Original Article

Arthroscopic Debridement After Total Knee Arthroplasty Is More Effective for Synovitis Than for Ankylosis

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Purpose: To investigate the effects of arthroscopy surgery on ankylosis and synovitis after total knee arthroplasty (TKA), with patient satisfaction as the main outcome measure. **Methods:** A single surgeon's database was queried for all knee arthroscopy procedures done from 2002 to 2024 using the *International Classification of Diseases, Ninth* and *Tenth Revision*, codes for ankylosis or synovitis and Current Procedural Terminology codes 29884 and 29876. Patients were excluded if they did not have a previous TKA, had a TKA but arthroscopy was done for multiple or other indications, were <2 months from TKA, lacked medical records, or were worker's compensation cases. Patients were separated into either the ankylosis group or the synovitis group. A patient satisfaction survey was collected at first and last follow-up and asked individuals to rate their condition as "better," "unchanged," or "worse" after arthroscopy. A total of 199 subjects were included: 48 in the ankylosis group and 151 in the synovitis group. **Results:** The mean initial follow-up time was 5.2 and 7.2 months for the ankylosis and synovitis groups, respectively. The mean final follow-up time was 3.7 and 4.8 years, respectively. For initial follow-up, the ankylosis group reported 31% better, 56% unchanged, and 13% worse, whereas the synovitis group reported 69% better, 29% unchanged, and 2% worse ($P < .001$). For final follow-up, the ankylosis group reported 44% better, 41% unchanged, and 15% worse, whereas the synovitis group reported 78% better, 10% unchanged, and 12% worse ($P < .001$). **Conclusions:** After TKA, arthroscopic surgery can reduce symptoms and improve satisfaction for patients with ankylosis or synovitis. Patient satisfaction is improved in a greater percentage of patients with synovitis compared with ankylosis. **Level of Evidence:** Level III, retrospective, comparative study.

Total knee arthroplasty (TKA) is a common and successful procedure for end-stage osteoarthritis management, with an 80% to 90% success rate.[1,2] However, roughly 10% to 20% of patients develop postoperative symptoms.[1-3] Severe symptoms may include infection or loosening requiring revision. Lesser symptoms that often limit patient function include stiffness, pain, mechanical symptoms, and swelling.[4-10] There are 2 general types of TKA implants: posterior stabilized and posterior cruciate sparing. Although one type does not generally predispose a patient to develop stiffness, there is a greater incidence of a subset of mechanical symptoms called patellar clunk syndrome, which occurs more commonly in posteriorly stabilized TKAs.[11,12]

Postoperative arthroplasty symptom diagnosis and management can be problematic.[1] Common diagnostic interventions are limited to synovial fluid analysis, radiographs, computed tomography scans, nuclear medicine scans, or magnetic resonance imaging. Knee arthroscopy is a useful tool when diagnostic studies lack conclusive results, often identifying and treating etiologies related to pain and stiffness.[5,13] Knee arthroscopy yields advantages over a repeat open procedure including reduced risk of infection, reduced risk of wound healing complications, reduced risk of stiffness, and more rapid recovery. A manipulation under anesthesia may result in improved range of motion. Furthermore, by directly visualizing the joint, surgeons can identify and address specific pathologies, including synovitis, stiffness, patellar clunk syndrome, patellar maltracking, adhesions,

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metallosis, loose bodies, benign tumors, and loose or damaged components.[5,14]

Previous studies have assessed the outcomes of arthroscopy post-TKA for stiffness and synovitis.[5,11-20] The incidence of synovitis is not well reported in the literature, but the incidence of the patellar clunk subset is between 0% and 12%, and the incidence of stiffness is between 3% and 6%.[11,12,15,21-23] One study reported on 75 knees in 68 patients with an average 4.2-year follow-up.[11] This study assessed risk factors for developing patellar clunk syndrome and the outcomes of arthroscopic management.[11] A study analyzing arthroscopy for post-TKA stiffness had a sample size of 19 patients.[19] Most studies have focused on a single pathology type or a mixture of pathologies, with no direct comparison between ankylosis and synovitis.[5,18] Previous research has also not had consistent, systematic use of viewing and working portals.[5,14]

This study identified 2 large cohorts that underwent arthroscopy after TKA to address either ankylosis or synovitis. The purpose of this study was to investigate the effects of arthroscopy surgery on ankylosis and synovitis post-TKA, with patient satisfaction as the main outcome measure. It was hypothesized that surgical intervention for ankylosis or synovitis, post-TKA, would improve patient satisfaction and quality of life, with patients with synovitis having better outcomes than those with ankylosis.

