An Arthroscopic Treatment Regimen for Osteoarthritis of the Knee

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Purpose: The purpose of this study was to evaluate the functional and subjective outcomes of patients with moderate to severe osteoarthritis of the knee who underwent a comprehensive arthroscopic treatment regimen. **Methods:** Between August 2000 and November 2001, 69 knees in 61 patients were treated with an arthroscopic regimen. Inclusion criteria included severe osteoarthritis and a minimum 2-year follow-up. Arthroscopic treatment included joint insufflation, lysis of adhesions, anterior interval release, contouring of cartilage defects to a stable rim, shaping of meniscus tears to a stable rim, synovectomy, removal of loose bodies, and removal of osteophytes that affected terminal extension. Exclusion criteria included the treatment of chondral defects with microfracture. Failure was defined as knees requiring arthroplasty because this was what patients were trying to avoid. **Results:** The average patient age was 57 (range, 37-78), with 35 men and 26 women. Patients had an average of 1.5 previous surgeries (range, 0-12). The average preoperative Lysholm score was 49 (range, 14-79). On average, knees were insufflated with 170 mL of lactated Ringer's solution (range, 120-240). Nine knees failed, with survivorship of 83% at 3 years. At an average follow-up of 31 months (range, 24-41), the average Lysholm score was 74 (range, 37-100), with an average improvement of 25 points. The average Tegner score was 4 (range, 0-8). Average patient satisfaction was 8 (range, 1-10). The average Western Ontario and McMaster University Osteoarthritis Index (WOMAC) pain score was 4 (range, 0-14), WOMAC stiffness was 2 (range, 0-4), and WOMAC function was 11 (range, 0-44). Independent predictors of improvement in Lysholm score included a shift in the weight-bearing axis and preoperative Lysholm score. **Conclusions:** This arthroscopic treatment regimen can improve function and activity levels in patients with moderate to severe osteoarthritis. Of 69 patients, 60 (87%) patients had a satisfactory result. However, in this group of 60, 11 patients needed a second procedure, resulting in a 71% satisfactory result after 1 surgery. **Level of Evidence:** Level IV, therapeutic case series. **Key Words:** Osteoarthritis—Arthroscopic treatment—Outcomes—Malalignment.

Arthroscopic procedures have been commonly performed for osteoarthritis of the knee, but the efficacy of such procedures remains unclear. Numerous studies have suggested their benefit[1-6]; however, other studies have documented modest and even minimal rates of improvement.[7-10] The variety of techniques and the different methods of assessment that have been used make comparison of studies difficult. Recently, the usefulness of arthroscopy for the degenerative knee has been challenged.[10]

Although arthroplasty provides predictable results for advanced degenerative joint disease of the knee, many patients seek to avoid or delay this surgery because they wish to maintain a high level of activity.

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Furthermore, the increased morbidity of these procedures and the limited lifetime of joint replacements make these procedures less desirable for some patients.

Many of the arthroscopic studies have used techniques that include lavage, debridement, and abrasion arthroplasty.[1-3,5-8,10-15] However, these studies have not emphasized increasing joint volume and treating capsular contracture. Furthermore, most of these studies have not emphasized the role of postoperative rehabilitation.

We hypothesized that in knees with severe osteoarthritis increasing joint volume with arthroscopy and maintaining it with rehabilitation would provide symptomatic relief by relieving joint-contact pressures. The purpose of the present study was to investigate the functional and subjective outcome of a comprehensive arthroscopic treatment and physical therapy regimen when applied to patients with severe osteoarthritis of the knee.

METHODS

Patient Selection

Between August 2000 and November 2001, 865 knee arthroscopies were performed by the senior author (J.R.S.). Our study group was composed of patients who underwent comprehensive arthroscopic treatment of their knee for generalized knee osteoarthritis. Each patient had failed a conservative treatment and was sent to the senior author (J.R.S.) for arthroscopic consideration. Typical conservative regimens included at least one of the following: activity modification, anti-inflammatory medications, physical therapy, weight reduction, viscosupplementation, oral glucosamine, or corticosteroid injections. Post-traumatic arthritis was included. Inclusion criteria included patients with a Kellgren-Lawrence radiographic grade of 3 or 4. Patients had to have an abnormal (moderate) or severely abnormal (severe) radiographic grade according to the International Knee Documentation Committee (IKDC). Patients with diffuse chondral damage who were not microfracture candidates were included in this study. Exclusion criteria included knees with traumatic chondral lesions, mild osteoarthritis (Kellgren-Lawrence grade 0-2), or incomplete radiographic studies. Patients with normal alignment and adequate cartilage rim surrounding the defect who underwent microfracture for chondral damage were also excluded. Seventy-four patients (82 knees) met these criteria.

