

All-Inside Knee Arthroscopic Repair Outcomes in Mongolia, Effectiveness and Challenges

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Objectives: We investigated the clinical outcomes of a few initial cases of interior knee arthroscopic surgical repair conducted in Ulaanbaatar, Mongolia. **Methods:** Arthroscopic knee repair patients were recruited into a single-arm trial study and followed up to the third month post-surgically. Subjects were the first cohort of all-inside arthroscopic knee surgery at the National Trauma and Orthopedics Research Center (NTORC) of Mongolia. We examined the subjects by tests including MRI prior to surgery, and complete knee evaluation including symptoms, functionality, and local examinations at the baseline and the third month after surgery. Pairwise statistical methods including McNemar Test and T-test were used. Additionally, Pearson's R Correlations tests were used. **Results:** Forty-nine knee arthroscopic surgery patients were included for analysis. Knee pain, some local symptoms during recovery, and functionality significantly improved post-surgically, ($p < 0.051$). Arthroscopic knee interventions including anterior cruciate ligament reconstruction, local partial meniscectomy, and meniscal repair were predominantly conducted, strongly reflecting the knee MRI scan findings. Surgical site infections were absent in this cohort of patients. Age was correlated with post-surgical pain ($p < 0.050$). **Conclusion:** Knee arthroscopic outcomes for symptom alleviation and recovery of function were satisfactory at 3 months of follow-up in this study. We conclude that we enjoyed an excellent experience with all-inside knee arthroscopy in a central Asian lower-middle income country (LMIC) setting with younger and middle-aged patients. Older age Mongolians may present with post-surgical pain more often than these subjects.

Keywords: Knee Injuries, Anterior Cruciate Ligament Injuries, Orthopedic Procedures, Arthroscopy, Mongolia

Introduction

Knee injury in sport athletes and young and middle-aged adults are common, and without proper orthopedic surgery can lead to disability, and poor health related quality of life [1]. Patients who received knee injury requires a carefully planned, stepwise orthopedic care including surgery and long-term rehabilitation. Arthroscopic knee repair is the standard of care for common knee element injuries such as anterior cruciate ligament (ACL) injuries, meniscal tears, and other minimal joint injuries. Mongolia bears a huge burden of trauma related illnesses including self-harm and remains the fourth leading country in death due to poor infra-structure, numerous major social aspects including alcohol consumption, stress, poor occupational safety, and negligence [2]. These factors, coupled with the expanding occurrence of obesity and knee osteoarthritis [2, 3], ultimately lead to substantial disabilities and a high number of years-lived with knee injury in Mongolia.

Knee pain is the most common complaint and a challenging one among knee injury patients and is followed by functional symptoms and signs including abnormal cracking sounds, knee lock, swelling, limping, a limited range of motion particularly in sports injuries, and ACL tears [4]. Although the visual analogue scale (VAS) as a knee pain measure is widely used for pre- and post-surgical patient analysis, it is less used as an investigation tool in long term follow-up evaluation in arthroscopic patients [5]. Knee pain after total knee arthroplasty has been reported to be managed successfully by local anesthesia administration in Mongolia [6]. However, pain management in post-arthroscopy and follow-up is poorly investigated in Mongolia. Although individual tests and measures of knee function are well-recognized, such as all-inclusive knee measures including the IKDC Subjective Knee Form and the Lysholm knee scoring scale, knee injury and osteoarthritis outcome score are the mainstay of pre- and post- measurement [7].

In developing countries coordinated strategy and development towards comprehensive knee surgery planning including arthroscopy and arthroplasty remain variable and at different levels of proficiency [8]. Orthopedic surgeries and novel approaches are being introduced to developing countries, although there are financial, educational, expertise, and multiple other barriers [8]. ACL surgery is a rapidly growing field in orthopedics with various techniques, biomaterials,

and rehabilitation care being reported [8, 9]. Arthroscopic reconstructive surgery of the knee was introduced in 2011 at the National Trauma and Orthopedic Research Center (NTORC) of Mongolia and substantial numbers of patients received knee arthroscopy at the center. In 2017, relatively new, all-inside knee arthroscopy technology was brought into practice at the NTORC, yet effectiveness and safety remain underexplored in the Mongolian setting.