Methods

Institutional review board approval (TOH247e) was obtained for this retrospective study. One surgeon's (H.E.) comprehensive 22-year (January 2002 to January 2024) patient database was queried for Current Procedural Terminology (CPT) codes 29884 and 29786 (lysis of adhesions and synovectomy of 2 or more compartments, respectively) with an *International Classification of Diseases, Ninth Revision* (ICD-9) or *Tenth Revision* (ICD-10) code for ankylosis (718.56 or M24.661/M24.662) or synovitis (727 or M65.851/M65.852). To be included, patients must have not responded at least 2 months of conservative treatment, including physical therapy and oral medications. These patients were given the option to accept their condition or consider arthroscopy. Patients were excluded if they did not have a previous TKA, underwent arthroscopy for multiple or other indications (e.g., open peroneal nerve release, open iliotibial band release, arthroscopic popliteus tendon release), were <2 months from TKA, lacked medical charts, and or were using worker's compensation. Thus, 87 patients were excluded (Appendix Table 1, available at www.arthroscopyjournal.org) and 199 were included for analysis.

Patients were classified as either having ankylosis (n = 48) or synovitis (n = 151). All patients were initially defined as having either ankylosis or synovitis prospectively on the basis of clinical presentation, including history and examination. On the basis of this initial assessment, patients were assigned an ICD-9 or ICD-10 code for ankylosis (718.56 or M24.661/M24.662) or synovitis (727 or M65.851/M65.852). This was then reassessed at the time of surgery on the basis of the examination under anesthesia and the findings during arthroscopy, and the CPT code 29884 or 29876 was assigned. Finally, these designations were subsequently confirmed with a retrospective chart review. Our criteria were rigorous and in-line with previous literature (see below).

All patients with ankylosis were defined as follows:

1. Stiffness was the chief complaint of the patient and the main reason to opt for surgery.
2. Flexion 90° or less or a 10° flexion contracture was an absolute criterion. Flexion less than 100° if combined with other criteria on this list on the basis of surgeon determination.
3. Stiff on examination under anesthesia at the time of surgery and underwent manipulation under anesthesia.
4. Thick hypertrophic capsular tissue identified at the time of surgery as the primary pathology.

All patients with synovitis were defined as follows:

1. None complained of stiffness, and none were manipulated.
2. All patients had synovial hypertrophy along the walls of the capsule with no pathologic capsular thickening.

Patient age, sex, surgical variables (surgical side, arthroscopy date, previous TKA date and primary or revision status, follow-up dates, CPT codes, ICD-9/10 codes), and patient satisfaction (Table 1), prospectively at the first follow-up visit and retrospectively at the final follow-up, were collected for all included patients.

Patient-reported outcome data were collected prospectively at the first arthroscopic follow-up and retrospectively for patients to reflect on their procedure and its effectiveness (Table 1). At the first arthroscopic follow-up, patients were asked, "Consider your pain and function before surgery. How were you after surgery?" with the option to reply "better," "the same," or "worse." Patient retrospective surveys were completed through text messaging and e-mails. These digital surveys asked the same question, in addition to "Was it worth it for you to have done the arthroscopic surgery?" (yes or no), as well as the Single Assessment Numeric Evaluation (SANE) Score Survey.[24]

Surgical Technique

All arthroscopy procedures were conducted consistently and systematically. All knees were examined under anesthesia. Manipulation was only performed if

Table 1. Custom First and Final Follow-Up Survey Questions

First Follow-Up Survey	Retrospective Final Follow-Up Survey
Consider your pain and function before surgery. How were you after surgery? a. Better than before surgery? b. The same as before surgery c. Worse than before surgery	Consider your pain and function before surgery. How were you after surgery? a. Better than before surgery? b. The same as before surgery c. Worse than before surgery Was it worth it for you to have done the arthroscopic surgery? a Yes b. No SANE - How would you rate your knee, which underwent arthroscopy, today as a percentage of normal (0% to 100% scale with 100% being normal)?

NOTE. The left column includes the question asked to all patients at first follow-up. The right column includes the 3 questions captured at final follow-up. Answer options are included for each question.

SANE, Single Assessment Numeric Evaluation (Knee).

the surgery was specifically intended to address stiffness. Arthroscopy was performed using established portals, including superomedial inflow, anterolateral viewing, anteromedial working, and superolateral working and viewing portals (Fig 1 A and B). Debridement of hypertrophic synovium or tissue was carried out using a 5.0-mm aggressive shaver. A complete synovectomy or capsulectomy was performed, with adjustments made to viewing and working positions as noted below. Patients with stiffness were treated with manipulation under anesthesia, lysis of adhesions, or capsular excision. Patients with mechanical symptoms, swelling, or pain were managed with extensive debridement of the synovium and capsule.

