

A comparison of open and arthroscopic surgery for treatment of diffuse pigmented villonodular synovitis of the knee

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Abstract

Purpose To compare the outcomes of diffuse pigmented villonodular synovitis (PVNS) of the knee treated with routine anteroposterior open surgery or modified multi-directional arthroscopy.

Methods Medical records of patients with diffuse PVNS who underwent surgery between 2002 and 2010 were reviewed. Patients were followed up at 3, 6, 12, 24, and 36 months. Operative time, blood loss, length of hospital stay, recurrence rate, and International Knee Documentation Committee (IKDC) scores and Lysholm knee scores at 1- and 3-year postoperatively were compared between the open surgery and arthroscopy groups.

Results A total of 41 patients with diffuse PVNS were included (20 in open surgery group and 21 in multi-directional arthroscopy group). There was no significant difference in the baseline characteristics between the two groups. Operation time, postoperative bleeding, and length of hospital stay were all significantly lower in the arthroscopy group than in the open surgery group (all, $P < 0.05$). There were four recurrences in the open surgery group and one in arthroscopy group. All five recurrences received a second surgery without any subsequent recurrences. At both 1- and 3-year postoperatively, IKDC and Lysholm scores were significantly greater in the arthroscopy group than the open surgery group (all $P < 0.001$).

Conclusions The multi-directional arthroscopic technique was associated with significantly shorter operation time

and hospital stay, less blood loss, and better postoperative IKDC and Lysholm scores than open surgery.

Level of evidence Retrospective study with controls, Level III.

Keywords Diffuse villonodular synovitis (PVNS) · Knee · Open surgery · Arthroscopy

Introduction

Diffuse pigmented villonodular synovitis (PVNS) of the knee is a rare disease with an incidence of 1.8/1,000,000 [5, 7]. PVNS is a synovial proliferative disease mainly involving the synovial membrane, synovial bursa, and tendon sheath [19]. The condition is seen in two forms, localized and diffuse, and both types have a similar histological appearance, the main characteristic being multinucleated giant cells scattered between an abundance of oval monocytes [11]. This disease occurs most commonly in young adults aged 20–40 years, with a male predominance [14]. The disease mainly occurs in the knee joint, and the incidence of knee joint PVNS is 28–70 % [14, 18]. The primary clinical manifestations of knee joint PVNS include diffuse swelling, pain, locking, and erosion of the articular cartilage [7]. Because the symptoms are not specific, delays in diagnosis and treatment are common. Brown or dark red synovial fluid obtained by the joint aspiration contributes to the diagnosis; however, this finding is uncommon and definite diagnosis depends on pathological examination of synovial tissue. Tuberculosis of the knee has been reported to mimic PVNS [9].

Tradition treatment for PVNS is removing the diseased synovium with open surgery, and in many cases, postoperative radiotherapy is recommended [2, 12, 15, 19].

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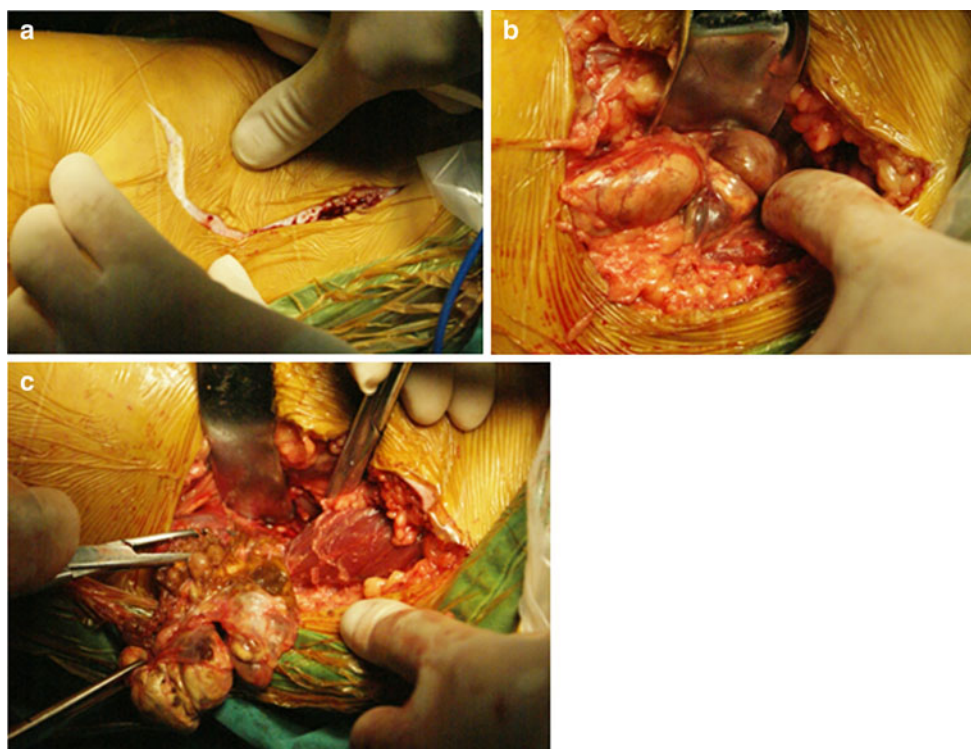