Safe yet affordable knee arthroscopy with minimal long-term discomfort is essential for orthopedic care particularly in knee injuries patients [9, 10]. Knee pain in conventional arthroscopic repairs including inside-out and outside-in techniques achieve relatively good pain outcomes, however pain in all-inside technique patients is less investigated particularly for the long term [9, 11-13]. In addition to pain, functionality of the knee joint needs concomitant assessment to ensure complete recovery. Tay et al. conducted an exemplary complete follow-up study of knee pain and functionality, however, this was done for only standard arthroscopy [14]. Although some investigations followed up with only knee pain measures without functionality measures including range of motion, prospective studies with follow-up of complete sets of clinical outcomes are less reported for all-inside arthroscopy [12, 14-15].

We, therefore, investigated well-recognized clinical outcomes including pain, knee functionality outcomes, and procedural frequencies to capture recovery and safety status with a three-month follow-up among a cohort of first cases of all-inside knee arthroscopy in Mongolian patients.

Materials and Methods

Study subjects and recruitment

Knee injury patients were recruited to study between March 2017 and May 2019 in Ulaanbaatar, Mongolia at the referral center for orthopedic surgery. Patients were primarily screened for anterior cruciate ligament (ACL) injury and concomitant knee structure damages. Among the abnormalities in MRI scan, ACL partial or complete tears were the predominant occurring finding (75.56%), followed by abnormalities of the posterior horn of the medial meniscus (52.27%) and the suprapatellar bursa (43.18%). We included adult patients who were eligible for one-side knee arthroscopic repair and who had MRI findings indicating arthroscopic operatively repairable injuries. Subjects

were informed and formally signed approval for the surgical procedure and voluntarily participated in the study.

Subjects were predominantly active young adults between the age of 24 - 35 (70%), and eighty-five per cent of subjects were males ($n = 42$). Knee injury onset and nature were reportedly due to sports injuries (63%), fall injury (12%), and others. Full description of demographic characteristics and the nature of knee injury are listed in the Table 1. Among subjects, 25 right knee and 24 left knee single-sided injury patients were recruited.

Study design and arthroscopy

We carried out a single-arm trial study for pre- and post-probability analysis at the National Trauma and Orthopedic Research Center (NTORC), Ulaanbaatar, Mongolia. Patients were followed for up to three months post-surgery. Baseline assessment had been conducted prior to surgery, and subjects were invited to revisit the center for a three-month assessment within 95 days calendar days after surgery.

All patients received all-inside arthroscopic reconstruction of the knee joint, for one-side knee injuries under subdural spinal anesthesia, figure 1. Two experienced orthopedic surgeons conducted the knee arthroscopic surgery. Medial and lateral knee incisions of 0.5 centimeters were made for arthroscopy, and anatomical structures were assessed including meniscuses, ligaments, capsules, joint artices, and other elements. An Arthrex® 4.8 mm, 4K arthroscope and Synergy UHD4K imaging system were used (Naples, FL 34108, USA). Meniscal tears and damages were trimmed or repaired by an Arthrex Meniscal Cinch™ (Naples, FL 34108, USA), based on local blood supply status. We then harvested semitendinosus autograft by tendon stripper via 2 cm medial-side calf incision. The primary graft was processed for removal of muscular tissue, folded 4 times and cortically fixated by ACL TightRope® (Naples, FL 34108, USA) for knotless fixation of ACL autograft restoration surgery. Femoral footprints were made at 10 and 2 o'clock positions for right and left knees, respectively. Meanwhile tibial footprints were located in the anteromedial side of the tibia. Patients received intravenous Cefotaxime 1 gr, TID, for 3 days, starting from the pre-surgery day.