Surgical Technique: Patients With Ankylosis

After manipulation under anesthesia, the knee was prepared and draped in sterile fashion. A superomedial inflow portal was established (Fig 1 A and B). The cannula was used to sweep the suprapatellar pouch to disrupt any adhesions.

An anterolateral viewing portal was subsequently established. Superolateral and anteromedial portals were established under direct vision. The typical finding was a smooth capsule, either white or red in color if inflamed. A 5.0 aggressive shaver was used in each of these 2 working portals to initiate a capsulectomy and lysis of any adhesions. A capsulectomy would reveal a dense thick capsule. The superolateral portal was used to excise the capsule and adhesions in the suprapatellar pouch and lateral gutter (Fig 1 C and D). The anteromedial portal was used to initiate the excision of the capsule and adhesions of the notch and medial gutter. Once work through these portals had been exhaustively completed, the arthroscope was moved to the superolateral portal (Fig 1B).

With the arthroscope in the superolateral portal, visualization was improved to allow access to the rest of the medial and lateral gutters and the anterior capsule. A complete capsulectomy of the anterior, medial, and lateral compartments was concluded with the shaver placed in the anteromedial and anterolateral portals. Care was taken to do a complete anterior capsulectomy without violating the patellar tendon (Fig 1 E-G).

Surgical Technique: Patients With Synovitis

The knee was examined under anesthesia, but no manipulation was performed. The same pattern of portals was established (Fig 2 A and B).

There was typically a mass of tissue at the junction of the quadriceps insertion and the superior border of the patella component (Fig 2C). This was easily accessed for debridement through the superolateral portal. The superolateral portal was then used to excise any further synovial or capsular hypertrophy in the suprapatellar pouch and lateral gutter (Fig 2D). The anteromedial portal was used to initiate excision of synovial or capsular hypertrophy in the notch and medial gutter (Fig 2E). Once work through these portals had been exhaustively completed, the arthroscope was moved to the superolateral portal (Fig 1B or 2B).

With the arthroscope in the superolateral portal, visualization was improved to allow access to the rest of the medial and lateral gutters and the anterior joint space and notch. Synovectomy was completed with the shaver placed in the anteromedial and anterolateral portals (Fig 2 D, E, and F). Care was taken to do a complete anterior capsulectomy without violating the patellar tendon. There was often hypertrophic synovium in the notch on the posterior border of the anterior capsule that was visualized and debrided.

