Pigmented Villonodular Synovitis of the Hip: A Systematic Review

David M. Levy, MD, Bryan D. Haughom, MD, Shane J. Nho, MD, and Steven Gitelis, MD

Abstract

Pigmented villonodular synovitis is a rare proliferative condition of the synovium that affects large joints. The primary treatment options are synovectomy and a combination of synovectomy and arthroplasty.

We performed a systematic review of the literature, excluding all nonclinical and review articles with follow-up of less than 2 years. Primary outcomes reported were disease recurrence, symptom progression, and revision surgery. Student *t* tests were used to compare outcomes after synovectomy with outcomes after synovectomy combined with arthroplasty.

Twenty-one studies (82 patients) were included. All represented level IV or V evidence. Fifty-one patients (59.3%) were female. Mean (SD) age was 33.2 (12.6) years. Synovectomy alone was performed in 45 patients (54.9%), and synovectomy with arthroplasty was performed in 37 patients (45.1%). Mean (SD) follow-up was 8.4 (5.9) years. The groups' revision rates were not significantly different (26.2% vs 24.3%; $P = .17$). Mean (SD) time to revision was significantly ($P = .02$) longer in the synovectomy-with-arthroplasty group, 11.8 (4.5) years, than in the synovectomy-only group, 6.5 (3.9) years.

Study results showed revisions are common after surgery for hip pigmented villonodular synovitis, affecting 1 in 4 patients regardless of which surgery they have—either synovectomy alone or synovectomy combined with arthroplasty. Revision is required sooner in synovectomy-only patients than in patients who also undergo arthroplasty.

Pigmented villonodular synovitis (PVNS) is a rare monoarticular disorder that affects the joints, bursae, or tendon sheaths of 1.8 per million patients.[1,2] PVNS is defined by exuberant proliferation of synovial villi and nodules. Although its etiology is unknown, PVNS behaves much as a neoplastic process does, with occasional chromosomal abnormalities, local tissue invasion, and the potential for malignant transformation.[3,4] Radiographs show cystic erosions or joint space narrowing, and magnetic resonance imaging shows characteristic low-signal intensity (on T1- and T2-weighted sequences) because of high hemosiderin content. Biopsy remains the gold standard for diagnosis and reveals hemosiderin-laden macrophages, vascularized villi, mononuclear cell infiltration, and sporadic mitotic figures.[5] Diffuse PVNS appears as a thickened synovium with matted villi and synovial folds; localized PVNS presents as a pedunculated, firm yellow nodule.[6]

PVNS has a predilection for large joints, most commonly the knee (up to 80% of cases) and the hip.[1,2,7] Treatment strategies for knee PVNS have been well studied and, as an aggregate, show no superiority of arthroscopic or open techniques.[8] The literature on hip PVNS is less abundant and more case-based, making it difficult to reach a consensus on effective treatment. Open synovectomy and arthroplasty have been the mainstays of treatment over the past 60 years, but the advent of hip arthroscopy has introduced a new treatment modality.[1,9] As arthroscopic management becomes more readily available, it is important to understand and compare the effectiveness of synovectomy and arthroplasty.

We systematically reviewed the treatment modalities for PVNS of the hip to determine how synovectomy and arthroplasty compare with respect to efficacy and revision rates.

Methods

Search Strategy

We systematically reviewed the literature according to PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines using the PRISMA checklist.[10] Searches were completed in July 2014 using the PubMed Medline database and the Cochrane Central Register of Clinical Trials. Keyword selection was designed to capture all level I to V evidence English-language studies that reported clinical and/or radiographic outcomes. This was accomplished with a keyword search of all available titles and manuscript abstracts: (*pigmented* [Title/Abstract] *AND villonodular* [Title/Abstract] *AND synovitis* [Title/Abstract]) *AND* (*hip* [Title/Abstract]) *AND* (*English* [*lang*])). Abstracts from the 75 resulting studies were reviewed for exclusion criteria, which consisted of any cadaveric, biomechanical,