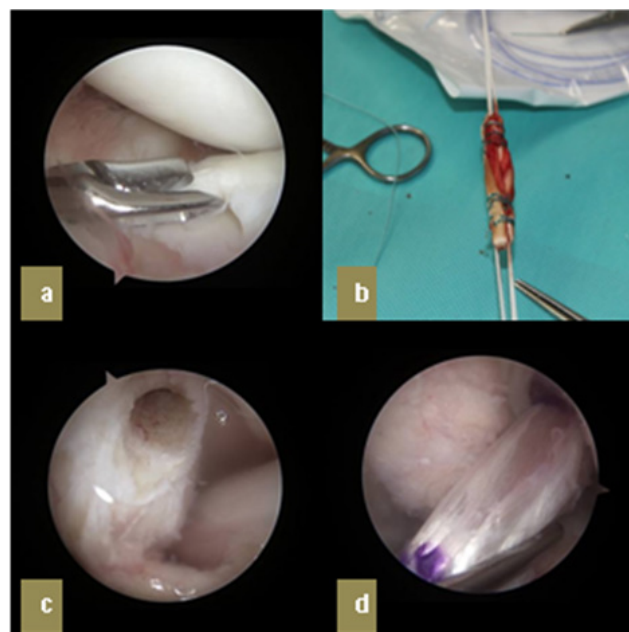


Figure 1. All-inside knee arthroscopy procedure exemplar images, a) Arthroscopic diagnosis and meniscal anterior horn removal, b) Fourstrand semitendinosus autograft, c) Tibial tunnel matching autograft size, d) ACL complete reconstruction.

Knee evaluations

Subjects were assessed by MRI scan at six different facilities at baseline and we analyzed for the presence of injuries in 21 elements of knee joint and moving apparatus. All subjects were interviewed for detailed demographic assessment, behavioral characteristics of sports activities, and the nature of knee injury.

Knee examinations included knee pain by visual analogue scale with 10 being the worst, knee functionality, and discomfort during ascending or descending staircases. General local knee examinations for erythema, swelling, disfiguration, tenderness on palpation, sensory abnormalities, and range of motion by active and inactive tests were obtained. Orthopedic advanced examinations were conducted in addition by the operating physicians including Varus, Valgus, Posterior drawer, Anterior drawer, Pressured, Lachman, Functional instability, and Knee laxity tests. All symptoms, general and orthopedic examinations were conducted pre- and post-operatively.

Statistical analysis

Expression of continuous variables are presented as mean \pm standard deviation. Only subjects with complete 3-month data for pre- and post-surgery statuses were included for pair-wise

analyses. We used McNemar test for baseline and post-surgical third month outcome analysis including symptoms, local signs. Signed-Rank test was used for knee functionality or range of motion, while paired T-test was used for knee pain outcomes. Pearson's R correlation test was used to identify correlations between pre- and post-surgical pain, difference in pain, age, weight, height, BMI, and hospitalization days.

Ethical statement

Research ethical clearance was obtained from Ach Medical University Research Ethics Board, under protocol of October 19, 2018 (No. B/08).

Results

Baseline characteristics and surgical procedural outcomes

Total of 49 patients were included in the analyses. At the baseline of the study, the majority of the participants (n = 41,

84%) had moderate functional loss with or without cane to severe functional loss of the knee. Knee pain was highest (6.19 ± 0.28) in the subgroup with severe functional loss.

However, multiple comparisons tests for post-hoc Tukey HSD did not observe significant differences in all subgroups according to knee functionality. The average BMI of subjects was 27.37 ± 5.07 (95% CI; 25.93, 28.81), and no linear correlations were observed in pain scale and pain duration. Meanwhile, the BMI was correlated with longer hospitalization days, and age was associated with higher post-operative pain, Table 2. We did not observe significant correlations between pain difference or alleviation, or other clinical variables other than pain ($p > 0.05$). Twenty-five (51.02%) participants had normal range of motion at the injured knee, while the remaining had limitation in range of motion with or without abnormal sounds in knee joint.