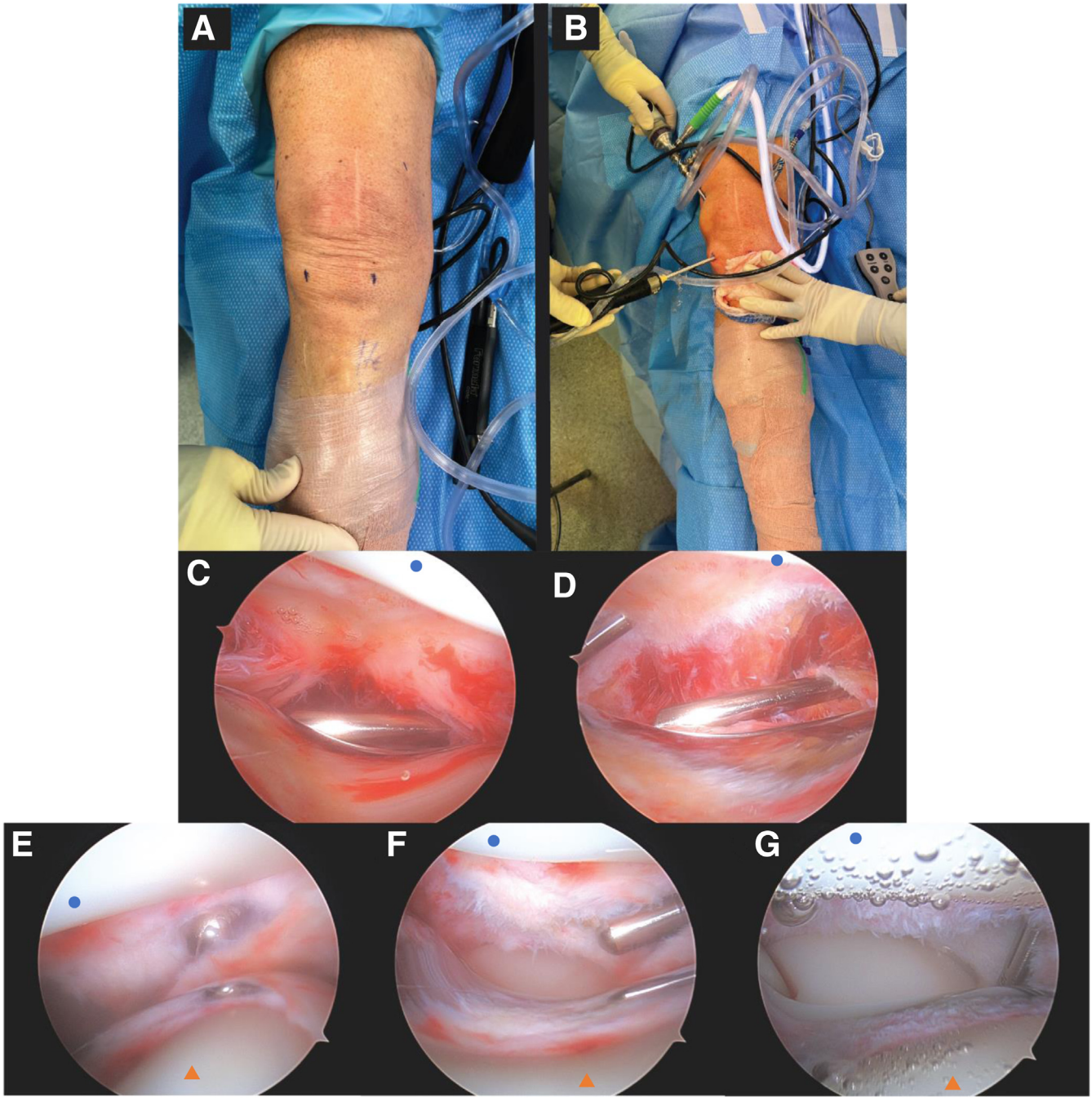

Fig 1. Portal placement and arthroscopic imaging for patients with ankylosis. Note that the patella and tibial tray have been identified with a blue circle and an orange triangle, respectively. (A) Outside view of a right knee with portal sites marked on the skin. (B) Outside view of a right knee showing the camera in the superolateral portal and shaver in the anterolateral portal. (C) Right knee view from the anterolateral portal. Capsular thickening and synovial hyperemia in a patient with ankylosis are shown. (D) Right knee view from the anterolateral portal. Near completion of resection of suprapatellar capsular thickening and adhesions in a patient with ankylosis are shown. (E) Superolateral view in the right knee of anterior capsular thickening in a patient with ankylosis. (F) The right knee view from the superolateral portal during the process of resection of the thickened anterior capsule. (G) The right knee view from the superolateral portal after resection is complete.

Postoperative Protocol

All patients were managed postoperatively with an acceptable approach as the standard of care. All patients were weight-bearing as tolerated immediately and allowed to start range of motion immediately. All patients with ankylosis were immediately sent to physical therapy 5 days per week for 2 weeks, then 3 days per week for 2 weeks, followed by 2 days per week for 8