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histologic, and/or kinematic results, as well as a lack of any clinical and/or radiographic data (eg, review or technique articles). Studies were also excluded if they did not have clinical follow-up of at least 2 years. Studies not dedicated to hip PVNS specifically were not immediately excluded but were reviewed for outcomes data specific to the hip PVNS subpopulation. If a specific hip PVNS population could be distinguished from other patients, that study was included for review. If a study could not be deconstructed as such or was entirely devoted to one of our exclusion criteria, that study was excluded from our review. This initial search strategy yielded 16 studies.[1,6,7,11-28]

Bibliographical review of these 16 studies yielded several more for review. To ensure that no patients were counted twice, each study's authors, data collection period, and ethnic population were reviewed and compared with those of the other studies. If there was any overlap in authorship, period, and place, only the study with the most relevant or comprehensive data was included. After accounting for all inclusion and exclusion criteria, we selected a total of 21 studies with 82 patients (86 hips) for inclusion (**Figure 1**).

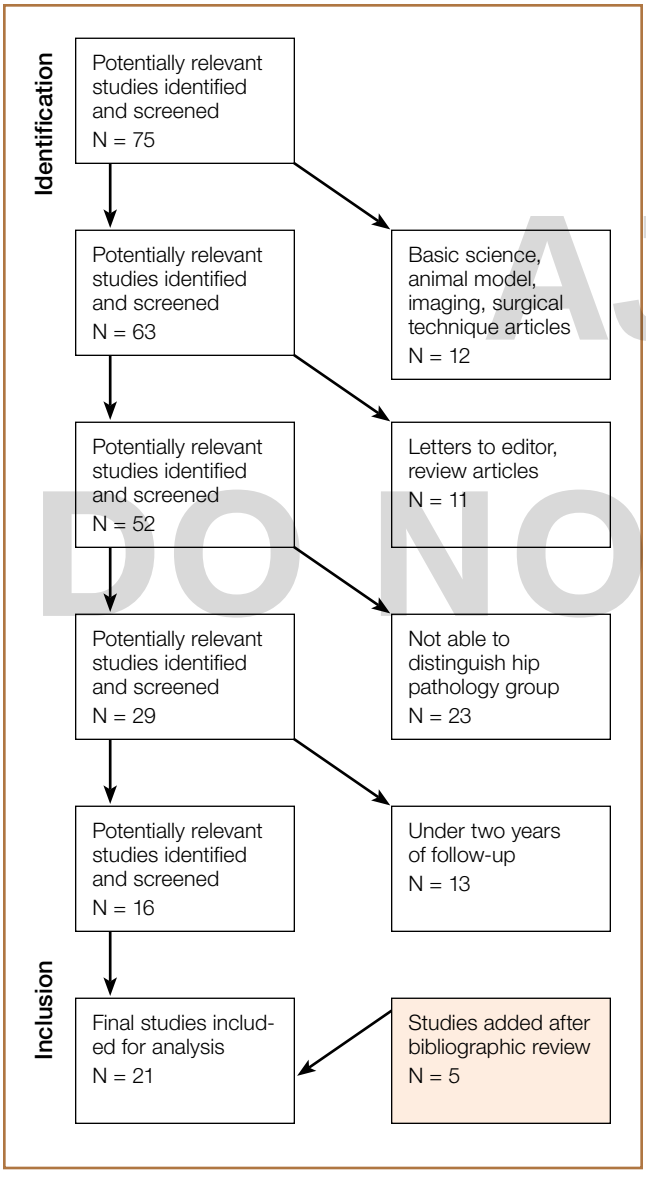

Figure 1. Systematic review search algorithm according to PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines.

Data Extraction

Details of study design, sample size, and patient demographics, including age, sex, and duration of symptoms, were recorded. Use of diagnostic biopsy, joint space narrowing on radiographs, treatment method, and use of radiation therapy were also abstracted. Some studies described multiple treatment methods. If those methods could not be differentiated into distinct outcomes groups, the study would have been excluded for lack of specific clinical data. Studies with sufficient data were deconstructed such that the patients from each treatment group were isolated.