Patients were diagnosed and surgically treated during arthroscopy. Procedures of choices were made during arthroscopic surgery in addition to MRI findings to guide the surgical plan. Among the arthroscopic procedures, ACL

Table 1. Participants' demographic characteristics and nature of knee injury.

Variables	Male (n = 42)	Female (n = 7)	Total (n = 49)
	Mean \pm SD	Mean \pm SD	Mean \pm SD
Age, years	30.38 \pm 7.83	34.80 \pm 6.30	30.97 \pm 7.72
	N (%)	N (%)	N (%)
Age group			
< 24	10 (31.3)	-	10 (27.0)
24-30	9 (28.1)	-	9 (24.3)
30-35	3 (9.4)	4 (80.0)	7 (18.9)
> 35	10 (31.3)	1 (20.0)	11 (29.7)
Education			
High school	4 (9.5)	-	4 (8.2)
Technical and professional	2 (4.8)	-	2 (4.1)
Higher education	36 (85.7)	7 (100)	43 (87.8)
Sports frequency			
None	16 (38.1)	2 (33.3)	18 (37.5)
Occasionally	4 (9.5)	1 (16.7)	5 (10.4)
2-3 times weekly, at least 30 mins	14 (33.3)	3 (50.)	17 (35.4)
Professional athlete	8 (19.0)	-	8 (16.7)
Onset of knee injury			
Fall injury from standing position	5 (11.9)	1 (14.3)	6 (12.2)
Road injury	5 (11.9)	-	5 (10.2)
Sports activities	26 (61.9)	5 (71.4)	31 (63.3)
Others	6 (14.3)	1 (14.3)	7 (14.3)

Table 2. Major clinical variables and some linear correlations.

	Pain difference	Preoperative pain	Postoperative pain	Age	Weight	Height	BMI	Hospitalization days
Pain difference	1	..	..	..	..	..	..	..
Preoperative pain	0.796**	1	..	..	..	..	..	..
Postoperative pain	0.248	0.389*	1	..	..	..	..	..
Age	0.031	0.032	0.475**	1	..	..	..	..
Weight	-0.132	-0.136	-0.217	0.032	1	..	..	..
Height	-0.131	-0.007	-0.075	-0.443**	0.543**	1	..	..
BMI	-0.07	-0.135	-0.208	0.238	0.924**	0.189	1	..
Hospitalization days	0.182	0.013	0.049	0.045	0.372*	0.156	0.362*	1

Pain difference= preoperative pain – postoperative pain, *p < 0.050, **p < 0.010

reconstruction was the most frequently conducted procedure followed by local partial meniscectomy, and meniscal repairs, Figure 2. Choices of procedures aligned with findings of baseline MRI scan among subjects. Appropriate procedures were conducted (81.63% reconstruction for 75.56% ACL damages on MRI findings, and 46.94% reconstruction by local partial meniscectomy for 52.27% damages to the posterior horn of medial meniscus, respectively). Patients had been hospitalized on an average of 6.42 ± 4.89 (95% CI: 4.81, 8.02) days. No major clinical complications were recorded among patients, and knee repair outcomes were uneventfully and successful. There were no surgical site infections and septic arthritis in these 49 patients.

Pain, functional loss, local signs follow-up outcomes

All 49 subjects completed the 3-month follow-up. Pain outcome evaluated on the discharge day was significantly lower than the baseline status by 4 times (t-test, p < 0.001), Figure 3. In addition, the number of patients reporting knee pain significantly dropped post-surgically at discharge, (n = 35, n = 22; p < 0.001). At 3 months, subjects did not report any pain associated with the knee post-surgically, and primary pain outcomes were maintained at a satisfactory level without requiring substantial medical or rehabilitative care.

