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Partial meniscectomy using needle arthroscopy associated with significantly less pain and improved patient reported outcomes at two weeks after surgery: A comparison to standard knee arthroscopy

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ABSTRACT

Purpose: to compare immediate post-operative pain and patient-reported outcomes (PROs) after partial meniscectomy with needle (NA) vs. standard (SA) arthroscopy technique.
Methods: A retrospective review of a consecutive series of patients who underwent partial meniscectomy before and after adoption of a needle arthroscopic technique was performed. Meniscus repairs, root repairs, and those with ligamentous injuries were excluded. Total milligram morphine equivalents (MMEs) consumed, Visual analog scale (VAS) pain, and Knee Injury and Osteoarthritis Outcome Scores (KOOS) were compared preoperatively and at 2 and 6-weeks postoperatively. Univariate analysis was used to compare results.
Results: Nineteen patients were in each group (NA: 10 females, SA: 11 females). Mean ± SD age (NA 42.8 ± 8.4 vs. SA 47.6 ± 10.4 years, $p = 0.13$) and body mass index (NA 31.4 ± 5.6 vs. SA 35.1 ± 5.4 m/kg^2, $p = 0.06$) were not significantly different. Seventeen (89%) patients in both groups had medial meniscus tears of the posterior horn. Preoperative Outerbridge score was significantly greater in the SA group (3.4 vs. 1.8, $p = 0.002$); however, preoperative VAS pain (NA 6.1 ± 1.7 vs. SA 6.1 ± 1.8, $p = 0.98$) and KOOS pain (NA 44 ± 17% vs. SA 37 ± 12.5%, $p = 0.20$) were similar. Amount of arthroscopic fluid used was significantly greater in the SA vs. NA group (1.4 ± 0.7 vs. 0.5 ± 0.3 L, $p < 0.0001$), but tourniquet time was equivalent (NA 20 ± 6 vs.16 ± 6 min, $p = 0.11$). VAS pain scores (NA 1.0 ± 1.1 vs. SA 2.6 ± 1.5, $p = 0.0014$), KOOS pain (NA 79 ± 15% vs. 58 ± 19%, $p = 0.0006$), and Quality of Life (QOL) scores (NA 70 ± 22% vs. SA 43 ± 24%, $p = 0.001$) were significantly better at 2-weeks post-op in the N group. By 6 weeks post-op, all PROs including VAS pain and KOOS scores were similar between groups.
Conclusions: Adoption of a needle arthroscopic technique for partial meniscectomy was associated with significantly improved VAS and KOOS pain scores two-weeks post-operatively. Differences were not sustained at 6 weeks after surgery.
Level of evidence: III, Retrospective Comparison Study.

1. Introduction

Needle arthroscopy (NA) has emerged as a diagnostic and therapeutic modality to identify and treat intra-articular pathology under local anesthesia with or without minimal sedation.[1,2] Needle arthroscopic visualization and instruments have improved since its introduction, with a novel NA device offering an optic chip at the tip of the camera which displays high-definition 400 x 400 resolution and wide 120° field of view.[3] With these improvements, the number of techniques utilizing NA for diagnostic and therapeutic interventions has dramatically increased.[4–8] In a recent systematic review, Zhang et al.[9] reported there is potential for improved diagnostic accuracy and cost savings compared to magnetic resonance imaging (MRI) primarily for knee pathology including meniscal, ligamentous, and chondral defects. However, they claim that widespread use of NA has not been achieved due to steep learning curves, product availability, and lack of published

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comparisons to more standard modalities.[9]

Arthroscopic partial meniscectomy is one of the most common orthopedic surgeries performed, with 465,000 cases performed per year in the United States.[10,11] Despite its incidence and relative ease, complications and hospital readmissions still exist after knee arthroscopy, including wound complications and increased post-operative pain.12,13 Due to NA's recent evolution, there is a need for comparative studies evaluating post-operative pain and functional outcomes after partial meniscectomy performed with needle vs. standard arthroscopy. Therefore, the purpose of this study is to compare immediate post-operative pain and patient-reported outcomes (PROs) after partial meniscectomy with needle (NA) vs. standard (SA) arthroscopy technique. We hypothesize that immediate post-operative pain and PROs is lower with NA without compromise of long-term outcomes.