Fewer than 5 studies reported physical examination findings, validated survey scores, and/or radiographic results. Therefore, the primary outcomes reported and compared between treatment groups were disease recurrence, clinical worsening defined as progressive pain or loss of function, and revision surgery. Revision surgery was subdivided into repeat synovectomy and eventual arthroplasty, arthrodesis, or revision arthroplasty. Time to revision surgery was also documented. Each study's methodologic quality and bias were evaluated with the Modified Coleman Methodology Score (MCMS), described by Cowan and colleagues.[29] MCMS is a 15-item instrument that has been used to assess randomized and nonrandomized patient trials.[30,31] It has a scaled potential score ranging from 0 to 100, with scores from 85 through 100 indicating *excellent*, 70 through 84 *good*, 55 through 69 *fair*, and under 55 *poor*.

Statistical Analysis

We report our data as weighted means (SDs). A mean was calculated for each study reporting on a respective data point, and each mean was then weighted according to the sample size of that study. We multiplied each study's individual mean by the number of patients enrolled in that study and divided the sum of all the studies' weighted data points by the number of eligible patients in all relevant studies. The result is that the nonweighted means from studies with a smaller sample size did not carry as much weight as those from larger studies. We then compared 2 groups of patients: those who had only a synovectomy and those who had a combination of synovectomy and arthroplasty. The synovectomy-only group was also compared with a group that underwent total hip arthroplasty (THA) specifically (**Figure 2**). Groups were compared with Student *t* test (SPSS Version 18, IBM), and statistical significance was set at $\alpha = 0.05$.

Results

Twenty-one studies (82 patients) were included in the final dataset (**Table 1**). Of these studies, 19 were retrospective case

series (level IV evidence) in which the number of eligible hip PVNS patients ranged from 1 to 15. The other 2 studies were case reports (level V evidence). Mean (SD) MCMS was 25.0 (10.9).

Fifty-one patients (59.3%) were female. Mean (SD) age of all patients was 33.2 (12.6) years. Mean (SD) duration of symptoms was 4.2 (2.7) years. The right hip was affected in 59.5% of patients in whom laterality was documented. Sixty-eight patients (79.1%) had biopsy-proven PVNS; presence or absence of a biopsy was not documented for the other 18 patients.

Of the 82 patients in the study, 45 (54.9%) underwent synovectomy without arthroplasty. Staged radiation was used to augment the synovectomy in 2 of these 45 cases. One series in this group consisted of 15 cases of arthroscopic synovectomy.[1] The 37 patients (45.1%) in the other treatment group had arthroplasty at time of synovectomy. These patients underwent 22 THAs, 8 cup arthroplasties, 2 metal-on-metal hip resurfacings, and 1 hemiarthroplasty. The remaining 4 patients were treated nonoperatively (3) or with primary arthrodesis (1).

Comparisons between the synovectomy-only and synovectomy-with-arthroplasty groups are listed in **Table 2**. Synovectomy patients were younger on average than arthroplasty patients, but the difference was not statistically significant ($P = .28$). Only 6 studies distinguished between local and diffuse PVNS histology, and the diffuse type was detected in 87.0%, with insufficient data to detect a difference between the synovectomy and arthroplasty groups. In studies with documented radiographic findings, 75.0% of patients had evidence of joint space narrowing, which was significantly ($P = .03$) more common in the arthroplasty group (96.7% vs 31.3%).