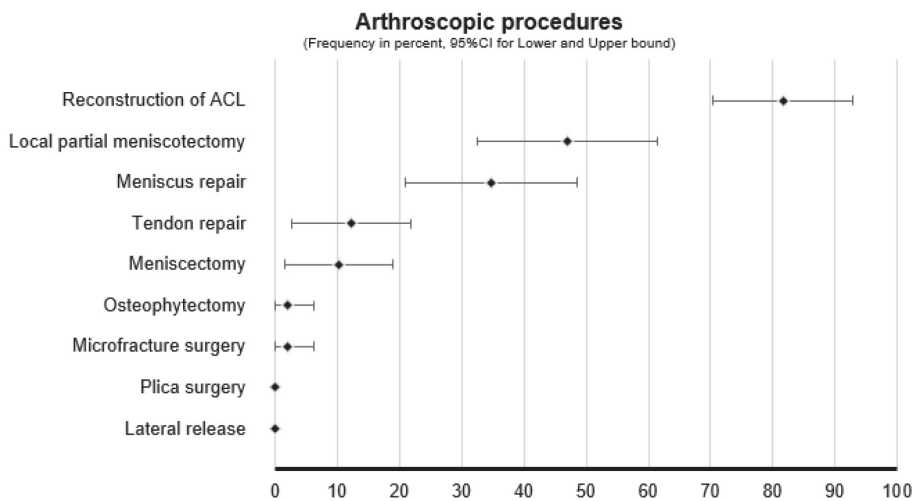


Figure 2. Frequency and choice for arthroscopic repair procedures of knee.

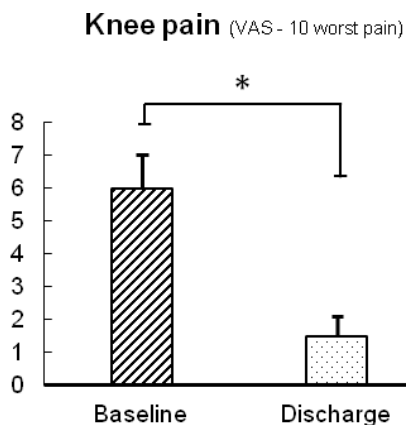


Figure 3. Pain in knee, pre- and 3-month post-surgical state.

We analyzed three-month follow-up status for the knee by local knee examinations. Pathological changes due knee injuries were significantly resolved under examination of professional orthopedic surgeons as summarized in the Table 3. All patients who had complete knee examinations for six local statuses pre- and post-operatively resolved to be normal. We observed

significant improvements in knee swelling, tenderness, and range of motion, although the remaining three signs were entirely negative post-surgery. Local signs of knee injuries were entirely absent in this cohort of patients.

Local knee examination outcomes were similarly resolved to a satisfactory level post-surgically. Knee instability was restored on anterior drawer sign to all 39 patients who completed the 3-month follow-up examinations post-surgically. At the baseline, 21 subject had a positive anterior drawer test and 18 were negative. All resolved to negative, respectively ($p < 0.001$, chi-square binomial distribution test) except a single patient who was positive for posterior drawer test, indicating swelling or edema in the knee. We observed significant improvement in the Valgus stress test for medial sided stress at month 3 in comparison to baseline, all 7 positives converted in 40 pre and post pairs ($p = 0.016$). Other remaining knee stress tests including Varus stress test, Pressure test, Lachman, Functional Instability, and Knee laxity tests were negative in all patients at third month of follow-up.

Table 3. Knee injury local status, at baseline and third month follow-up.