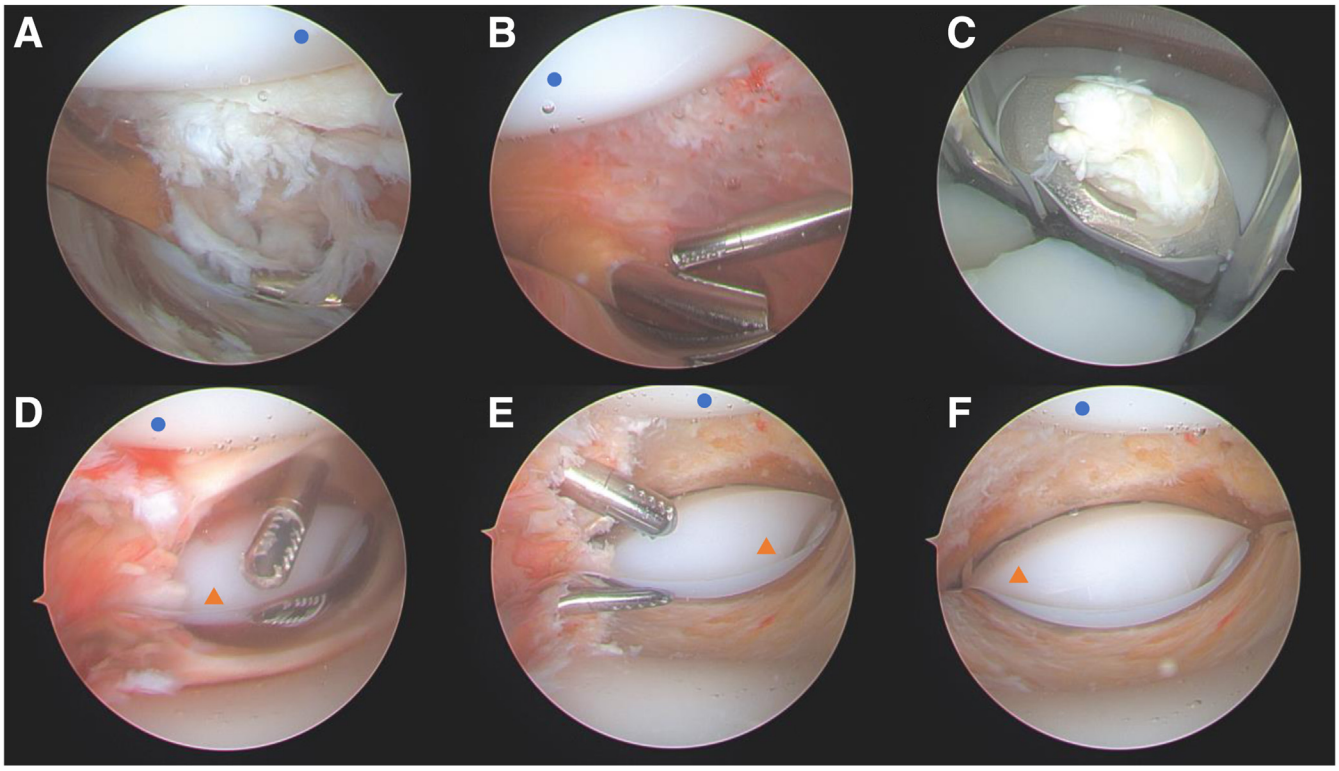

Fig 2. Portal placement and arthroscopic imaging for patients with synovitis. Note that the patella and tibial tray have been identified with a blue circle and an orange triangle, respectively. (A) Left knee view from the anterolateral portal. Soft-tissue hypertrophy on the undersurface of the distal quadriceps at the superior pole of the patella in a patient with synovial hypertrophy without ankylosis is shown. (B) Left knee view from the anterolateral portal post resection of suprapatellar soft tissue. Inflow cannula in the superomedial portal is shown, and shaver is in the superolateral portal. (C) Left knee view from the anterolateral portal. Fibrinous tissue in the notch in a patient with synovial hypertrophy without ankylosis is shown. (D) Left knee view from the superolateral portal. The shaver is in the anteromedial portal before resection. (E) Left knee view from the superolateral portal. Resecting capsular hypertrophy using shaver in the anterolateral portal is shown. (F) Left knee view from the superolateral portal. Postresection of anterior capsular thickening is shown.

weeks. A continuous passive motion machine was used in all patients when approved by insurance. Strengthening was initiated immediately, but the focus was on range of motion. All patients with synovitis were managed with a home exercise program, which involved heel slides, quadriceps sets, straight leg raises, and calf pumps for 6 to 12 weeks without formal physical therapy. Statistical significance was determined by either the χ^2 test or Student t test, assessed at a value of $P < .05$.

Results

Study Population

In total, 286 cases were identified. Eighty-seven were excluded, leaving a total of 199 subjects included in this study. Forty-eight were in the ankylosis group and 151 in the synovitis group (Fig 3, Appendix Table 1, available at www.arthroscopyjournal.org). Patient demographics are shown in Table 2. Patients with synovitis were statistically older ($P = .002$) and had a greater primary-to-revision ratio ($P = .007$).

Intraoperative Findings

Qualitatively, the typical findings for the patients with ankylosis were a thick capsule along all of the walls of the joint space, including the suprapatellar pouch, the medial and lateral gutters, and the anterior capsule, posterior to the patellar tendon. The typical findings for the synovitis group were a more pliable, thinner capsule with hypertrophic soft synovium on the undersurface of the quadriceps, the medial and lateral gutter walls, and in the notch along the posterior aspect of the anterior capsule.

Prospective First Follow-Up Survey

The 48 patients in the ankylosis group responded to the first satisfaction survey with a mean follow-up time of 5.2 ($\sigma \pm 12$) months. The 151 patients with synovitis responded to the first satisfaction survey with a mean follow-up time of 7.2 ($\sigma \pm 18$) months. A summary of