Fig. 1 Representative images of an open surgical case. **a** An L-shaped incision was made over the posterior knee joint. **b** Lesions posterior to the knee joint were exposed between the

medial head of the gastrocnemius and the semimembranosus. **c** The posterior lesion was dissected and removed completely

However, an open procedure cannot totally remove the diseased synovium located inferior to the meniscus, in the joint capsule, and on the surface of the cruciate ligament [1, 2, 12, 17]. Arthroscopic surgery may provide better visualization of diseased tissue and the surgical field than traditional open surgery. Reports have indicated that arthroscopic management of PVNS can provide improved outcomes over those of traditional open surgery [4, 8, 10, 16]. However, standard arthroscopy of the knee using the anteromedial and anterolateral approaches does not allow access to all areas where diseased tissue may be present.

The purpose of this respective study was to compare the outcomes of patients with diffuse PVNS of the knee who underwent the routine anteroposterior open surgical removal with those who received removal via modified multi-directional arthroscopic surgery. The hypothesis was that the clinical outcomes of treating diffuse PVNS using the modified arthroscopic surgical technique would be comparable with those of conventional open surgery and with a lower recurrence rate.

Materials and methods

The medical records of patients with PVNS of the knee who underwent surgery between August 2002 and

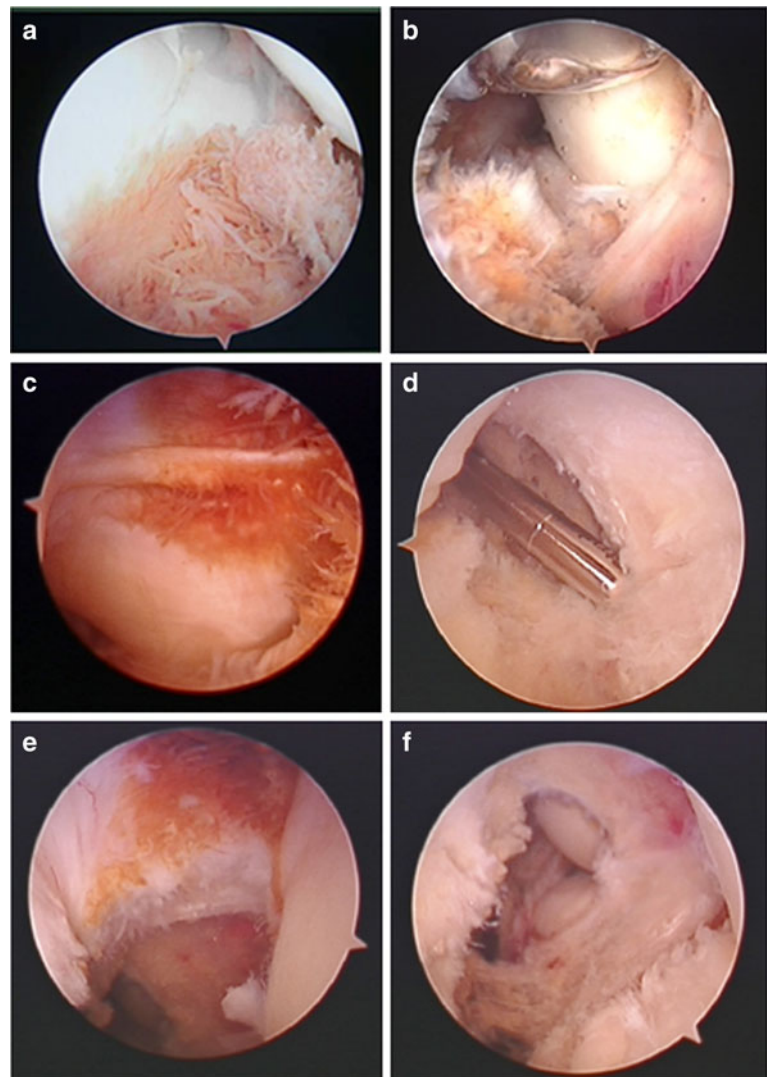
September 2010 at our hospital were retrospectively reviewed. During the period from 2002 to 2010, patients received either anteroposterior open surgical resection or modified multi-directional arthroscopic surgery. The surgical procedure a patient received was assigned based on hospital admission number (odd number vs. even number). All cases were pathologically diagnosed as diffuse PVNS of the knee.

