complication after TKA, occurring in approximately 1.3%-5.2% of surgical patients [5,6]. As the population continues to age and the number of TKAs performed each year grows, cases of arthrofibrosis will also increase. A nuanced understanding of optimal treatment strategies for post-TKA arthrofibrosis is therefore needed. We performed a retrospective review of patients who underwent arthroscopic LOAs for late-presenting or treatment-refractory arthrofibrosis and found significant improvements in ROM even out to 17.5 years after index TKA.

While the functional impact of arthrofibrosis on patients is well agreed upon, there are many definitions of arthrofibrosis in the literature. Laubenthal et al. [12] studied the minimum degree of knee flexion required to perform ADLs. They determined that individuals require a minimum of 83 degrees of knee flexion to walk upstairs, 84-88 degrees of knee flexion to walk downstairs, and 93 degrees of knee flexion to sit in a chair, suggesting that at least 90 degrees of flexion is required for ADLs. As such, we chose to define arthrofibrosis as a functional loss of ROM (ie, flexion <90 degrees), which is consistent with other studies [6,13,14]. Limitations in knee extension can also pose significant challenges for patients. A loss of only 5 degrees of extension has been shown to cause patellofemoral pain and limping, a loss of 10 degrees has been associated with activity limitations, while a flexion contracture in excess of 20 degrees can result in a functional leg length discrepancy [15-17].

Arthrofibrosis is most commonly treated with a combination of a closed MUA and physical therapy. A closed MUA has the best efficacy when performed within 3 months of the index procedure, achieving double the gain in flexion compared with beyond 3 months [8,18]. A number of studies have evaluated the increase in ROM and flexion after MUA, citing increases in total ROM of 32-47 degrees [6,13,19] and increases in flexion of 26-33 degrees [20,21]. Arthroscopic LOA is an additional treatment modality. Adhesions often form at predictable locations within the knee, including the anterior interval, infrapatellar fat pad, pretibial recess, and between the capsule and femoral condyles [22]. These can be readily accessed through standard arthroscopy portals. Tjoumakaris et al. demonstrated an average improvement of knee ROM of 36 degrees after an arthroscopic LOA in a cohort of patients who had failed a closed MUA. [23] Additional studies have also supported the role of arthroscopic LOAs in the stiff TKA [11,22,24,25]. Volchenko et al. [26] performed a matched-cohort study of 70 total patients with post-TKA arthrofibrosis. One cohort was treated with a closed MUA alone and another with an arthroscopic LOA combined with MUA. They reported that the addition of an arthroscopic LOA resulted in a significantly improved percentage increase in knee ROM (49.1% vs 31.4%, $P = .026$) and final knee flexion (91.3 degrees vs 80.9 degrees,