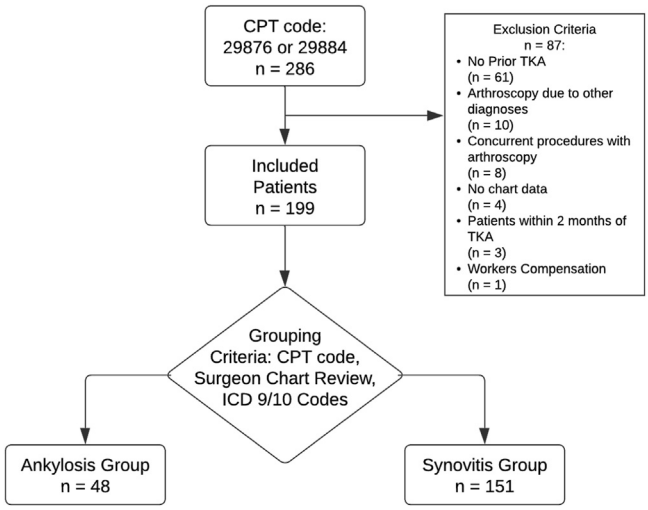

Fig 3. Patient inclusion flowchart. This flowchart highlights the number of patients initially identified (n = 286), with exclusion criteria and total number of patients excluded (n = 87). Included patients (n = 199) were separated into ankylosis (n = 48) and synovitis (n = 151) groups based on CPT code, ICD-9/10 codes, and surgeon chart review. (CPT, Current Procedural Terminology; ICD-9/10, *International Classification of Diseases, Ninth* and *Tenth Revisions*; TKA, total knee arthroplasty.)

the patient satisfaction survey results is shown in Table 3 and Appendix Table 2 (available at www.arthroscopyjournal.org).

Retrospective Arthroscopy Survey

Of the 48 patients with ankylosis, 32 (67%) responded with a mean time after arthroscopy of 3.7 ($\sigma \pm 2.2$) years. Of the 151 patients with synovitis, 102 (68%) patients responded with a mean time after arthroscopy of 4.8 ($\sigma \pm 3.0$) years. A summary of the patient satisfaction survey results is in Table 4, Appendix Table 3, and Appendix Fig 1 (available at www.arthroscopyjournal.org). The change of response from the first prospective follow-up survey to the retrospective survey is highlighted in Figure 4 .

Table 2. Group Demographics

	Ankylosis n = 48	Synovitis n = 151	*P* Value
Age, yr	62.9 ± 6.5	66.4 ± 8.3	**.002**
Sex, male/female	19/29	43/108	.148
Average TKA to arthroscopy, yr	1.9 ± 2.3	2.4 ± 2.4	.281
Median TKA to arthroscopy, yr	1.1	1.5	—
TKA to arthroscopy range, yr	0.2-11.7	0.3-13.6	—
Bilateral arthroscopy	(n = 0)	(n = 5)	—
Repeat arthroscopy	(n = 3)	(n = 7)	—
Primary/revision	34/14	132/19	**.007**

NOTE. Demographics with patients with ankylosis compared with synovitis highlight significant differences in age and proportion of revisions while also including bilateral procedures, repeat procedures, sex, and TKA to arthroscopy time analyses. *P* values in bold are statistically significant.

TKA, total knee arthroplasty.

Table 3. Arthroscopic First Follow-Up Patient Satisfaction Survey Results

	Ankylosis Group n = 48	Synovitis Group n = 151	*P* Value
Average time to first follow-up, mo	5.2 ± 12	7.2 ± 18	.370
Median time to first follow-up, mo	2.0	2.0	—
Time to first follow-up range, mo	0.3-81.2	0.3-123	—
Better	15	104	**< .001**
Same	27	44	**< .001**
Worse	6	3	.739

NOTE. Ankylosis and synovitis group comparisons for first follow-up time and survey answers. *P* values in bold are statistically significant.

Discussion

The results confirm our hypothesis that arthroscopic surgery post-TKA for ankylosis and synovitis will improve patient symptoms and satisfaction, with a significantly larger portion of patients with synovitis reporting symptom improvement compared with patients with ankylosis (Tables 3 and 4, $P < .001$). Improvement was sustained over many years for both groups, with patients with synovitis showing greater rates of satisfaction (Table 4).

At final follow-up, 85% of patients with ankylosis felt better or the same, and SANE scores were 58.3 (Fig 4, Table 4). These findings are consistent with or slightly worse than the literature. In 2017, Bodendorfer et al.[21] retrospectively assessed 18 patients who underwent arthroscopic lysis of adhesions on average 117 days after TKA. Mean improvements at final follow up of 1 year and 3 months were 6.1° of extension, 29.45° of flexion, and a 32.3% improvement in Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) scores.[21] In 2013, Schwarzkopf et al.[19] found a greater than 20° increase in range of motion with associated increases in Knee Society Score and WOMAC scores at average 21-month follow-up. The average time from TKA to arthroscopy was not documented, but the criterion for surgery was failure of 3 months of conservative treatment. In 2019, Volchenko et al.[17] compared improvements in range of motion in 70 patients with arthrofibrosis who underwent either manipulation under anesthesia alone or with arthroscopic lysis of adhesions. They found increased total range of motion and improved flexion in the patients who had both manipulation under anesthesia and arthroscopic lysis of adhesions. In particular, they found greater improvements in both groups when the procedure was within 4 to 12 weeks of index TKA.[17] In our

