Single-Portal Versus Two-Portal Knee Arthroscopy: First Clinical Experience With a New Surgical Technique

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the introduction of the arthroscope for treatment of knee disorders revolutionized the surgical approach for many patients. This procedure requires adequate fluid inflow and outflow, visualization with an arthroscope, and triangulation of working instruments through 2 or more portals.

New designs in fiber optics, digital image transmission, high-definition monitors, and fluid inflow pumps have improved efficiency and visualization during arthroscopic surgery. However, many basic aspects of knee arthroscopy have remained unchanged since 1972. There is a need for triangulation and intra-articular convergence of instruments through at least 2 portals. In 1977, O’Connor reported the use of an “operating arthroscope” designed to allow passage of a working instrument through the same portal as the scope. This was similar to cystoscopy instrumentation and was not designed for a single-portal technique.

Single-port laparoscopy was developed to reduce morbidity as a result of abdominal surgery. With a similar goal, a new single-portal arthroscopy technique with instrumentation has been reported. Surgical instruments with designs similar to previous instruments generally receive Food and Drug Administration approval through the process known as 510K, where the safety profile is considered similar to that of the existing approved instrument.
Such was the case for these instruments. However, to more rigorously evaluate patient safety as well as the clinical efficacy of this method, a study was performed with approval of the institutional review board of a university hospital system.

This prospective study included 156 patients. The morbidity and complications associated with the new single-portal arthroscopy technique were compared with those of a standard 2-portal arthroscopy technique. The hypothesis was that the 2 techniques would have similar morbidity and complications and that the single-portal technique would be technically feasible.

**Materials and Methods**

*Study Design*

Institutional review board approval was obtained, and all patients provided informed consent. A prospective study was performed of 156 patients who underwent arthroscopic knee surgery. Of these, 106 patients had surgery with a traditional 2-portal technique with a modern mechanical fluid pump. The other 50 patients had surgery with the new single-portal technique and the same fluid pump. The patients in the single-portal group were the first 50 patients ever treated with this technique. The 2 groups were not concurrently studied or randomized. Rather, the study groups were collected longitudinally by performing all procedures in the 2-portal group first as a control group and then performing single-portal arthroscopy on all patients in the single-portal group as a subsequent series of cases with similar pathology and similar indications once the instrumentation was commercially available. Based on a preliminary power study, the author intended to compare 100 patients treated with the 2-portal technique with 50 patients treated with the single-portal technique. However, the staff enrolled an additional 6 patients treated with the 2-portal technique, and the statistician recommended inclusion of all 106 patients rather than exclusion of the additional 6. Inclusion criteria were meniscus tear, chondral lesion, loose body, and synovial lesion.

Exclusion criteria were obesity, reconstructive procedures, lateral retinacular release, advanced osteoarthritis, revision, and microfracture. All patients of both sexes were between the ages of 18 and 64 years. Patient demographics and pathologies were carefully assessed by the statistician and were not significantly different. In both groups, the most common diagnosis was meniscus tear. Meniscectomy was the most common primary procedure.

One surgeon (D.E.C.) performed all procedures in both groups. Surgical treatment of pathology, prescribed medications, and the rehabilitation protocol were no different between the 2 groups. All portals were injected with 0.5% bupivacaine, and no knee was injected with corticosteroids. The 2-portal group had surgery with horizontally oriented, approximately 8-mm medial and lateral infrapatellar portals under tourniquet control and using a mechanical pump (Arthrex, Naples, Florida), a 4.0×160-mm arthroscope, and a 5.8-mm arthroscope cannula (Stryker Endoscopy, San Jose, California). The single-portal group underwent surgery with a single horizontally oriented 8- to 9-mm medial infrapatellar portal under tourniquet control and using the same pump (Arthrex), a new 2.9-mm HD Ideal Eyes arthroscope (Stryker Endoscopy), and a 4.6-mm arthroscope cannula (Stryker Endoscopy). Only the technique of entry into the knee joint differed between the 2 groups.

**Single-Portal Arthroscopic Surgical Technique**

A previous report described the positioning, instrumentation, and technique of single-portal knee arthroscopy. This procedure was performed with a new 2.9-mm high-definition arthroscope in the 4.6-mm cannula and a parallel sliding, rotating, and locking 4.2-mm cannula that assembles to the arthroscope cannula (Figures 1-4). New powered cutters that are proximally bent...
(Figures 3-4) (Stryker Endoscopy) and low-profile manual biters (Shutt; ConMed Linvatec, Largo, Florida) were used. This technique allows the triangulation point to be moved outside the knee joint with the arthroscope and instruments in parallel entry into the joint, easing the traditionally difficult aspect of arthroscopic triangulation.

