How I do it

Pigmented villonodular synovitis

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Most orthopedic surgeons are familiar with the principles of treating proliferative synovial disorders such as rheumatoid arthritis, septic arthritis or gout. In patients presenting with intraarticular swelling, the differential diagnosis also includes pigmented villonodular synovitis (PVNS), a disorder which is uncommon and therefore less well known, and may be difficult to treat.

3 types of PVNS have been identified: extraarticular tenosynovial giant cell tumors, commonly in the hand, solitary intraarticular nodules, commonly in the knee and a diffuse villous, pigmented process, involving the entire synovial membrane of large joints.

Tenosynovial giant cell tumors and solitary intraarticular nodules of the knee seldom recur after simple excision and will not be further discussed. However, diffuse PVNS is difficult to treat and recurrence is common, sometimes with extraarticular extension.

Pathogenesis and etiology

PVNS was described by Jaffe et al. (1941) as a benign proliferative process of the synovial mebrane, with a potential for local recurrence after excision. Microscopically, PVNS shows villous projections of the synovial membrane, consisting essentially of histiocyte-like and fibroblast-like cells, as well as giant cells. Cytology of the joint fluid reveals considerable amounts of yellow-brown hemosiderin in the cytoplasm of numerous histiocytes and large numbers of multinucleated foreign body giant cells.

The genesis of PVNS is disputed. Most authors regard PVNS as a reactive process, a chronic inflammatory response or a benign neoplasm of fibrohistiocytic origin. Sakkers et al. (1991) found that PVNS was polyclonal by X-chromosome inactivation analysis, supporting the view that PVNS is a reactive process rather than a true neoplasm. A neoplastic origin is indicated by monoclonality, metastasis and chromosomal abnormalities, as in a case report by Choong et al. (1995). Trisomy 7 has been found in short-term cultures of PVNS specimens (Fletcher et al. 1992), but similar chromosomal aberrations have also been found in nontumorous synovial tissue (Mertens et al. 1993) and the available cytogenetic data cannot resolve the controversy as to whether PVNS is truly neoplastic or only a reactive proliferation.

An interesting finding of chromosome 1 aberration, including a deletion of the locus of coagulation factors III and V genes, possibly playing some role in the hemorrhagic tendency and histiogenesis of PVNS, has recently been presented (Ohjimi et al. 1996).

Genetic factors have also been considered important in the development of PVNS by Wendt et al. (1986), who identified the disorder in three generations, and it may be that preadolescent PVNS, in particular, has a genetic component.

Epidemiology

PVNS is usually found in adults aged 20–50 years, without sex predilection. The mean age at onset of symptoms is 35 years and the knee is by far the commonest location, comprising three quarters of the cases (Dorwart et al. 1984, Ushijima et al. 1986). The hip is the second commonest location, followed by the ankle (Dorwart et al. 1984, Friscia 1994). Involvement of the shoulder (Dorwart et al. 1984), the foot (Imhoff and Schreiber 1988) or the facet joints at all levels of the spine has also been reported (Giannini et al. 1996). PVNS may occasionally be seen in children and then often in otherwise unusual locations, such as the foot (Soifer et al. 1993) or even the sacro-iliac joint (Kang et al. 1992).

Even if PVNS, by definition, is a monoarticular disease, polyarticular involvement has been reported

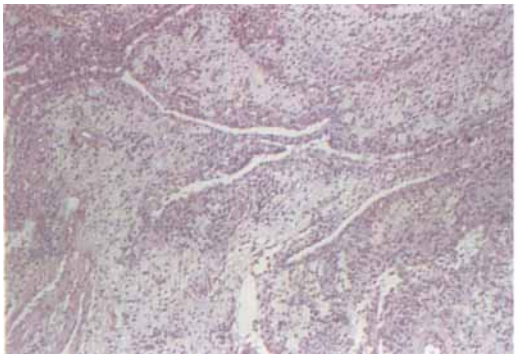

Figure 1. Villonodular synovitis with numerous foamy cells (HE, ×270).

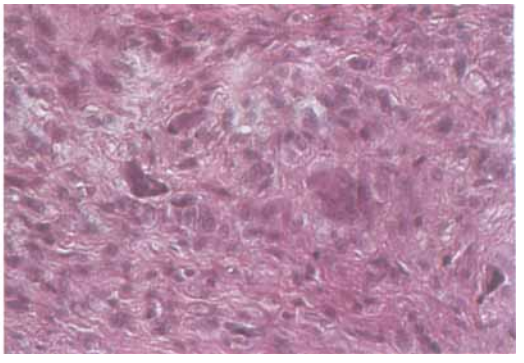

Figure 2. Spindle cell population and giant cell of osteoclast-like type (HE, ×600).