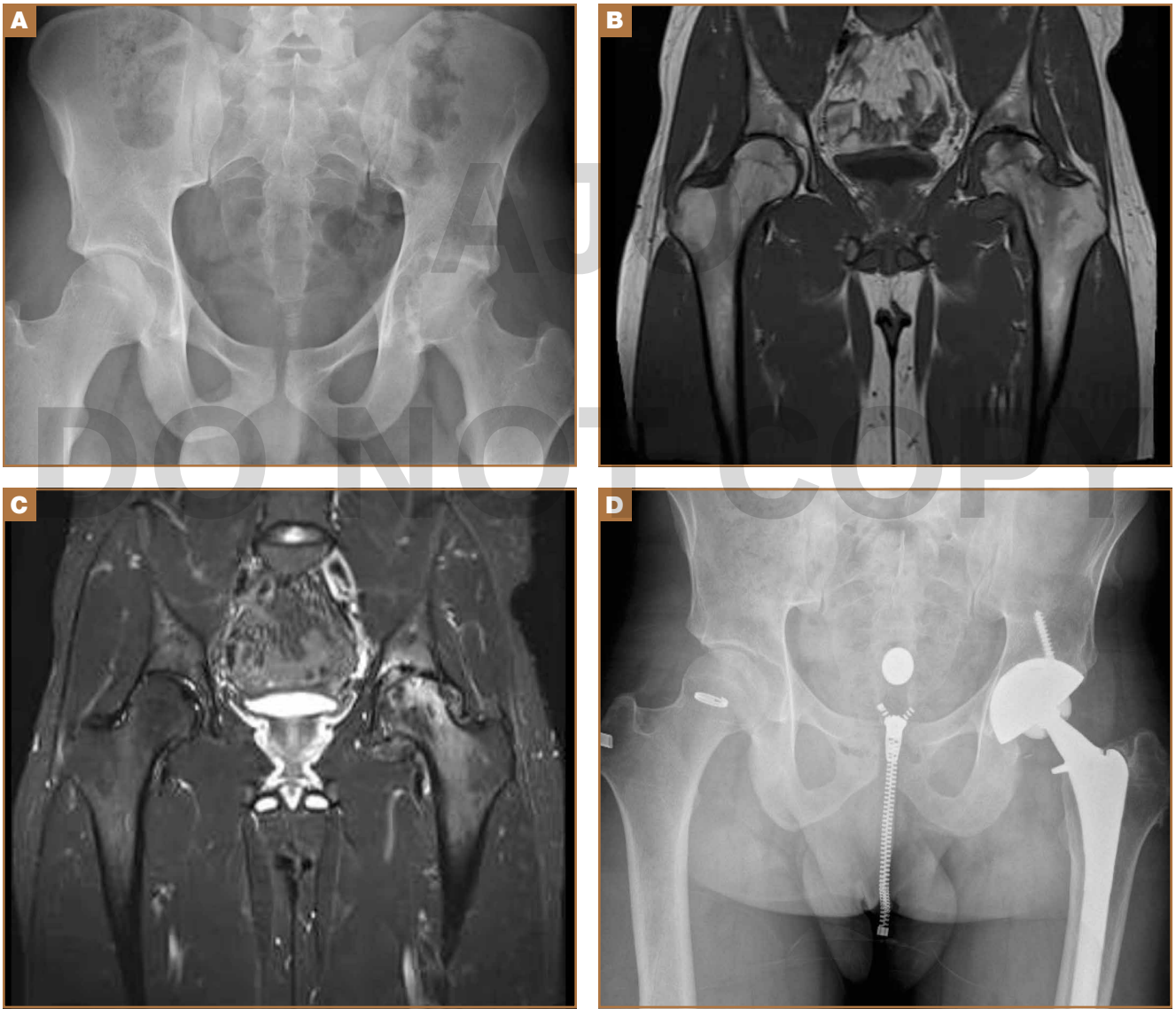

Figure 2. (A) Anteroposterior radiograph of pelvis of 22-year-old man shows advanced joint space narrowing and cortical erosions in femoral head and acetabulum of left hip. Magnetic resonance imaging shows characteristic synovial process with low-signal intensity in both (B) T1-weighted and (C) T2-weighted sequences. (D) Patient underwent total hip arthroplasty.

Mean (SD) clinical follow-up was 8.4 (5.9) years for all patients. A larger percentage of synovectomy-only patients experienced recurrence and worsened symptoms, but neither trend achieved statistical significance. The rate of eventual THA or arthrodesis after synovectomy alone was almost identical (P = .17) to the rate of revision THA in the synovectomy-with-arthroplasty group (26.2% vs 24.3%). Time to revision surgery, however, was significantly (P = .02) longer in the arthroplasty group. Two additional patients in the synovectomy-with-arthroplasty group underwent repeat synovectomy alone, but no patients in the synovectomy-only group underwent repeat synovectomy without arthroplasty.

One nonoperatively managed patient experienced symptom progression over the course of 10 years. The other 2 patients were stable after 2- and 4-year follow-up. The arthrodesis patient did not experience recurrence or have a revision operation in the 5 years after the index procedure.