All patients had symptoms such as the recurrent paroxysmal joint effusion, pain, swelling, and limitation of activity. In all cases, there was a sponge-like or bread-like elastic sensation with tenderness when touching the suprapatellar bursa. All patients received magnetic resonance imaging examinations (MRI) of the knee which showed a soft tissue mass with low or intermediate signal intensity on T1-weighted images and intermediate or slightly high signal intensity on T2-weighted images and varying degrees of knee effusion. No patient had received any prior treatment.

Surgical procedure

All surgeries were performed by the same team (three surgeons with more than 3 years of arthroscopy experience each who often worked together). Procedures were performed under general anaesthesia or combined spinal–

Fig. 2 Representative intraoperative arthroscopic surgery images. Brownish hyperproliferative papillary villi representing diseased tissue are seen in the preoperative images. **a** Preoperative and **b** postoperative images of the posterior capsule. **c** Preoperative and **d** postoperative images of the posteromedial compartment. **e** Preoperative and **f** postoperative images of the posterior septum



epidural anaesthesia, and a pneumatic tourniquet was applied.

Open anteroposterior surgical resection

In brief, the patient was initially placed in the supine position, and an anterior midline skin incision from the medial margin of the rectus femoris and the patella to the medial margin of the tibial tubercle was made. Intra-articular lesions were removed under direct visualization, the incision was closed, and the patient was placed in the prone position. An S-shaped incision was made posterior to the knee joint, the posterior joint capsule was exposed, incised, and the lesion was removed under direct visualization. The incision was then closed, and routine negative pressure drainage was placed. Representative intraoperative images of an open surgical case are shown in Fig. 1.

Multi-directional knee arthroscopic surgery

First, the superolateral portal anterolateral approach and the standard anteromedial approach were established at 90° knee flexion. A shaver or pituitary forceps was used to remove lesions in the anterior chamber of the knee, infrapatellar fat pad, and all diseased synovial tissues in the medial and lateral joint space including the inferior aspect of the meniscus. At full knee extension, a shaver or pituitary forceps was inserted through the auxiliary suprapatellar bursa and lateral approaches. The diseased synovium in the suprapatellar bursa, articular surface of the patella, and medial and lateral recesses were removed, and radio-frequency coagulation was carried out. To remove lesions in the posterior joint capsule, a Gillquist manoeuvre [6] was used at 90° knee flexion. Diseased synovium in the posterior chamber, posterior aspect of the PCL, and

posterior aspect of the tibial plateau was removed via posteromedial and posterolateral approaches.

Anterolateral and anteromedial manipulations were performed via a posteromedial and posterolateral approach to remove diseased tissue between the ligaments of Wrisberg and Humphrey. Briefly, the posterior septum (namely the septum between medial and lateral compartments) was removed using a shaver, and then, synovial lesions in the posterior joint capsule were able to be removed completely. Representative intraoperative images are shown in Fig. 2.

Postoperative management

In open surgery cases, a suction drain was placed and was removed on postoperative day 2. In all cases, compressive dressings and ice pack were applied after surgery. Patients received non-steroidal anti-inflammatory drugs and pain management as needed. Passive functional exercises were begun on the third postoperative day, and lower extremity open-chain exercises were begun 1 week after surgery. The range of knee passive activity reached approximately 100° by 2 weeks postoperatively.

Patients were followed up at 3, 6, 12, 24, and 36 months via telephone or mail survey. Outcome measures in this study were operative time, blood loss, length of hospital stay, recurrence rate, and International Knee Documentation Committee (IKDC) scores and Lysholm knee scores at 1- and 3-year postoperatively.

This study was approved by the Ethics Committee of Zhejiang Province People's Hospital (approval number 2013KY062), and because of the retrospective nature, the requirement of informed consent was waived. All patients provided surgical consent at the time of the procedure.