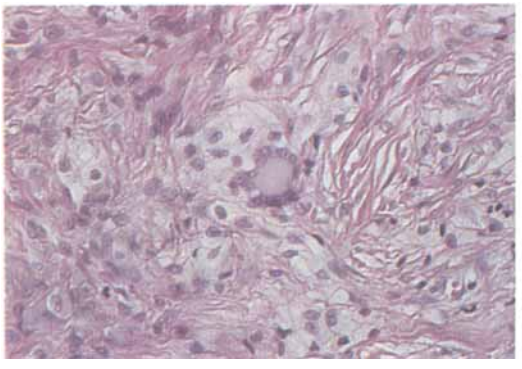

Figure 3. Numerous foamy cells and giant cells of Touton type (HE, ×600).

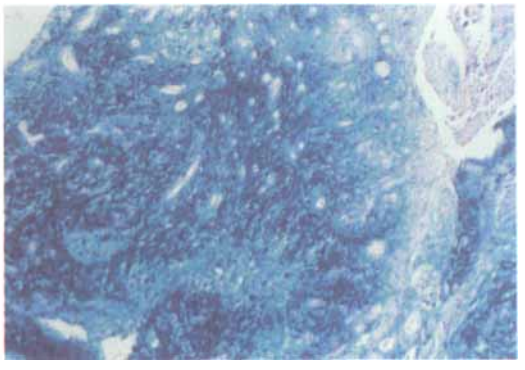

Figure 4. Massive iron deposition (Berlin blue iron staining, ×600).

in a few cases (Wendt et al. 1986, Flandry et al. 1994).

Clinical findings

Patients with PVNS of a large joint show a great variability in clinical symtoms and signs. Pain, swelling (not obvious in the hip) and limitation of motion are common. Heat and tenderness are uncommon. The duration of symptoms and signs before diagnosis is often one or several years. The amount of effusion may vary and may be increased by exercise or trauma.

Diagnostic investigations

Joint aspiration should be performed on wide indications in every patient with a swollen joint. In case of PVNS, the fluid is commonly serosanguineous and, without a history of trauma, almost diagnostic. Synovial fluid of normal appearance may, however, occur in patients with "inactive" disease. Synovial biopsy shows large villi and noduli with synovial cell proliferation and foam cells of histiocytic origin (Figure 1). Spindle cell population and multinuclear giant cells of osteoclast-like type or Touton type (Figures 2 and 3) are characteristic. A considerable amount of hemosiderin in the cytoplasm of histiocytes can be shown by iron staining (Figure 4). The PVNS lesions can show a high mitotic activity and extensive necrosis, which mimic malignancy. This is particularly true in lesions which have extended extraarticularly.

The histologic pattern of PVNS is almost pathognomic, but it may also be seen as an incidental finding in the synovium of patients having osteoarthritis or rheumatoid arthritis, operated on with total hip or knee replacement (Vigorita 1984). The histologic finding of foci of synovial hemorrhage may be present after trauma with hemarthrosis and is no proof of PVNS.

Arthrography is not diagnostic. Multiple lobulated filling defects may also be seen in inflammatory arthritis and in synovial chondromatosis.

Plain film radiography may show increased density of the synovium, secondary to hemosiderin deposition, and later typical radiolucent defects equally common on both sides of the joint and often at some distance from the joint line. The defects are mostly