Radiographic Analysis

The following radiographic studies were obtained of the knee: weight-bearing anteroposterior (AP) films with the knee in extension; weight-bearing posteroanterior films with the knee at 45° of flexion; lateral views; patellar views at 30° and 60° of flexion; and a long-standing lower-extremity view to include the pelvis, hip, knee, and ankle. We graded the degree of osteoarthritis by the radiographic definition of the IKDC, which is used by the International Cartilage Repair Society Cartilage Injury Evaluation Package. To be included in this study, patients had to have an abnormal (moderate) or severely abnormal (severe) IKDC radiographic grade. Moderate grade is defined as small osteophytes, slight sclerosis, and joint space narrowing (e.g., a joint space of 2-4 mm or up to 50% joint-space narrowing). Severe changes include sclerosis, osteophytes, and a joint space of less than 2 mm or greater than 50% joint-space narrowing. We also graded the degree of osteoarthritis by examining the AP knee films as described by Kellgren and Lawrence[16] (Table 1). In 1961, the Kellgren-Lawrence grading system was accepted by the World Health Organization as the gold standard for cross-sectional and longitudinal epidemiologic studies of the knee.

We determined the lower-extremity mechanical axis on the long-standing films. A line from the center of the femoral head to the center of the ankle joint was drawn. A 0° mechanical axis was defined as intersecting the center of the knee joint. A shift in the mechanical axis (SMA) was calculated as the ratio of the distance between the center of the knee joint to the point the axis intersected the knee and the width of the compartment through which the axis crossed. Therefore, if the axis intersected the edge of the joint, the shift was calculated as 100%. The hip-knee-ankle (HKA) angle was used as another marker of the mechanical axis and

TABLE 1. *The Kellgren Lawrence Scale*

Grade	Description
0	Normal
1	Doubtful narrowing of joint space and possible ostophytic lipping
2	Definite osteophytes and possible narrowing of joint space
3	Moderate multiple osteophytes, definite joint-space narrowing, some sclerosis, and possible deformity of bony ends
4	Large osteophytes, marked joint-space narrowing, severe sclerosis, and definite deformity of bony ends

was defined as the angle between a line from the center of the femoral head to the center of the knee joint and a line from the center of the knee joint to the center of the ankle. The femorotibial angle was also calculated and defined as the angle between the anatomic axes of the femur and tibia. We measured the joint space height in millimeters of the medial and lateral compartments on both the AP extension and posteroanterior flexion views by using electronic calipers at the compartment's narrowest point. All measurements were made by 1 orthopaedic surgeon. This was performed twice, and the reliability of the measurements was adequate.

Surgical Procedure

The comprehensive arthroscopic regimen consisted of distinct steps. The procedures were performed after general anesthesia or after a spinal anesthetic was administered. A tourniquet was rarely used. Initially, joint insufflation with lactated Ringer's solution was performed via intra-articular injection by using a superolateral injection site. The joint capsule was stretched with sequential insufflation and aspiration. Care was taken to avoid rupturing the capsule.[4] An attempt to introduce 180 mL of fluid was made.

Subsequent to the insufflation, a superomedial inflow portal was established followed by an anterolateral viewing portal and anteromedial working portal. Joint lavage of approximately 250 mL was performed followed by the removal of loose bodies. Unstable meniscus tears and loose or unstable chondral flaps were resected with motorized shavers and manual instruments. The preservation of meniscus tissue was prioritized. A partial synovectomy was performed by using radiofrequency ablation if synovitis was present. Lysis of adhesions within the suprapatellar pouch was performed to improve joint volume (Fig 1). Care was taken to maintain capsular integrity. Particular attention was given to release adhesions that tethered the extensor mechanism. A scar or plica in the anterior interval, the space between the patellar tendon and the anterior tibia, was released by using radiofrequency ablation (Fig 2). Osteophytes were removed if they involved the intercondylar notch and limited extension. Hemostasis throughout the procedure was considered essential and was achieved with electrocautery.