Postoperative Management

All patients underwent outpatient surgery and were treated with the same postoperative protocol. A compressive elastic bandage was placed over a sterile dressing, and an inexpensive cryotherapy gel pack was applied. All patients had identical exercise instruction before discharge and were seen by a physical therapist twice weekly until they were doing well and were independent with exercises. Patients without allergy were prescribed a combination hydrocodone 5 mg and acetaminophen 325 mg analgesic for pain. Patients were asked to rate their pain and keep track of analgesic use.

Follow-up

All patients were evaluated at the following postoperative intervals: 1 week, 1 month, and 3 months. Patients completed a preoperative questionnaire to assess symptoms and function levels (Figure 5). At each interval of follow-up, all patients were examined by the treating surgeon or physician assistant and also completed questionnaires (Figures 6-7). Complications and adverse findings on examination were documented. Patient questionnaires gathered data on pain, drainage, complications, narcotic use, portal fibrosis or tenderness, popping, swelling, and function in daily activities and participation in sports. Follow-up was 100%.

Disclosure

The surgeon investigator is a consultant to the manufacturer of the instruments for single-portal arthroscopy and has a financial conflict of interest. This information was disclosed to the institutional review board, and the study was designed to minimize the possibility of bias. The institutional review board accepted this situation because the inventing surgeon was the only surgeon familiar enough with the instruments and technique to perform the surgery to ensure maximum patient safety. The surgeon was blinded to data collection and analysis, which was performed by an independent university research institute statistician who was blinded to patient encounters. Patients were not blinded, for obvious reasons. No sham portals were created.

Statistical Analysis

A power study was performed and estimated that the sample size was sufficient to detect a 20% difference in responses (2/10 on a visual analog scale) between the 2 groups, with alpha of 0.05 and power of 0.8. One-way analysis of variance, Student’s t test, chi-square test, and Wilcoxon/Kruskal-Wallis tests were applied with JMP, version 10.0, statistical software (SAS Institute, Cary, North Carolina).

RESULTS

Patient demographics, including age, weight, height, and comorbidities, were carefully assessed by the statistician and were not statistically different. All of the study participants were healthy, nonobese patients between 18 and 64 years old who were seen in a sports medicine practice. As previously stated, surgical indications and inclusion/exclusion criteria were no different in the 2 groups, and the groups were as similar in demographics, pathology, and indications as was possible in this type of study. The severity of preoperative symptoms was no different in the 2 groups, as determined by the preoperative questionnaire.

Postoperative Pain

There was no difference between groups in reported pain level in the recovery room or on day 2, but the single-portal group reported less pain on day 4 ($P=.0437$) and day 7 ($P=.0043$). Patients in the single-portal group were also less likely to use narcotics for pain relief (Figure 8). In addition, 42% of patients in the single-portal group reported no narcotic use after leaving the surgical facility compared with 10% of patients in the 2-portal group ($P=.0001$) (Figure 9).
Swelling

One month after surgery, patients in the single-portal group reported less swelling than those in the 2-portal group ($P=.02$).

Activity

One month after surgery, the single-portal group reported significantly less interference with function in activities of daily living ($P=.0367$) (Figure 10). In addition, at 3 months, these patients had less interference with sports participation compared with the 2-portal group ($P=.0355$) (Figure 10).

Tenderness

Three months after surgery, patients in the single-portal group reported less portal scarring and tenderness compared with the 2-portal group ($P=.0311$).

Drainage

More portals drained in the 2-portal group, but this difference was not significant (Figure 11).

Complications

No significant difference was found in the rate of complications or adverse events, although trends were detected and an isolated adverse event occurred. One procedure in the single-portal group was converted to a 2-portal procedure to adequately address the pathology. One patient early in the single-portal series had portal drainage after snow skiing at 10 days postoperatively. The portal popped open when the patient hyperflexed the knee in therapy. A secondary infection ensued 2 weeks later. This patient underwent another arthroscopic procedure with 2 portals for lavage and was excluded from further follow-up as part of the single-portal group because of the second surgery and the use of a 2-portal technique. Even when this case was included in the single-portal group, however, there was a trend toward increased portal drainage in the 2-portal group. However, neither the infection rate nor the trend toward portal drainage in the 2-portal group was statistically significant (Figure 11).