Discussion

PVNS is a proliferative disorder of synovial tissue with a high risk of recurrence.[15,32] Metastasis is extremely rare; there is only 1 case report of a fatality, which occurred within 42 months.[12] Chiari and colleagues[15] suggested that the PVNS recurrence rate is highest in the large joints. Therefore, in hip PVNS, early surgical resection is needed to limit articular destruction and the potential for recurrence. The primary treatment modalities are synovectomy alone and synovectomy with arthroplasty, which includes THA, cup arthroplasty, hip resurfacing, and

Table 1. **All Studies Included for Review**

Study	Evidence Level	n[a]	Treatment[b]	MCMS
Shoji et al[11]	IV	2	Synovectomy (open)	27
Byrd et al[1]	IV	13	Synovectomy (arthroscopic)	49
Li & Jeffery[12]	V	1	Hemiarthroplasty	15
Hoberg & Amstutz[13]	IV	2	Hip resurfacing	15
Yoo et al[14]	IV	8	THA	46
Park et al[28]	V	1	THA	15
Chiari et al[15]	IV	3	Synovectomy (open)	35
Vastel et al[16]	IV	15	Synovectomy (open) (8) THA (4) Cup arthroplasty (3)	31
Shabat et al[17]	IV	1	Synovectomy (open, plus adjuvant radiation)	40
González Della Valle et al[18]	IV	3	Synovectomy (open) (1) Nonoperative (2)	34
Martin et al[6]	IV	4	Synovectomy (open) (1) THA (3)	30
de Visser et al[19]	IV	3	Synovectomy (open) (1) Synovectomy (open, plus adjuvant radiation) (1) THA (1)	27
Aboulafia et al[20]	IV	1	Synovectomy (open)	15
Moroni et al[21]	IV	4	Synovectomy (open)	27
Aglietti et al[22]	IV	6	Synovectomy (open) (4) THA (2)	15
Danzig et al[7]	IV	5	Synovectomy (open) (1) THA (2) Arthrodesis (1) Nonoperative (1)	24
Docken[23]	IV	1	Synovectomy (open)	15
Scott[24]	IV	1	Synovectomy (open)	15
Chung & Janes[25]	IV	2	THA (1) Cup arthroplasty (1)	18
McMaster[26]	IV	2	Synovectomy (open)	15
Ghormley & Romness[27]	IV	4	Cup arthroplasty	18

Abbreviations: MCMS, Modified Coleman Methodology Score; THA, total hip arthroplasty.
[a]Number of patients per study who were eligible for this review.
[b]Number in parentheses indicates number of patients per treatment; otherwise corresponds to third column.

Table 2. **Comparison of Synovectomy-Only and Synovectomy-With-Arthroplasty Patients**

	Synovectomy Only (n = 45)	Synovectomy With Any Arthroplasty (n = 37)	*P*[a]	Synovectomy With THA in Particular (n = 26)	*P*[a]	Total (N = 82)
Mean (SD) age, y	31.0 (11.3)	36.7 (14.8)	.28	36.4 (14.1)	.43	33.2 (13.0)
Mean (SD) duration of symptoms, y	3.2 (2.4)	4.9 (2.9)	.22	5.7 (3.0)	.08	4.2 (2.7)
Preoperative joint space narrowing, %	31.3	96.7	.03[c]	100	.02[c]	75.0
Mean (SD) follow-up, y	7.3 (6.6)	10.0 (5.9)	.65	10.1 (5.1)	.71	8.4 (5.9)
Recurrence, %	17.8	5.4	.30	3.8	.33	12.0
Worsening symptoms, %	40.5	32.4	.55	26.9	.37	36.1
Eventual THA or revision THA,[b] %	26.2	24.3	.17	23.1	.18	24.1
Mean (SD) time to revision, y	6.5 (3.9)	11.8 (4.5)	.02[c]	11.9 (5.2)	.08	8.6 (5.3)

Abbreviation: THA, total hip arthroplasty.
[a]*P* values represent *t* tests used to compare patient groups: (a) synovectomy only versus synovectomy plus any arthroplasty; (b) synovectomy only versus synovectomy plus THA in particular.
[b]One patient in synovectomy-only group eventually underwent arthrodesis (ie, not arthroplasty).
[c]Statistically significant.

hemiarthroplasty. According to our systematic review, about one-fourth of all patients in both treatment groups ultimately underwent revision surgery. Mean time to revision was significantly longer for synovectomy-with-arthroplasty patients (almost 12 years) than for synovectomy-only patients (6.5 years). One potential explanation is that arthroplasty component fixation may take longer to loosen than an inadequately synovectomized joint takes to recur. The synovectomy-only group did have a higher recurrence rate, though the difference was not statistically significant.