2. Methods

We retrospectively reviewed a consecutive series of patients who underwent partial meniscectomy between September 2021 and September 2022. An equal number of patients were identified and reviewed before and after adoption of a needle arthroscopic technique. Patients who received meniscus repair, root repair, or those with associated ligamentous injuries were excluded. Patients were treated by three orthopedic surgeons fellowship-trained in sports medicine. Demographic information recorded included age, sex, height, weight, body mass index (BMI), race, ethnicity, and smoking status. Laterality (medial vs. lateral tears), tear type, and extent of chondromalacia at the time of surgery via Outterbridge classification (OB) were also recorded at baseline. Procedure data including total volume of arthroscopic fluid (milliliters, mL) and tourniquet time (minutes, min) were also recorded for comparison.

The primary outcome compared between groups was postoperative pain and PROs within the first two months after surgery. Total opioid consumption within the first 24 h after surgery were compared using milligram morphine equivalents.[14] Patients were asked how many prescription opioids they consumed during day-after discharge telephone follow up. Visual analog scale (VAS) pain scores, and Knee Injury and Osteoarthritis Outcome Scores (KOOS) were compared pre-operatively and at 2 and 6-weeks postoperatively. VAS pain and KOOS surveys were administered via written surveys by nursing staff in the office at preoperative appointment and at the patients' 2- and 6-week follow up appointments. The number of patients who met the minimum clinically important difference (MCID) and patient-acceptable symptomatic state (PASS) after partial meniscectomy at 2- and 6-weeks was also reported.[15,16]

2.1. Surgical technique

For the NA group, surgical technique was performed as previously described.[17] Briefly, all patients underwent pre-operative MRI which confirmed meniscus pathology. Patients were taken to the operating room, placed in the supine position, and general anesthesia was induced. The operative extremity was placed in a leg holder (Zimmer Biomet, Warsaw, IN) and a tourniquet was applied to the thigh. Non-operative extremity was placed over a well-padded pillow. After standard sterile prep, the operative extremity was exsanguinated. In the standard arthroscopy group, anterolateral and anteromedial portals were created with incisions. In the needle arthroscope group, the 1.9 mm NanoScope (Arthrex, Naples, FL) system was inserted without making skin incisions. Diagnostic arthroscopy exam was performed in both groups. In the NA group, single-use instrumentation including 2-mm meniscal biters and shavers were used to debride meniscus tears. Chondroplasty was performed as needed. At the conclusion of each case, the remaining fluid in the joint was aspirated. Local anesthesia was not utilized prior to waking the patient in either group. Post-operatively, patients were allowed to weight bear as tolerated on the operative extremity. A homegoing prescription of hydrocodone-acetaminophen 5–325 mg taken as needed every 4 h was provided. Aspirin 325 mg daily x 2 weeks was prescribed for deep vein thrombosis (DVT) prophylaxis and was not taken as an analgesic.

2.2. Statistical analysis

Descriptive statistics were performed. Continuous data were described using means and standard deviations (SD). Categorical data were described with frequencies and percentages. Students t-test and Fischer exact tests were used to compare continuous and categorical data, respectively. The significance level was set to $p = 0.05$. Statistical analysis was performed using Excel v.16.43 (Microsoft Inc., Redmond, WA).

3. Results

Nineteen patients were in each group (N: 10 females, S: 11 females). Mean ± SD age (NA 42.8 ± 8.4 vs. SA 47.6 ± 10.4 years) and body mass index (NA 31.4 ± 5.6 vs. SA 35.1 ± 5.4 m/kg^2) were not significantly different (Table 1). The degree of chondromalacia at the time of surgery was more significant in the SA group (Mean OB 3.4 vs. 1.8, $p = 0.002$). All patients in had PROs available at 2 weeks post-operatively. At 6 weeks, 14 (74%) patients in the SA group vs. 15 (79%) in the NA group had PROs available ($p = 1.0$).

As expected, the total amount of arthroscopic fluid used during needle arthroscopic partial meniscectomy was significantly less than with standard arthroscopy (1447 ± 715 vs. 471 ± 345 mL, $p < 0.0001$). Tourniquet time was similar (NA 20 ± 6 vs. SA 16 ± 6 min, $p = 0.11$). Most tears were degenerative tears of the posterior horn of the medial meniscus – four patients in the SA group had bucket handle tears (21%).