Statistical analysis

Demographics and clinical characteristics were presented as mean \pm standard deviation (SD) for continuous data, and number (%) for categorical data. Differences between groups were compared using the two-sample *t* test for continuous data and Pearson's chi-square test or Fisher's exact test, as appropriate, for categorical data. Pre- and postoperative IKDC and Lysholm scores were presented as mean \pm SD by group for given time points. Preoperative IKDC and Lysholm scores were compared between groups using the two-sample *t* test, and differences IKDC and Lysholm scores over time between groups were compared using repeated measurement ANOVA. All statistical assessments were two-tailed, and a value of $P < 0.05$ was considered to indicate statistical significance. Non-significant *P* values are denoted as n.s. Statistical analyses were

Table 1 Patient demographic and clinical data

Variables	Open surgery (<i>n</i> = 20)	Arthroscopic surgery (<i>n</i> = 21)	<i>P</i> value
Age (years)	35.5 \pm 10.7	38.0 \pm 12.5	n.s.
Sex			n.s.
Male	11 (55)	13 (61.9)	
Female	9 (45)	8 (38.1)	
Knee			n.s.
Right	9 (45)	10 (47.6)	
Left	11 (55)	11 (52.4)	
Disease duration (months)	18 \pm 6.4	16 \pm 7.2	n.s.

Continuous data are presented as mean \pm SD and categorical data as number (percentage)

n.s. (non-significant) indicates a value of $P \geq 0.05$

Table 2 Perioperative data

Variables	Open surgery (<i>n</i> = 20)	Arthroscopic surgery (<i>n</i> = 21)	<i>P</i> value
Operation time (min)	143.6 \pm 14.7	79.6 \pm 16.9	<0.001 ^a
Postoperative bleeding (ml)	332.5 \pm 79.2	153.8 \pm 43.6	<0.001 ^a
Hospital time (days)	18.0 \pm 2.9	8.9 \pm 2.2	<0.001 ^a
Lost to follow-up			n.s.
Yes	2 (10 %)	4 (19 %)	
Recurrence ^a	4 (22.2 %)	1 (5.9 %)	n.s.

Continuous data are presented as mean \pm SD and categorical data as number (percentage)

n.s. (non-significant) indicates a value of $P \geq 0.05$

^a Significant difference between groups, $P < 0.05$

performed using SPSS 18.0 statistics software (SPSS, Inc., Chicago, IL, USA).

Results

A total of 41 patients with diffuse PVNS who underwent surgery between August 2002 and September 2010 at our hospital were included in the study. In total, 20 patients underwent open anteroposterior surgical resection, and 21 patients underwent multi-directional knee arthroscopic removal (Table 1).

Perioperative data are summarized in Table 2. Operation time, postoperative bleeding, and length of hospital stay were all significantly lower in the arthroscopic surgery group than in the open surgery group (all, $P < 0.05$). No cases of neurovascular injury were noted. Postoperatively, two patients in the open surgery group and four in the

Table 3 Comparison of pre- and postoperative IKDC and Lysholm scores

	Preoperative	1-Year postoperative	3-Year postoperative	<i>P</i> value
IKDC score				
Open surgery	58.2 ± 3.8	73.6 ± 3.1	72.1 ± 3.0	<0.001*
Arthroscopic surgery	56.3 ± 2.7	84.7 ± 4.1	89.4 ± 2.7	
Lysholm score				
Open surgery	38.7 ± 3.5	77.3 ± 2.9	75.1 ± 3.0	<0.001*
Arthroscopic surgery	40.5 ± 2.6	88.4 ± 1.5	90.2 ± 1.9	

Data were presented as mean ± SD

* IKDC and Lysholm scores over time were significantly different between groups, $P < 0.05$

arthroscopic surgery group were lost to follow-up (n.s.). Four patients in the open surgery group and one in the arthroscopy group had a recurrence (n.s.), and all received a second operation. All five patients with recurrences received a second surgery without any subsequent recurrences. The mean follow-up time for all patients was 2.9 years (range 1–7.9 years).

A comparison of pre- and postoperative IKDC and Lysholm scores between groups is shown in Table 3. Preoperative IKDC and Lysholm scores were similar between the open surgery and arthroscopic surgery groups. At both 1- and 3-year postoperatively, IKDC and Lysholm scores were significantly greater in the arthroscopic surgery group than in the open surgery group (all, $P < 0.001$). Representative pre- and postoperative MRI studies of a patient in the open surgery group and the arthroscopic surgery group are shown in Fig. 3.

Discussion

The most important finding of the present study was that a modified multi-directional arthroscopic approach for the treatment of PVNS of the knee was associated with significantly shorter operation time, less blood loss, and shorter hospital stay than open surgery, and importantly 1- and 3-year postoperatively, IKDC and Lysholm scores were significantly better in the arthroscopy group than in the open surgery group, while the recurrence rate was similar. The modified multi-directional arthroscopic approach is minimally invasive and allows prompt postoperative joint functional recovery with fewer complications than open surgery. The modified arthroscopic method is unique and differs from traditional arthroscopic methods in that lesions are completely removed via multiple approaches.