Table 4. Final Retrospective Arthroscopic Patient Satisfaction Survey Results

	Ankylosis Group n = 32	Synovitis Group n = 102	*P* Value
Average follow-up, yr	3.7 ± 2.2	4.8 ± 3.0	**.023**
Median follow-up, yr	3.4	4.1	—
Range follow-up, yr	0.9-8.8	0.4-13.6	—
Better	14	80	**< .001**
Same	13	10	.308
Worse	5	12	.083
Final SANE score	58.3 ± 23.7	75.5 ± 25.5	**< .001**
Was arthroscopy worth doing? Yes/no	20/12	85/17	**< .001**

NOTE. Shown are ankylosis and synovitis group comparisons for final follow-up time and survey answers. SANE scores and arthroscopy worth questions are also noted for statistical significance. *P* values in bold are statistically significant.

SANE, Single Assessment Numeric Evaluation (Knee).

study, the time from TKA to arthroscopy for ankylosis or stiffness was 1.1 years. This may account for the worse results compared to the literature.

At final follow-up, 88% of patients with synovitis felt better or the same with a final SANE score of 75.5 (Fig 4, Table 4). These findings are consistent with the literature. In 2017, Gholson et al.[12] found that 3.1% of a cohort of 1488 TKAs developed patellar clunk syndrome. Eighteen of the 46 cases elected to proceed with arthroscopic debridement. At a mean 5.1-year follow-up, 79% of patients rated themselves as very satisfied or extremely satisfied. Mean knee society scores were 92.4, and mean WOMAC scores were 82.9.[12] In 2014, Costanzo et al.[11] compared the outcomes of 75 knees in 68 patients who underwent arthroscopy for patellar clunk syndrome with a control group. The results showed no difference in WOMAC, SF-12 mental, and SF-12 physical scores at 4.2 years.

Hou et al.[18] in 2020 assessed 74 patients with peripatellar impingement (35), arthrofibrosis (25), and generalized synovitis (14). With a mean follow-up time of 81.3 months, range of motion and Knee Society Scores improved for all groups, but the greatest improvement occurred in the peripatellar impingement group and the worst improvement occurred in the generalized synovitis group.[18]

In this study, more patients in the synovitis group stated that the arthroscopy had been worth trying. In both groups, however, some patients who did not improve still thought arthroscopy was worth trying (Table 4, Appendix Table 4, available at www.arthroscopyjournal.org). This may reflect their understanding of the diagnostic nature of the procedure or their desire to avoid revision arthroplasty.

The 2 groups in this study were similar in terms of sex and time from TKA to arthroscopy (Table 2). However, the patients with ankylosis were significantly younger than those with synovitis and had a greater percentage of revisions. These 2 factors suggest that this subset of patients may have other variables such as greater activity levels, greater expectations, or previous trauma or surgery that resulted in early TKA that could result in a poor outcome.

In this study, a consistent and detailed 4-portal arthroscopy technique for patients post-TKA is described. The use of a superolateral viewing portal is critical to ensure a complete assessment and synovectomy or capsulectomy for both indications.[13,14] Viewing from the superolateral portal allows visualization of pathology that is difficult to see or access as compared to a standard 2-portal technique. The need for accessory portals has been previously documented and expanded on in this study.[5]

Limitations

Regarding the limitations of this study, there is no effective control group since these patients have already tried physical therapy and oral medications. All patients chose arthroscopy because the alternative treatment had failed. This includes 8 patients in the ankylosis group (17%) who had not responded to previous manipulation under anesthesia between the primary TKA and the arthroscopic procedure. The fact that these patients had already failed a previous attempt to improve motion suggests a structural issue that is unlikely to be corrected with arthroscopic intervention and may require revision of the implants. The data collection was retrospective, and only one patient-reported outcome was collected. This was done to increase the patient response rate. Despite this, not all patients responded to the final retrospective survey, which could introduce sampling bias in the results. As with all retrospective surveys, recall bias may occur. All patients belong to one surgeon, which could introduce bias regarding a generalizable patient population. The postoperative protocol regarding physical therapy was different for both groups. No physical follow-up was done, and no range of motion measurements were obtained.