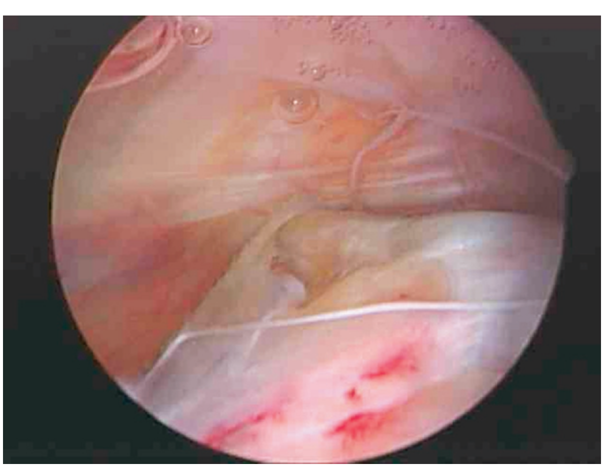

Figure 1. Adhesions within the suprapatellar pouch.

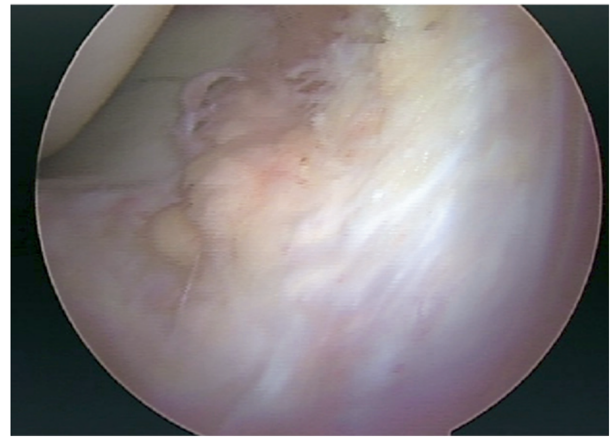

Figure 2. Scar to be removed from the anterior interval, the space between the patellar tendon and the anterior tibia.

Postoperative Care

The principal goals of the rehabilitation program included the maintenance of joint volume and the prevention of scar reformation while preserving joint mobility.[17] Regaining strength was secondary to these goals. Throughout the rehabilitation program, exercises that elicited pain were strictly avoided. The postoperative regimens were specifically tailored to each patient.

In general, patients recovering from this treatment package progressed through a 3-phase rehabilitation protocol. The initial phase was characterized by passive and active-assisted range of motion exercises and stretching exercises. Patients were treated with protected weight bearing, which included the use of crutches, for the initial 1 to 2 weeks after surgery. Continuous passive motion machines were used during the first postoperative week. Extensor mechanism mobilization exercises including patellar and patellar tendon mobilization were central to the rehabilitation protocol. Strength exercises included quadriceps and hamstring sets as well as heel and toe raises. Stationary bicycling exercises helped sustain flexibility while improving muscle tone. Patients proceeded with caution while stretching to avoid joint inflammation and pain.

During the next phases, the static strength training, stretching, and cardiovascular exercises from the initial phase were continued during this phase, and additional exercises were sequentially added. After approximately 6 weeks, phase 2 began with a goal of achieving functional strength. Treadmill walking on an incline, elastic resistance exercises, and one-third knee bends were started. A 7% to 12% incline minimizes patellofemoral contact stresses and is beneficial to the soft tissues and muscles of the knee.[18] Deeper bends place significant stress on the intra-articular surfaces and were avoided. If pain was encountered during any of these exercises, then the patient resumed training at a level that did not produce pain. Phase 3 began at approximately 3 months after surgery, with goals of advanced strengthening and return to sport. At 4 months, weight-training exercises were begun as was running, outdoor biking, and golf (if possible). After 5 months, patients resumed activities such as skiing and tennis.

Outcome Analysis

At the initial presentation, all patients completed a self-administered questionnaire. Postoperatively, the patients completed the same questionnaire for the evaluation of symptoms, function, and satisfaction. Patient satisfaction questions were graded on a 10-point ordinal scale (1 = dissatisfied and 10 = satisfied). All data were obtained and maintained prospectively in a clinical database. The Lysholm score was calculated preoperatively and at the latest follow-up.[19] At follow-up, patients also completed the Tegner Activity Level and the Western Ontario and McMaster University Osteoarthritis Index (WOMAC).[20,21] Clinical failure was defined as the need for total knee replacement during the follow-up period.