	Before surgery		After surgery _{month 3}		p-value
	Present	Absent	Present	Absent	
Erythema	1	40	0	41	1.000 ^b
Edema or swelling	11	30	0	41	0.001 ^b
Deformation	0	41	0	41	1.000 ^b
Tenderness	37	3	0	40	0.001 ^c
Abnormal sensation	2	39	0	41	0.500 ^b
Range of motion change	19	21	0	40	0.000 ^b

^aMcNemar test, ^bBinomial distribution test, ^c χ^2 –Continuity corrected

Table 4. Recovery of knee joint range of motion, pre-and post-surgical comparison.

	Before surgery	After surgery _{month 3}	Z	p-value ^a
Range of motion, active examination			-3.624 ^b	0.000
Normal	25	41		
Limited, no abnormal sounds	9	0		
Limited, abnormal sounds	13	0		
Range of motion, passive examination			-3.787 ^b	0.000
Normal	25	41		
Limited, no abnormal sounds	6	0		
Limited, abnormal sounds	16	0		

^aWilcoxon Signed Ranks Test, ^bBased on positive ranks

Range of motion

The range of motion and abnormal cracking sounds were analyzed in 41 pairs of pre- and post-surgical patients. We observed significant improvements in all 41 patients, as summarized in table 4. All subjects resolved to normal range of motion in active and passive examinations, $p < 0.05$. All subjects achieved full recovery of range of motion, as to secondary outcomes at month 3.

Discussion

We demonstrated the first study investigating clinical outcomes of all-inside arthroscopic knee reconstruction outcomes with 3 months follow-up in Mongolia. All patients achieved favorable symptom alleviation and knee functionality in our study, without any surgery related complications or septic arthritis. Although surgical site infection related complications are relatively rare, they can potentially be fatal or leading to surgery failure that predominantly occur in developing country settings [8, 10]. In this national reference, single-center orthopedic reconstructive surgical experience of all-inside knee arthroscopy, we analyzed pain discomfort, functionality, and range of motion as primary outcome measure for pre- and post-surgical comparison in a commonly reported manner of knee arthroscopy research. Furthermore, according to NTORC, septic arthritis should be prioritized and prevented in knee arthroscopy patients [10].

Knee pain in arthroscopic reconstruction is well investigated in previous studies, particularly for standard arthroscopies. In a randomized-controlled trial comparing all-inside arthroscopic reconstruction and standard arthroscopy, all-inside technique showed slightly better knee pain outcomes at month 1, post-surgically [11]. Despite different measures being used for pain scale, near discharge post-operative outcomes were similar with mostly minimal pain VAS 0-3 to our study. A two-year knee pain follow-up study of arthroscopically repaired ACL injuries predicted that predisposed knee extension failures were associated with prolonging knee pain [12]. In our study findings support the absence of pain with 1.5 ± 0.49 pain scores at discharge and 0 at month 3, in accordance with the negative report of all subjects for anterior drawer test for knee extension. Furthermore, BMI has been a strong predictor for post-operative pain for all-inside arthroscopic meniscal repair patients [13]. We did not observe BMI and knee pain correlations at baseline

and post-operatively, and this could be partially due to small sample size and biological factors including young age, nature of injury, and injury duration in the study. However, the BMI was linearly correlated with hospitalization days, signifying overall importance in surgical recovery. We also observed linear correlations ($r = 0.362$, $p < 0.005$) for age and post-operative pain at month 3 noting that knee joint healing could be slow at older ages. These findings suggest that higher BMI and older age may determine post-operative recovery and pain in Mongolian subjects. Findings from pain outcomes at month 3 indicate all-inside arthroscopy at NTORC was favorable and presumably superior to similarly conducted studies and different from standard arthroscopies [13].