PVNS has traditionally been managed with open surgery and in many cases postoperative radiotherapy; however, the recurrence rate is high. Akinçi et al. [1] treated 19 patients with PVNS (15 diffuse, 4 localized) with open

total synovectomy and recurrence was noted in five patients, and during the follow-up (average, 80.2 months), 7 of the 19 received total knee replacement. Nakahara et al. [12] treated 17 patients with diffuse PVNS with open synovectomy and reported recurrences in 2 patients with extra-articular lesions. In a review of 19 patients with diffuse PVNS of the knee treated with anterior and posterior synovectomies and adjuvant radiotherapy, Chen et al. [2] reported that postoperative MRI indicated residual disease in five of the patients of which two had recurrences at 6 and 9 months postoperatively.

Many authors have investigated arthroscopic management of PVNS for both localized and diffuse disease. Zvijac et al. [20] reported that arthroscopic treatment of PVNS may enhance the functional recovery, reduce the incidence of joint stiffness, and decrease joint pain. Kubat et al. [8] treated four patients with localized PVNS and nine with diffuse PVNS with arthroscopic synovectomy and reported excellent results in all patients with localized disease and 8 of the 9 patients with diffuse disease. Colman et al. [3] compared the results of 48 patients with diffuse PVNS treated with either an arthroscopic procedure, open posterior with arthroscopic anterior synovectomy or open anterior and open posterior synovectomy and reported recurrence rates of 62, 9 and 64 %, respectively. The authors acknowledged that the recurrence rates may have been affected by the technical challenges of posterior arthroscopic synovectomy and a selection bias of more aggressive disease in the open/open group. Loriaut et al. [10] treated 30 consecutive patients with localized PVNS arthroscopically and reported a median Lysholm Knee score of 85.5 with an average follow-up of 75 months.

Complete resection of the diseased synovium cannot be accomplished via the routine arthroscopic anteromedial and anterolateral approaches. A modified multi-directional knee joint arthroscopic approach was used in this study; namely, approaches medial and lateral to the suprapatellar bursa were added to completely remove the synovium located in the anterior chamber, suprapatellar bursa, and



Fig. 3 Representative pre- and postoperative MRI of a patient who received open surgery (**a, b**) and a patient who received arthroscopic surgery (**c, d**). **a, b** A 26-year-old male with a 4-year history of recurrent left knee pain and swelling, which was worsening for 6 months. The patient received open surgical treatment and the pathological diagnosis was diffuse pigmented villonodular synovitis. **a** Preoperative T2-weighted MRI showed diseased tissues within and outside the posterior joint capsule. **b** Postoperative T2-weighted MRI

showed thorough removal of the lesions. **c, d** A 25-year-old male with a 2-year history of left knee pain and swelling. The patient received arthroscopic surgery and the pathological diagnosis was diffuse pigmented villonodular synovitis. **c** Preoperative T2-weighted MRI showed diseased tissues in both the anterior and posterior compartments of the joint space. **d** Postoperative T2-weighted MRI showed thorough removal of the lesions

medial and lateral recesses. The technique was associated with a high rate of effective resection, and the rate of recurrence was only 5.9 % with a mean follow-up of approximately 3 years. This result may be an improvement of that reported by Ogilvie-Harris et al. [13] where a 9 % recurrence rate was reported at 4.5 years after arthroscopic total synovectomy. The method is minimally invasive, and postoperative joint functional recovery is faster with fewer

complications and a lower recurrence rate than with open surgery.

The two primary limitations of this study are the relatively small number of patients and the retrospective nature. However, the disease is rare and the number of cases is not dissimilar from that in other reports, and the two groups were similar with respect to demographic and disease characteristics.

Conclusion

In summary, the multi-directional arthroscopic technique described was associated with significantly shorter operation time, less blood loss, and shorter hospital stay than open surgery in the treatment of diffuse PVNS, and 1- and 3-year postoperatively, IKDC and Lysholm scores were significantly better in the arthroscopy group than in the open surgery group while the recurrence rate was similar. The minimally invasive nature of the technique and faster recovery of joint function postoperatively may facilitate the acceptance of patients to receive treatment at an earlier stage and thus improve clinical outcomes. The technique, however, requires advanced arthroscopic skills.

Conflict of interest None.

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