Statistical Analysis

Improvement in the Lysholm score was determined by using paired *t* tests. The comparison of Lysholm improvement for binary categorical variables was performed by using the independent samples *t* test and for multiple (>2) categorical variables was performed by using 1-way analysis of variance. The comparison of Lysholm improvement for continuous variables was performed by using the Pearson correlation coefficient. Comparisons between categorical variables were performed by using Fisher' exact test. To determine independent predictors of improvement in the Lysholm score, multivariate analysis was performed by using a linear regression model with backward selection. Survivorship data were calculated with the use of the method of Kaplan and Meier. Statistical analysis was performed by using an SPSS (version 11.0; SPSS, Chicago, IL) software package. All reported P values are 2 tailed, with an alpha level of 0.05 indicating statistical significance.

RESULTS

Of the 73 patients (82 knees), 2 patients were deceased, 1 patient refused to participate, and 9 patients were lost to follow-up, leaving a study group of 61 patients (69 knees). Of the bilaterals, 2 patients had bilateral surgery on the same day, and 2 had the surgeries staged. The mean age of the study group was 57 years (range, 37-78 years). There were 35 men and 26 women. Each patient had been advised by his/her referring physician that he/she was a candidate for total knee replacement. Prior surgeries were reported in 47 (68%) knees, with 22 having 1 previous surgery, 16 having 2 previous surgeries, and 9 having 3 or more previous surgeries for an average of 1.5 surgeries per knee.

At arthroscopy, 6 knees had a documented anterior cruciate ligament rupture, 5 knees had an absent anterior cruciate ligament, and 1 knee had an absent posterior cruciate ligament. No other ligament pathology was noted. The results of other surgical findings are shown in Table 2. On average, knees were insufflated with 171 mL (range, 120-240) of sterile lactated Ringer's solution. Normal knees usually accept 180 mL of solution.[4] Male knees had a higher volume compared with female knees (177 *v* 164, $P = .031$).

Radiographic findings for the 69 knees are shown in Table 3. There was no significant difference between the medial joint-space height between the extension and flexed knee views. However, there was a significant difference between views for lateral joint-space height ($P = .012$). Men had a significantly higher HKA angle compared with women (5.5 *v* 3.2, $P < .05$). Men also had a higher average SMA compared with women (46% *v* 26%, $P < .05$).

Of the 69 knees, 9 (13%) were considered failures. The average survivorship at 1 year was 100%, 94% at 2 years, and 83% at 3 years. Patients who failed were significantly older (64 years) than the nonfailure group

Table 2. *Findings at Arthroscopy in 69 Study Knees*

Findings	Number of Knees
Medial compartment (1 compartment) OA*	19 (19 grade 4 lesions)
Lateral compartment (1 compartment) OA	8 (8 grade 4 lesions)
PF compartment (1 compartment) OA	4 (4 grade 4 lesions)
Lateral and medial compartment (2 compartment) OA	4 (3 medial grade 4 lesions and 4 lateral grade 4 lesions)
Lateral and PF compartment (2 compartment) OA	4 (4 lateral grade 4 lesions and 1 grade 4 patellar femoral lesion)
Medial and PF compartment (2 compartment) OA	16 (14 medial grade 4 lesions and 11 grade 4 patellar femoral lesions)
Lateral, medial, and PF compartment (3 compartment) OA	14 (11 medial grade 4 lesions, 9 grade 4 lateral lesions, and 12 grade 4 patellar lesions)
Lateral meniscus pathology requiring shaving/partial excision	17
Medial meniscus pathology requiring shaving/partial excision	26
Loose bodies	14
Synovitis	46
Adhesions	69

Abbreviations: OA, osteoarthritis; PF, patellofemoral.
*Osteoarthritis was defined at grade 3 and 4 changes on the chondral surfaces of the compartment.

(55 years, $P = .019$). Patients who failed did not have lower preoperative Lysholm scores. There was no relationship between failure and preoperative radiographic findings. Knees that failed did have a lower insufflation volume (163 mL) compared with nonfailures (173); however, this was not significant. There was no association between meniscus pathology requiring treatment and failure ($P = .586$). Failure was related to the presence of 4 chondral "kissing" lesions ($P = .049$). Of the patients with bilateral surgeries, 2 of the 4 failed and required bilateral knee replacements.

Table 3. *Radiographic Findings*

	N	Avg	Range
HKA angle	69	4.55	0 to 17
SMA	69	38.79	0 to 129
FT angle	69	6.1	1 to 16
AP extension view Medial joint-space height (mm)	69	3.3	0 to 10
AP extension view Lateral joint-space height (mm)	69	6.04	.4 to 10.5
PA 45° flexion view Medial joint-space height (mm)	58	3.4	0 to 8.10
PA 45° flexion view Lateral joint-space height (mm)	58	4.5	0 to 11.3

Abbreviations: PA, posteroanterior; FT, femorotibial; HKA, hip-knee-ankle; SMA, shift in mechanical axis.