Conclusions

After TKA, arthroscopic surgery can reduce symptoms and improve satisfaction for patients with ankylosis or

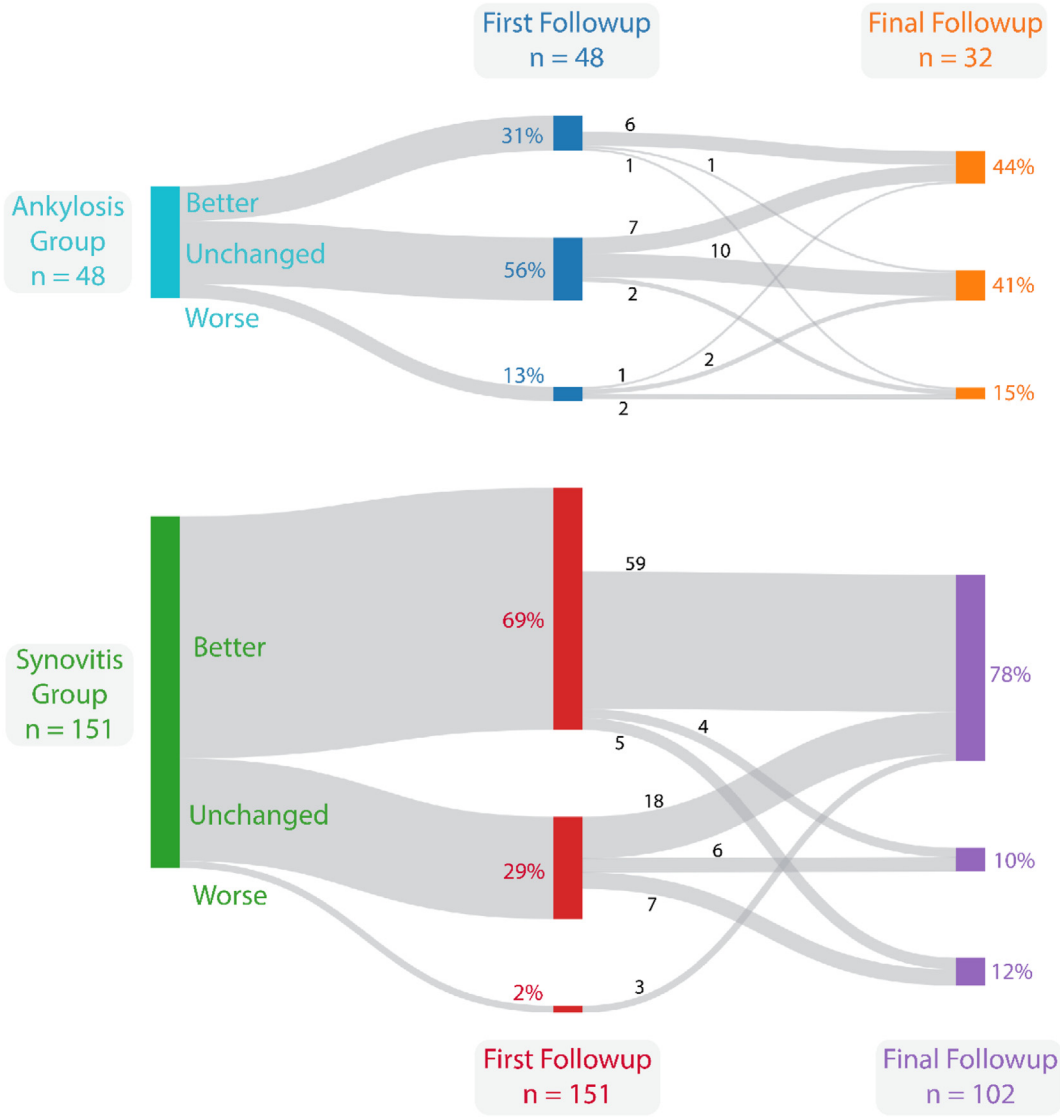

Fig 4. A Sankey diagram of ankylosis and synovitis after arthroscopy recovery flow. Groups begin this Sankey diagram at the left (ankylosis = light blue, synovitis = green), and on the basis of their first follow-up answer (better = top, unchanged = middle, worse = bottom), flow to the middle group, which describes percentages for symptom improvement. Then, patients with a final follow-up survey flow to the group on the right, which again describes their symptom improvement at their most recent follow-up point (individual counts = black).

synovitis. Patient satisfaction is improved in a greater percentage of patients with synovitis compared with ankylosis.

Disclosures

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: The Fondren Orthopedic Research Institute at the Texas Orthopedic Hospital supported a portion of the study team. All authors (H.E., D.K.F., L.E., M.R., A.N.P., and C.F.H.) declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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