Local knee status and functionality had improved and returned to normal status in our investigation at month 3. Functional recovery and range of motion were assessed at a short-term follow-up in our study, while Tay et al reported follow-up of 2 years for sports activities in addition to standardized knee scores and patient satisfaction [14]. Local knee symptoms, and impairments of everyday function and sports activities have been reported to have improved significantly starting from 3 months follow-up to 24 months in a time-dependent manner by Schurz et al and in a similar follow-up study by IKDC, Lysholm, Tegner, and VAS score measures [15]. Stability of the knee, ACL damage and medial sided tests, range of motion, functional loss had been restored back to near normal at month 3 in this single-arm trial of 49 patients. Among functional measures, walking time has been associated with knee pain in a recent nationwide health survey from Korea. Future research should additionally address moderate level physical activities in a follow-up of arthroscopic surgery [16]. Although standardized scale including IKDC were not included, we achieved preferable level of functional recovery and local knee status post-surgically with 100% success rate for subjects who completed follow-up. Range of motion has been restored to normal status in all subjects.

MRI scans remain the major pre-surgical test for knee injury pathologies. We successfully incorporated MRI findings to surgical plan in arthroscopic diagnosis and reconstruction. Surgical procedures of choices had been near identical to MRI findings in our subjects, and studies support the need for and accuracy of MRI studies for knee injuries including ACL and meniscal damages [17-19]. Unfortunately, post-surgical follow-up with MRI scans are not the mainstay of patient follow-up and

rarely conducted in Mongolia.

Our investigation has several highlights exceeding previously reported investigations. We are reporting data of one of the first all-inside knee arthroscopy surgical techniques from central Asian countries in a LMICs situation [20]. Previous investigations have reported similarly three month and longer follow-ups for all-inside arthroscopy, however they lacked measures of range of motion to illustrate functionality of the knee [11, 13]. Additionally, aseptic safety in a developing country setting is less understood and we report a safe introduction of a novel arthroscopy technique [8, 14-15].

We explored the experience of the first cohort of patients who received all-inside knee arthroscopy at the NTORC of Mongolia. The initial procedures are well recorded at the national reference center, at least for the personnel, equipment and system for modern knee arthroscopic care. Arthroscopic repair outcomes and recovery of knee function could vary in developing countries. Therefore, early intervention, follow-up, and preventing further injuries, thereby avoiding high-cost total knee arthroplasty is recommended for countries introducing arthroscopy. Over the past 10 years, more than 1558 arthroscopic knee surgeries have been conducted at NTORC. We, therefore, recognize the importance of long-term follow-up and rehabilitative care systems for these patients at NTORC. Such long-term follow-ups may be challenging to establish due the dispersed residential population of Mongolia. Karimov et al, reported early-onset arthroscopy of knee injury patients with 3, 6- and 12-months follow-up in Uzbekistan [20]. Clinical pain outcomes and functional recovery was similar in this other central Asian study of knee arthroscopy with total of 81.36 ± 0.55 percent scale at month 3. Obesity is one of the risk factors associated with prolonging knee pain in post-arthroscopic patients and recent estimates indicate the prevalence of obesity is increasing in Mongolia [3]. However, long-term outcomes research for knee-arthroscopy is yet to be available in Mongolia [21].

Our study has several limitations. This study lacks standardized knee evaluations that are validated in the Mongolian language, namely IKDC Subjective Knee Form, KOOS, WOMAC, and Lysholm Knee Scoring Scale. In addition, all study design limitations of a single-arm trial apply to our investigation. We also could not rule out professional skills differences or technical variances of staff orthopedic surgeons at NTORC. Lastly, we did not incorporate controls or rehabilitation care into

our study.

Conclusion

Knee arthroscopic reconstruction and repair for primarily ACL injuries have achieved satisfactory level of knee pain, functional recovery, and range of motion recoveries at 3 months of follow-up in Mongolia. We demonstrated excellent experience in all-inside knee arthroscopic repair in a central Asian LMICs setting in Mongolia. Older age may present with post-surgical pain more often in Mongolian subjects. Future investigations should validate standardized subjective knee scales in the Mongolian language and conduct cultural adaptation to improve pre-surgical and post-surgical patient evaluations in Mongolia.

Conflict of Interest

The authors state no conflict of interest.

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