Table 4. *Descriptive Statistics of Study Population at the Final Follow-Up*

Variable*	Mean	Range
Number of Knees = 83		
Follow-up (mo)	31	24-41
Preoperative Lysholm	49	14-79
Postoperative Lysholm†	74	37-100
Lysholm improvement	25	−8 to 68
Postoperative Tegner	3.7	0-8
Patient satisfaction	7.8	1-10
WOMAC pain	3.9	0-13
WOMAC stiffness	2.1	0-7
WOMAC function	11.4	0-44
WOMAC total	16.5	0-61

*Lysholm, a knee-specific score, on a scale of 1 to 100 (best = 100). Tegner, an activity score, on a scale of 1 to 10 (best = 10).
†At a P value of $<.05$, these changes between preoperative and final follow-up scores were significant.

The average follow-up on the 60 nonfailure knees was 31 months (range, 24-41). The outcome scores are summarized in Table 4. There was no significant relationship in any outcomes measured and gender. When comparing knees that had meniscus pathology requiring treatment to those without it, no differences were noted in outcomes measured. There was no difference in postoperative Lysholm scores, Tegner scores, WOMAC scores, or satisfaction by the number of degenerative compartments. There was also no difference in postoperative Lysholm scores, change in Lysholm scores, Tegner scores, WOMAC scores, or satisfaction between patients with meniscus pathology and those without.

Patient satisfaction was correlated with postoperative Lysholm scores ($P = .001$, $r = 0.49$) and total WOMAC scores ($P = .001$, $r = -0.61$). Postoperative Lysholm scores were also correlated with the SMA ($P = .02$, $R = -0.31$) but not with the HKA angle. Knees with >50% shift in their mechanical axis had an average postoperative Lysholm score of 67, whereas those knees with <50% shift in their mechanical axis had a postoperative Lysholm score of 77 ($P = .013$). Both groups improved over 20 points relative to their preoperative Lysholm scores. Postoperative Lysholm scores were significantly correlated with the flexed-view medial joint-space height (P = .045, R = 0.285) but with no other joint-space measurements. The IKDC radiographic grade or the Kellgren-Lawrence score were also not associated with any outcomes measured. Multivariate analysis showed preoperative Lysholm score as a positive predictor and SMA as a negative predictor of improvement in Lysholm score (r^2 = 0.36).

Additional Surgical Procedures

Of the 60 nonfailures, 11 (18%) had subsequent arthroscopic treatment during the follow-up period. The patients who underwent repeat arthroscopy had higher postoperative Lysholm scores and patient satisfaction, but these differences did not reach statistical significance. This subgroup of patients also had significantly lower WOMAC physical function scores (P = .0001).

DISCUSSION

In the present study, an arthroscopic treatment regimen that focused on increasing joint volume followed by a rehabilitation program aimed at maintaining volume and joint mobility improved function in patients with severe knee osteoarthritis. There is a desire among many patients to delay arthroplasty to allow certain recreational goals as well as to avoid the morbidity associated with such surgery. Arthroscopic surgery is typically characterized by low morbidity and does not preclude future reconstructive procedures, thereby making it an attractive surgical option. However, controversy persists about the effectiveness of arthroscopic treatment of the degenerative knee.

Previous authors have advocated a variety of arthroscopic procedures for degenerative arthritis of the knee. Livesley et al[13] compared arthroscopic lavage and physiotherapy with physiotherapy alone and found better pain relief with the combination treatment. Edelson et al[11] documented pain relief after arthroscopic washout in osteoarthritic knees at 1 and 2 years after lavage. Hubbard[22] showed in a prospective fashion that arthroscopic debridement was superior to lavage for the treatment of medial femoral condyle articular degeneration. A variety of studies have shown that arthroscopic debridement can successfully relieve the symptoms of osteoarthritis at rates greater than 60%.[2,3,5,6,14] However, a more recent study has suggested a much lower success rate,[7] and another study has proposed that improvements after arthroscopic debridement were equivalent to placebo.[10]