Total MME's consumed within 24 h post-operatively was statistically less in the NA group (1.2 ± 1.0 vs. 2.4 ± 1.6, $p = 0.006$). A comparison of PROs at 2 and 6-weeks post-operatively found that VAS scores (NA 1.0 ± 1.1 vs. SA 2.6 ± 1.5, p =), KOOS pain (NA 79 ± 15% vs. SA 58 ± 19%), and Quality of Life (QOL) scores (NA 70 ± 22% vs. SA 43 ± 24%) were significantly better at 2-weeks in the NA group. By 6 weeks post-operatively, all PROs including VAS pain and KOOS scores were similar between groups (Table II). Fourteen (74%) vs. 4 (21%) patients in the NA group met the MCID for KOOS Symptoms at 2 weeks post-op ($p = 0.003$). In addition, the number of patients who met the PASS for KOOS Symptoms and QOL at 2 weeks post-op was significantly greater in the NA vs. SA group (KOOS Symptoms: 17 (89%) vs. 9 (47%), $p = 0.013$; KOOS QOL: 14 (74%) vs. 6 (32%), $p = 0.02$). For all other PROs,

Table 1
Baseline characteristics.

	Needle Arthroscopy, (NA) (n = 19)	Standard Arthroscopy, (SA) (n = 19)	P-value
Age (years)	42.8 ± 8.4	47.6 ± 10.5	0.13
Sex (females, n, %)	10 (53%)	11 (58%)	1.0
Body mass index (kg/m^2)	31.4 ± 5.6	35.1 ± 5.4	0.06
Outerbridge score	1.83 ± 2.0	3.35 ± 1.06	**0.002**
Laterality (right, n, %)	13 (68%)	8 (42%)	0.19
Pre-operative VAS score	6.1 ± 1.8	6.1 ± 1.7	0.98
Pre-operative KOOS (%)			
Pain	44 ± 17	37 ± 13	0.20
Symptoms and Stiffness	50 ± 16	44 ± 17	0.34
Activities of Daily Living	61 ± 19	51 ± 16	0.11
Sports and Recreation	31 ± 20	26 ± 25	0.47
QOL	25 ± 17	19 ± 16	0.24

Table I. Baseline Characteristics of Needle (NA) vs. Standard (SA) Arthroscopy.

Table 2
Patient reported outcomes.

	NA (n = 19)	SA (n = 19)	P-value
Pre-op			
VAS (n)	6.1 ± 1.8	6.1 ± 1.7	0.98
KOOS Pain	44 ± 17	37 ± 13	0.20
KOOS Symptoms and Stiffness	50 ± 16	44 ± 17	0.34
KOOS Activities of Daily Living	61 ± 19	51 ± 16	0.11
KOOS Sports and Recreation	31 ± 20	26 ± 25	0.47
KOOS QOL	25 ± 17	19 ± 16	0.24
Two weeks			
VAS (n)	1.0 ± 1.1	2.6 ± 1.5	**0.0014**
KOOS Pain	79 ± 15	58 ± 19	**0.0006**
KOOS Symptoms and Stiffness	79 ± 12	61 ± 18	**0.002**
KOOS Activities of Daily Living	86 ± 12	70 ± 19	**0.003**
KOOS Sports and Recreation	72 ± 25	44 ± 28	**0.003**
QOL	70 ± 22	43 ± 24	**0.001**
Six weeks			
VAS	0.4 ± 0.8	0.7 ± 1.3	0.47
KOOS Pain	82 ± 16	78 ± 17	0.24
KOOS Symptoms and Stiffness	85 ± 13	85 ± 13	0.24
KOOS Activities of Daily Living	91 ± 11	88 ± 13	0.39
KOOS Sports and Recreation	73 ± 26	67 ± 27	0.85
KOOS QOL	72 ± 25	68 ± 28	0.74

Table 2. Patient reported outcomes in patients who underwent partial meniscectomy with needle arthroscopy (NA) vs. standard arthroscopy (SA). Knee Injury and Osteoarthritis Outcome Scores (KOOS) Pain, Symptoms and Stiffness, Activities of Daily Living, Sport and Recreation, and Quality of Life (QOL) compared at pre-op, 2-weeks, and 6-weeks.
VAS = Visual Analog Scale.

there were no significant differences in the number of patients who met MCID or PASS at 2 or 6 weeks post-operatively.

One patient in the SA group (5%) was diagnosed with a DVT at two weeks after surgery. No other complications were recorded in either group.