## Discussion

Few studies have reported morbidity related to the portal sites. However, each portal has the potential for drainage, stitch abscess, fibrosis, and tenderness that can contribute to postoperative morbidity. Portal fibrosis peaks at 6 months postoperatively and resolves in only 50% of cases at 1 year postoperatively, as determined by magnetic resonance imaging. A previous study showed that 2-portal knee arthroscopy improved recovery of knee strength and time to return to work by more than half compared with a 3-portal technique. This is the first study to report clinical experience, safety, efficacy, morbidity, and complication rates related to knee arthroscopy with a new single-portal technique. The new single-portal technique warrants investigation in an institutional review board–supervised clinical study to ensure patient safety. This report of morbidity, complication rates, and early experience with the technique is of importance to surgeons who may consider adopting this technique for their patients.

In 49 of 50 patients, knee joint pathology was treated to the surgeon’s satisfaction, with outcomes similar to those with a mul-
tiportal technique (Figure 12). In 1 patient, the procedure was converted to a 2-portal technique to adequately treat the pathology. This patient had a difficult medial meniscus tear with a tight medial compartment, and completion of the procedure with the use of 2 portals was difficult as well.

The single-portal technique was feasible in treating numerous conditions of the knee, including meniscus tears, chondral lesions, loose bodies, and synovial plicae. The findings showed that this technique may lead to less pain, less narcotic use, and improved short-term morbidity and functional parameters at 1 and 3 months postoperatively. An advantage of the 2-portal technique was that the pathology was adequately treated in all cases. However, when the 2-portal group was compared with 49 of 50 single-portal cases in which pathology was adequately treated, the data showed no trend or significant finding favoring the 2-portal technique. There can be criticism that the power study and statistical analysis were performed on nonvalidated patient assessments of morbidity and therefore could lead to invalid conclusions. This possibility is acknowledged, but validated outcomes measures make no effort to assess portal site tenderness and drainage, and the assessment in some categories was very objective. There is strong evidence that the single-portal group used less narcotic analgesic medication than the 2-portal group.

The case complicated by portal drainage and infection merits further discussion. Any such complication is a concern. This was a noncompliant patient who went snow skiing 10 days after surgery and began draining. However, the rate of portal drainage was higher in the 2-portal group, and the difference between the groups was not statistically significant.

**Study Strengths**

This study had several strengths: (1) It was the first clinical study of this new technique, and it emphasized patient safety. (2) It was a prospective institutional review board–supervised Level II study.
that included both objective and subjective measures. (3) Importantly, it compared the morbidity and complication rates associated with a new technique with those of a current, widely used technique. (4) It used questionnaires that specifically addressed common perioperative morbidity and complications that occur in the first 3 months after arthroscopic knee surgery. (5) The surgeon was blinded to data collection and analysis, and the statistician was blinded to patient encounters.

Study Limitations
Weaknesses of this study included a minimum follow-up of less than 2 years and the use of nonvalidated questionnaires. This was not a long-term outcomes study, and the short follow-up was justified because this study reported the morbidity and complications associated with the first clinical experience with a completely new technique. It was imperative to evaluate patient safety and the feasibility of the technique compared with the 2-portal technique that was previously the standard procedure. Because arthroscopic treatment of pathology was no different between the study groups and only the surgical approach differed, the short follow-up to gauge the morbidity of surgical access to the joint can be justified. Although the questionnaires have not been validated, they included many of the parameters and visual analog scales used by validated outcomes measures as well as assessments specific to arthroscopic surgery portals. Therefore, long-term outcomes measures are not appropriate to assess the short-term morbidity and complications associated with a new surgical method.

Conclusion
The current study found that single-portal arthroscopy was a technically feasible procedure. Both techniques provided appropriate treatment of pathology in almost all cases, but the single-portal technique may need to be converted to the 2-portal technique on occasion. Compared with knee arthroscopy performed with 2 portals, the current findings suggest that single-portal arthroscopy leads to less morbidity and improved functional recovery at 1 month and 3 months postop.

Figure 9: Patient-reported narcotic use after surgery. The single-portal (SPA) group took fewer narcotic analgesics (P < .0001).

Figure 10: Significant differences were found between the single-portal (SPA) and 2-portal groups in some quality of life assessment parameters at 1 and 3 months postoperatively (P < .05).

Figure 11: Portal drainage. More portals drained in the 2-portal group than in the single-portal (SPA) group, but the difference was not significant.
eratively in some but not all parameters, as reported by patients. The potential benefits of this technique warrant further independent study with longer follow-up and validated outcomes measures. This study provides evidence of patient safety and useful data on the clinical efficacy of this technique.

**REFERENCES**


![Figure 12: Before (A) and after (B) single-portal arthroscopic treatment of a medial meniscus tear in a right knee. These images show the ability to adequately treat pathology with this new technique.](image)