Our surgical and rehabilitation approach emphasizes increasing joint volume by addressing joint contracture and intra-articular adhesions. Joint contracture has been associated with the development of osteoarthritis, pain, and loss of motion.[23] Joint contracture has also been associated with increased capsular stiffness and decreased volume.[24] Intra-articular adhesions have been experimentally shown to increase joint reactive forces.[25] Furthermore, increased joint pressures have been postulated to result in pain.[26,27] Specifically, contracture in the peripatellar tissues and infrapatellar space has been recognized as a cause of pain and arthrosis.[28,29] Therefore, by improving joint volume and treating joint adhesions, we hoped to decrease joint contact pressures and relieve pain. Our surgical technique focused on the release of adhesions throughout the joint but especially in the suprapatellar pouch and the anterior interval, the area between the patellar tendon and anterior tibia. Careful intraoperative hemostasis and a structured postoperative rehabilitation program were used to maintain the intraoperative volume and mobility gains.

By using the senior author's technique, a relatively high success rate was found for treating knees with severe osteoarthritis. Significant improvements in the Lysholm score were found, with an average improvement of 25 points. However, a failure rate of 13% was noted, and an additional 18% of patients required reoperation. Our series exclusively studied those patients with severe osteoarthritis. Uniformly poor results have been reported for the arthroscopic treatment of knees with severe osteoarthritis as defined by radiographic parameters and intraoperatively noted chondral degeneration. Results have been so poor that severe arthritis has been considered a contraindication to arthroscopy.[3,6-8,14] Yang and Nisonson[6] reported a success rate of 36% in a subgroup of patients with severe osteoarthritis, whereas Baumgaertner et al[7] noted a success rate of 33% in a similar subgroup.

Knee malalignment has been considered a relative contraindication to arthroscopic management of knee osteoarthritis, but our study shows functional improvement in knees with significant angular deformity. Multiple authors have recommended against arthroscopic treatment of knees with malalignment.[2,7,14,15] For example, Baumgaertner et al[7] reported a success rate of 26% in patients with malalignment. The average mechanical axis of our patient population intersected the knee 39% from the center of the knee. Even though a higher SMA was an independent negative predictor of Lysholm score, patients who showed a shift of greater than 50% (i.e., the mechanical axis fell within the inner half of the medial compartment or the outer half of the lateral compartment) had significant gains in their Lysholm score.

Meniscus pathology has been suggested as a predictor of a positive clinical outcome after arthroscopy for degenerative knee disease.[8,14] Arthroscopic partial meniscectomy of unstable meniscus tears has been shown to have moderate rates of success in degenerative knees, although these rates are lower than those achieved in knees without osteoarthritis.[30-33] In our study, 35 of 69 knees (51%) had meniscus pathology requiring treatment, and 9 knees (13%) had meniscus pathology that did not require treatment. This rate of meniscus injury is similar to a prevalence of 63% unstable meniscus tears noted by Dervin et al.[8] Despite the similar prevalence, we did not show meniscus pathology to be correlated with outcome.

There was a moderate failure rate in our study because 13% of the cohort underwent knee arthroplasty during the follow-up period. Age and the presence of "kissing" grade 4 chondral degeneration correlated with failure. Furthermore, a trend was noted in the amount of fluid insufflated in the nonfailure knees versus those that failed. This volume difference may reflect the degree of capsular contracture present in those knees that failed. A failure was defined as knee arthroplasty because the patients' goals were to avoid arthroplasty. Eighteen percent of the patients did require repeat arthroscopy. By study definition, these were not considered a failure, even though they were reoperations. The additional arthroscopies were required to help the patients meet their expectations of function and activity levels. Further follow-up will be required to determine how long patients maintain the benefits after the second arthroscopy.

There were a few limitations of our study. This is a retrospective analysis of prospectively collected data, with no control group. The intermediate nature of follow-up coupled with the modest failure rate raises concerns about the durability of the procedure. We intend to follow this cohort of patients to further assess the success of our treatment regimen. This study did not evaluate patients based on body mass index or the presence of mechanical symptoms. These factors have been associated with outcome after treatment of the degenerative knee by arthroscopy.[6,7,14] Finally, enlisting a larger number of consecutive patients would lower the risk of underpowering the study.

CONCLUSIONS

This arthroscopic and rehabilitation regimen improved function of the arthritic knee. Knee function and activity levels improved in patients with moderate to severe osteoarthritis. Of 69 patients, 60 (87%) patients had a satisfactory result. However, out of this group of 60, 11 needed a second procedure, resulting in a 71% satisfactory result after 1 surgery.

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