4. Discussion

The results of this study show that after adoption of a needle arthroscopic technique for partial meniscectomy, patients reported lower VAS pain and improved functional scores at two weeks post-operatively. In addition, the total amount of MMEs consumed within 24 h after surgery was statistically lower in the NA group. Pain scores and PROs were equivalent by 6 weeks after surgery, indicating that NA technique also did not limit patients' improvement in comparison to standard techniques and instruments.

Recently, various applications of NA have been published in the literature, including for diagnosis and treatment. Utilizing in-office needle arthroscopy (IONA) for diagnosis of intra-articular pathology has dramatically increased. In a prospective, blinded, multicenter trial, Gill et al.[5] found that the use of IONA for diagnosis of intra-articular knee pathology was statistically equivalent to MRI for non-ligamentous joint pathology.[5] Similarly, Wagner et al.[6] demonstrated comparable accuracy for diagnosis of articular cartilage, labrum, rotator cuff, and biceps pathology in the shoulder joint.[6] As NA instrumentation availability has improved, reported surgical techniques for treatment of a wide range of orthopedic pathologies have increased.[4,6–8] Specifically for the knee, NA techniques for partial meniscectomy and meniscus repair have been described.[17–20] The present study expands on reported techniques and compares early outcomes of partial meniscectomy performed with NA in the operating room. Our study provides new data that suggests that good outcomes are not sacrificed with NA technique and instrumentation, and these patients may even experience less pain and have a quicker recovery in the immediate post-operative period.

The present study also establishes a baseline comparison to standard arthroscopy partial meniscectomy in the operating room. If partial meniscectomy is performed with IONA under local anesthesia, our data suggest that the clinical improvement of these patients is likely to be comparable to standard procedure in the operating room. All three metrics – MME consumption, VAS pain, and KOOS subscales – used to compare early postoperative pain and functional status were statistically different between NA and SA groups at 2 weeks postoperatively. Significantly more patients in the NA group even met the MCID for KOOS Symptoms at 2 weeks (74% vs. 21%, p = 0.003), as well as the PASS for KOOS Symptoms and QOL at 2 weeks (Symptoms: 89% vs. 47%, p = 0.013; QOL: 74% vs. 32%, p = 0.02). These differences were not sustained at 6 weeks postoperatively. Fewer MMEs were utilized in the needle arthroscopy group in the immediate postoperative period, and this finding must not be overlooked, as opioid analgesia is often overutilized in simple orthopedic procedures and overprescribing of opioids may contribute to diversion, misuse, and addiction.[21] This study and others like it may raise awareness to techniques to reduce post-operative opioid requirements and lead to fewer pills being prescribed in arthroscopic cases, particularly cases that utilize needle arthroscopy.[22] Additionally, decreased postoperative pain and improved function immediately after surgery may hasten return to sport, work, and driving times, thereby reducing the economic impact of partial meniscectomy surgery.

Knee arthroscopy with meniscal intervention remains one of the most common procedures in orthopedics.[10,11,23,24] Complications and 30-day hospital readmissions still occur after routine arthroscopic procedures, though.[12,13] Overall, reported hospital readmission rates after knee arthroscopy are low (91 of 9920 patients, 0.92%[10]; 635 of 69,022 patients, 0.92%[11]) - complications and risk factors for readmission include wound complications, increasing operative time, and post-operative pain.[12,13] Utilizing needle arthroscopy for meniscus procedures could potentially further decrease these adverse outcomes due to its minimally invasive nature, decreased incision size, soft tissue trauma, and arthroscopic fluid utilization with decreased extravasation into surrounding tissues.[20] Additionally, increasing size and complexity of the meniscus tears intervened upon during NA is another factor to consider because of the influence on operative time. In the present single-surgeon series, tourniquet time was not significantly greater in the NA group, indicating that that the use of a smaller zero-degree scope did not hinder surgical technique and subsequently lengthen operative times. Future studies of larger cohorts could better elucidate potential differences in complication rates between needle and standard arthroscopy.