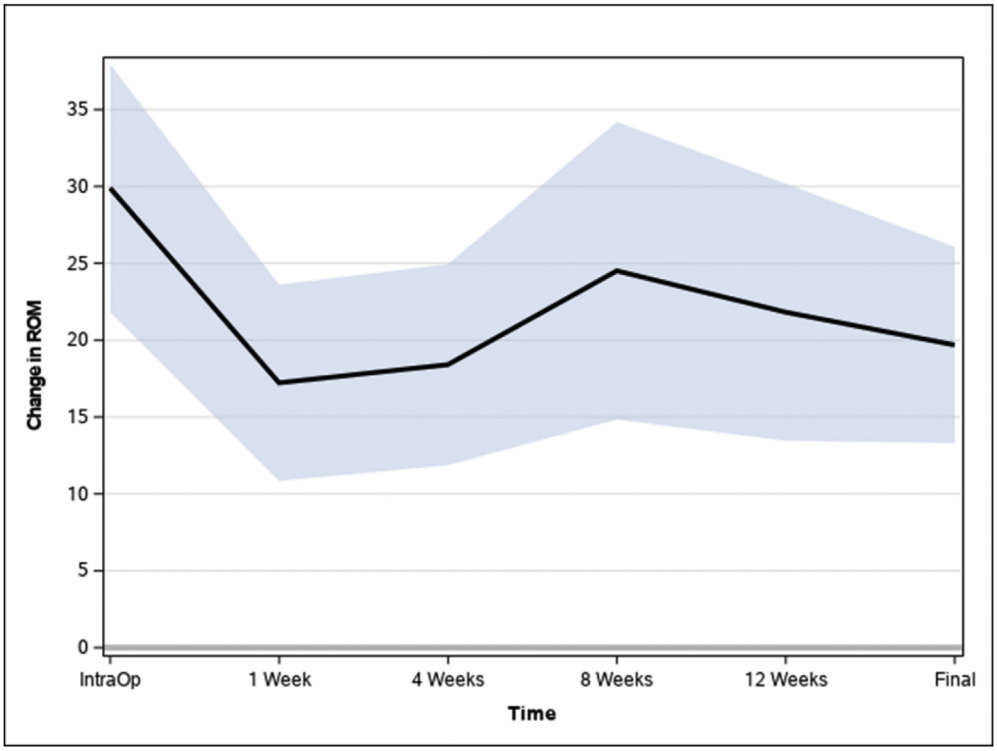

Figure 1. Change in ROM from preoperatively. Change in ROM ± standard deviation (shaded) compared with ROM preoperatively.

$P = .028$) [26]. In their systematic review of treatment of post-TKA arthrofibrosis, Fitzsimmons et al. [27] found similar gains in knee ROM after an arthroscopic LOA with or without closed MUA. Our findings corroborate prior data that indicate arthroscopic LOA is a successful treatment option for postarthroplasty arthrofibrosis.

There are 2 unique aspects of our study population. First, there was an extended period of time between the index TKA and eventual treatment at our institution for this cohort. On average, patients in our study underwent arthroscopic LOA 57.2 months after their index TKA. The majority of prior studies which have investigated arthroscopic LOA with or without closed MUA for arthrofibrosis have included patients within 1 year from index TKA [11,23-26]. Volchenko et al. did report a diminished benefit of arthroscopic LOA + MUA when performed later from index TKA; however, this was stratified at the 12-week postoperative mark [26]. Second, 10 of the 13 patients in our study had undergone prior interventions for arthrofibrosis including closed MUAs, open LOAs, and revision TKA. Despite their delayed presentation and failure of prior treatments, patients in our study experienced significant improvements in both knee flexion and ROM at the time of final follow-up, with no association identified between prior treatments or time from the index TKA and improvements in ROM. This suggests that arthroscopic LOA with closed MUA can be an effective salvage operation in cases of arthrofibrosis, which fail alternative intervention strategies and/or present late in the postoperative period from the index TKA.

Patient pain and discomfort after surgery can present significant barriers postoperatively, allowing for the reformation of scar tissue and resulting in diminished knee motion compared with that achieved in the operating room [28]. We noted a trend toward diminished ROM, compared with intraoperative values, during the first 4 weeks after surgery (Table 2). This trend highlights the importance of an appropriate postoperative physical therapy program and pain control modalities, which was a key component of our treatment strategy.

Our study cohort did not experience any complications. Although arthroscopy is minimally invasive, this procedure does carry associated risks, which should be considered before surgery. These risks can include infection, damage to the prosthesis, hemarthrosis, extensor mechanism injury, fracture, and neurovascular injury [29]. Closed MUA also carries risks including periprosthetic fracture and extensor mechanism disruption, which are amplified when manipulation is undertaken outside of 12 weeks from the index TKA [9].

Our study has several limitations. First, the size of the cohort is small with follow-up of less than 1 year, limiting the power of our statistical analysis. Without long-term follow-up, we are unable to be certain that stiffness did not recur in some patients; nonetheless, prior studies have not found significant differences between ROM at early follow-up after MUA and final follow-up [6]. Second, the retrospective nature of the study inhibits the ability to obtain uniform metrics and design a protocol to optimally evaluate outcomes. Measurement of patient outcomes outside of the arc of knee motion, such as pain and functional outcome scores, would be a valuable addition to future research. Finally, there was no control group undergoing MUA alone, or any other treatment modality, against which to compare our results.

Conclusions

Knee arthrofibrosis after TKA poses a difficult challenge to clinicians, with no literature consensus on optimal treatments and a paucity of literature on management for patients who present in a very delayed fashion or have failed prior surgical interventions. Our findings support the combination of an arthroscopic LOA with MUA as a salvage option for the treatment of late-presenting or treatment-refractory arthrofibrosis.

Conflict of interest

The authors declare there are no conflicts of interest.

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