Open synovectomy is the most widely described technique for addressing hip PVNS. The precise pathophysiology of PVNS remains largely unknown, but most authors agree that aggressive débridement is required to halt its locally invasive course. Scott[24] described the invasion of vascular foramina from synovium into bone and thought that radical synovectomy was essential to remove the stalks of these synovial villi. Furthermore, PVNS most commonly affects adults in the third through fifth decades of life,[7] and many surgeons want to avoid prosthetic components (which may loosen over time) in this age group. Synovectomy, however, has persistently high recurrence rates, and, without removal of the femoral head and neck, it can be difficult to obtain adequate exposure for complete débridement. Although adjuvant external beam radiation has been used by some authors,[17,19,33] its utility is unproven, and other authors have cautioned against unnecessary irradiation of reproductive organs.[1,24,34]

The high rates of bony involvement, joint destruction, and recurrence after synovectomy have prompted many surgeons to turn to arthroplasty. González Della Valle and colleagues[18] theorized that joint space narrowing is more common in hip PVNS because of the poor distensibility of the hip capsule compared with that of the knee and other joints. In turn, bony lesions and arthritis present earlier in hip PVNS.[14] Yoo and colleagues[14] found a statistically significant increase in Harris Hip Scale (HHS) scores and a high rate of return to athletic activity after THA for PVNS. However, they also reported revisions for component loosening and osteolysis in 2 of 8 patients and periprosthetic osteolysis without loosening in another 2 patients. Vastel and colleagues[16] similarly reported aseptic loosening of the acetabular component in half their patient cohort. No studies have determined which condition—PVNS recurrence or debris-related osteolysis—causes the accelerated loosening in this demographic.

Byrd and colleagues[1] recently described use of hip arthroscopy in the treatment of PVNS. In a cohort of 13 patients, they found statistically significant improvements in HHS scores, no postoperative complications, and only 1 revision (THA 6 years after surgery). Although there is a prevailing perception that nodular (vs diffuse) PVNS is more appropriately treated with arthroscopic excision, no studies have provided data on this effect, and Byrd and colleagues[1] in fact showed a trend of slightly better outcomes in diffuse cases than in nodular cases. The main challenges of hip arthroscopy are the steep learning curve and adequate exposure. Recent innovations include additional arthroscopic portals and enlarged T-capsulotomy, which may be contributing to decreased complication rates in hip arthroscopy in general.[35]

The limitations of this systematic review were largely imposed by the studies analyzed. The primary limitation was the relative paucity of clinical and radiographic data on hip PVNS. To our knowledge, studies on the treatment of hip PVNS have reported evidence levels no higher than IV. In addition, the studies we reviewed often had only 1 or 2 patient cases satisfying our inclusion criteria. For this reason, we included case reports, which further lowered the level of evidence of studies used. There were no consistently reported physical examination, survey, or radiographic findings that could be used to compare studies. All studies with sufficient data on hip PVNS treatment outcomes were rated poorly with the Modified Coleman Methodology Scoring system.[29] Selection bias was minimized by the inclusive nature of studies with level I

to V evidence, but this led to a study design bias in that most studies consisted of level IV evidence.

Conclusion

Although the hip PVNS literature is limited, our review provides insight into expected outcomes. No matter which surgery is to be performed, surgeons must counsel patients about the high revision rate. One in 4 patients ultimately undergoes a second surgery, which may be required within 6 or 7 years after synovectomy without arthroplasty. Further development and innovation in hip arthroscopy may transform the treatment of PVNS. We encourage other investigators to conduct prospective, comparative trials with higher evidence levels to assess the utility of arthroscopy and other treatment modalities.

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This paper will be judged for the Resident Writer's Award.