4.1. Limitations

There are limitations of this study which should be considered. The small sample size indeed limits the power of the study and the potential to uncover longer term benefits of needle arthroscopy. The retrospective nature of the study also introduces the possibility of selection bias. Collecting the amount of opioid consumption within 24 h from surgery is also subject to reporting bias. The extent of chondromalacia was significantly greater in the SA group (Mean OB, 3.4 vs. 1.8, p = 0.002), which may partially explain some of the postoperative differences in functional and pain scores; however, preoperative VAS pain and KOOS scores were similar, which suggests that this difference was not clinically meaningful in this cohort. The clinically important difference analysis should also be interpreted with caution, as the PASS and MCID for arthroscopic partial meniscectomy was determined with standard arthroscopy techniques and at 1 and 2-year timepoints after surgery.[15,16] In addition, there is a learning curve associated with needle arthroscopy - using a zero-degree scope may make diagnosis and treatment of intraarticular knee pathology more difficult in inexperienced surgeons. Lastly, our cohort was limited to partial meniscectomy procedures, excluding patients who underwent meniscus repair.

5. Conclusion

Adoption of a needle arthroscopic technique for partial meniscectomy resulted in significantly improved VAS and KOOS pain scores two-weeks post-operatively. Differences were not sustained at 6 weeks after surgery.

Author contributions

Andrew L. Schaver MD: Investigation, Formal analysis, Writing- Original draft, Review and Editing. **Jonathan G. Lash MD**: Investigation, Formal analysis, Writing- Original draft. **Micah L. MacAskill MD:** Writing- Original draft. **Shane Taylor MD**: Writing- Original draft. **Timothy E. Hewett PhD**: Supervision. **John J. Jasko MD**: Visualization, Investigation, Supervision. **Evan H. Argintar MD:** Visualization, Investigation. **Chad D. Lavender MD**: Visualization, Investigation, Supervision.

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Informed consent

None.

Institutional ethical committee approval

This study was approved by the Institutional Review Board.

Declaration of competing interest

None.

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References

1 Stornebrink T, Stufkens SAS, Appelt D, Wijdicks CA, Kerkhoffs G. 2-Mm diameter operative tendoscopy of the tibialis posterior, peroneal, and achilles tendons: a cadaveric study. *Foot Ankle Int*. Apr 2020;41(4):473–478. https://doi.org/10.1177/1071100719895504.
2 Stornebrink T, Altink JN, Appelt D, Wijdicks CA, Stufkens SAS, Kerkhoffs G. Two-millimetre diameter operative arthroscopy of the ankle is safe and effective. *Knee Surg Sports Traumatol Arthrosc*. Oct 2020;28(10):3080–3086. https://doi.org/10.1007/s00167-020-05889-7.
3 NanoScope: Nano Operative Arthroscopy System. Arthrex, Inc. Accessed March 7, 2023,.
4 Colasanti CA, Mercer NP, Garcia JV, Kerkhoffs G, Kennedy JG. In-office needle arthroscopy for the treatment of anterior ankle impingement yields high patient satisfaction with high rates of return to work and sport. *Arthroscopy*. Apr 2022;38(4):1302–1311. https://doi.org/10.1016/j.arthro.2021.09.016.
5 Gill TJ, Safran M, Mandelbaum B, Huber B, Gambardella R, Xerogeanes J. A prospective, blinded, multicenter clinical trial to compare the efficacy, accuracy, and safety of in-office diagnostic arthroscopy with magnetic resonance imaging and surgical diagnostic arthroscopy. *Arthroscopy*. Aug 2018;34(8):2429–2435. https://doi.org/10.1016/j.arthro.2018.03.010.
6 Wagner ER, Woodmass JM, Zimmer ZR, et al. Needle diagnostic arthroscopy and magnetic resonance imaging of the shoulder have comparable accuracy with surgical arthroscopy: a prospective clinical trial. *Arthroscopy*. Jul 2021;37(7):2090–2098. https://doi.org/10.1016/j.arthro.2021.03.006.
7 Peters M, Gilmer B, Kassam HF. Diagnostic and therapeutic elbow arthroscopy using small-bore needle arthroscopy. *Arthrosc Tech*. Nov 2020;9(11):e1703–e1708. https://doi.org/10.1016/j.eats.2020.07.013.
8 Fournier M, Corning E, Witt A, Lang S, Gilmer BB. Arthroscopically assisted fixation of terrible triad variant injuries of the elbow with small-bore needle arthroscopy. *Arthrosc Tech*. Jun 2021;10(6):e1469–e1474. https://doi.org/10.1016/j.eats.2021.02.011.
9 Zhang K, Crum RJ, Samuelsson K, Cadet E, Ayeni OR, de Sa D. In-office needle arthroscopy: a systematic review of indications and clinical utility. *Arthroscopy*. Sep 2019;35(9):2709–2721. https://doi.org/10.1016/j.arthro.2019.03.045.
10 Thorlund JB, Hare KB, Lohmander LS. Large increase in arthroscopic meniscus surgery in the middle-aged and older population in Denmark from 2000 to 2011. *Acta Orthop*. Jun 2014;85(3):287–292. https://doi.org/10.3109/17453674.2014.919558.
11 Kim S, Bosque J, Meehan JP, Jamali A, Marder R. Increase in outpatient knee arthroscopy in the United States: a comparison of national surveys of ambulatory surgery, 1996 and 2006. *J Bone Joint Surg Am*. Jun 1 2011;93(11):994–1000. https://doi.org/10.2106/jbjs.i.01618.
12 Westermann RW, Pugely AJ, Ries Z, et al. Causes and predictors of 30-day readmission after shoulder and knee arthroscopy: an analysis of 15,167 cases. *Arthroscopy*. Jun 2015;31(6):1035–1040.e1. https://doi.org/10.1016/j.arthro.2015.03.029.
13 Hartwell MJ, Morgan AM, Johnson DJ, et al. Risk factors for 30-day readmission following knee arthroscopy. *J Knee Surg*. Nov 2020;33(11):1109–1115. https://doi.org/10.1055/s-0039-1692631.
14 Centers for Disease Control and Prevention NCfIPaC. *CDC Guideline for Prescribing Opioids for Chronic Pain*. US Department of Health and Human Services; 2019.
15 Beletsky A, Gowd AK, Liu JN, et al. Time to achievement of clinically significant outcomes after isolated arthroscopic partial meniscectomy: a multivariate analysis. *Arthrosc Sports Med Rehabil*. Dec 2020;2(6):e723–e733. https://doi.org/10.1016/j.asmr.2020.06.002.
16 Dwyer T, Zochowski T, Ogilvie-Harris D, Theodoropoulos J, Whelan D, Chahal J. Determining the patient acceptable symptomatic state for patients undergoing arthroscopic partial meniscectomy in the knee. *Am J Sports Med*. Mar 2020;48(4):847–852. https://doi.org/10.1177/0363546520904017.
17 Lavender C, Lycans D, Sina Adil SA, Kopiec A, Schmicker T. Incisionless partial medial meniscectomy. *Arthrosc Tech*. Mar 2020;9(3):e375–e378. https://doi.org/10.1016/j.eats.2019.11.003.
18 Stornebrink T, van Dijck R, Douven D, Kerkhoffs G. Needle arthroscopic all-inside repair of meniscal tears under local anesthesia. *Arthrosc Tech*. Sep 2021;10(9):e2173–e2180. https://doi.org/10.1016/j.eats.2021.05.020.
19 Lavender C, Flores K, Patel T, Berdis G, Blickenstaff B. Nanoscopic medial meniscus repair. *Arthrosc Tech*. Aug 2021;10(8):e1943–e1947. https://doi.org/10.1016/j.eats.2021.04.024.
20 Quinn R, Lang SD, Gilmer BB. Diagnostic needle arthroscopy and partial medial meniscectomy using small bore needle arthroscopy. *Arthrosc Tech*. May 2020;9(5):e645–e650. https://doi.org/10.1016/j.eats.2020.01.018.
21 Lee M, Silverman SM, Hansen H, Patel VB, Manchikanti L. A comprehensive review of opioid-induced hyperalgesia. *Pain Physician*. Mar-Apr 2011;14(2):145–161.
22 Scarcella MJ, Farrow LD, Jones MH, Rosneck J, Briskin I, Spindler KP. Opioid use after simple arthroscopic knee surgery. *Am J Sports Med*. May 2022;50(6):1644–1650. https://doi.org/10.1177/03635465221080788.
23 Abrams GD, Frank RM, Gupta AK, Harris JD, McCormick FM, Cole BJ. Trends in meniscus repair and meniscectomy in the United States, 2005-2011. *Am J Sports Med*. Oct 2013;41(10):2333–2339. https://doi.org/10.1177/0363546513495641.
24 Garrett Jr WE, Swiontkowski MF, Weinstein JN, et al. American board of orthopaedic surgery practice of the orthopaedic surgeon: Part-ii, certification examination case mix. *J Bone Joint Surg Am*. Mar 2006;88(3):660–667. https://doi.org/10.2106/jbjs.e.01208.