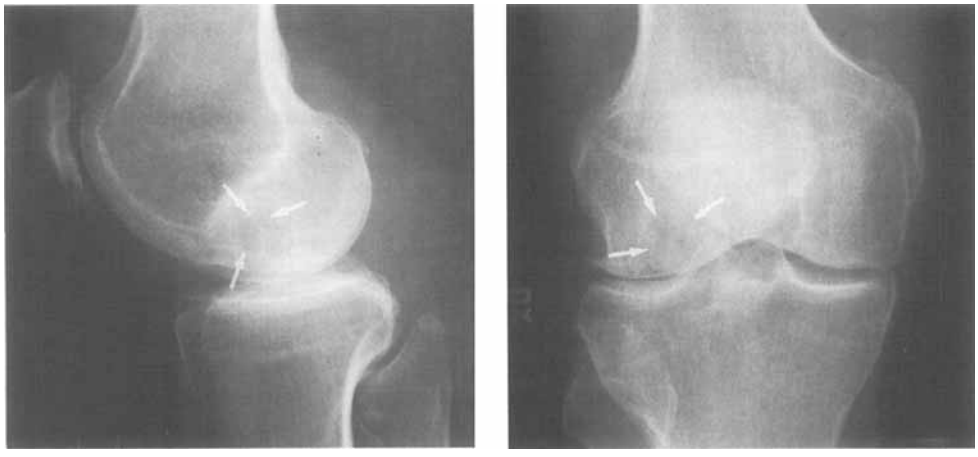

Figure 5. Case 1. Preoperative radiographs. Note joint space reduction and intraosseous cyst with sclerotic rim in the lateral femoral condyle (arrows).

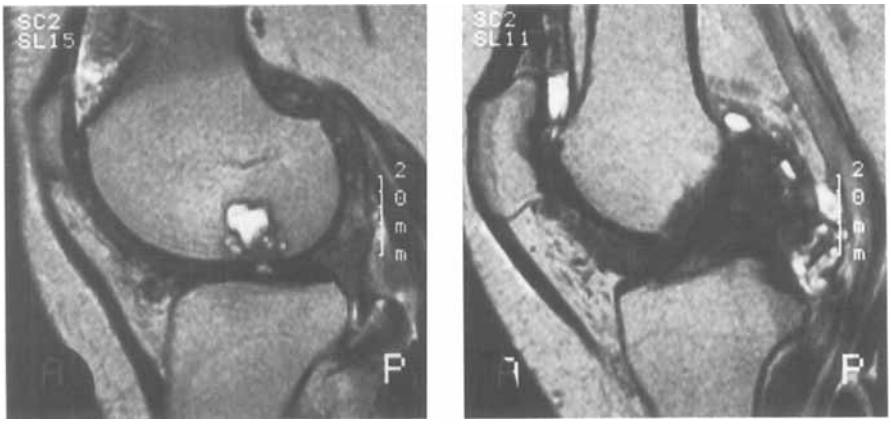

Figure 6. Case 1. T2-weighted MRI showing a fluid-containing cystic lesion in the lateral femoral condyle (left) and synovial masses posteriorly in the joint with low signal intensity indicating hemosiderin deposition (right).

cystic, with a thin sclerotic rim, 1–2 cm in diameter and, in some cases lobulated (Figures 5 and 8). Osteophytes and cartilage space-narrowing occur late and are signs of secondary arthrosis. Bony lesions, including cortical erosions and joint space-narrowing, are much commoner in the hip than in the knee (Rydholm 1987, Cotten et al. 1995), possibly due to the lower compliance of the hip, with resulting increased intraarticular pressure.

CT is helpful for demonstrating the location and degree of bone loss in the hip and knee, and helps to determine the need for bone grafts or prosthetic modifications. Contrast-medium enhanced CT may also be useful for detecting recurrent lesions and demonstrating extraarticular popliteal and posterior calf masses (Butt et al. 1990).

MRI often provides useful information (Hughes et al. 1995). It can reveal scattered low-signal intensity areas in the synovial membrane, representing hemosiderin deposition on T2-weighted images, and dotted areas of low-signal intensity, probably representing fibrous components of the lesion on T1-weighted images. At least for the knee, it seems possible to make the diagnosis solely on the MRI findings (Araki et al. 1994). MRI also provides a detailed map of the distribution of the disease in and outside the joint, which is especially important in the knee, with the possibility of PVNS masses in the popliteal fossa (Goldman and DiCarlo 1988) (Figure 6).

Scintigraphy gives no specific information, but a case reported by Kobayashi et al. (1994) showed an intense uptake of ^{99}Te, but not of ^{67}Ga, giving PVNS the radionuclide feature of a hyperplastic rather than an inflammatory lesion.

Arthroscopy is the most indispensable tool in diagnosis and treatment of PVNS in the hip, shoulder and

knee. The affected synovial membrane appears macrovillous, with a red-brownish color similar to that of bricks, which is soft and bleeds easily on probing. With the use of arthroscopy for diagnosis of knee disorders, many nodular PVNS lesions have been detected and cured at the same time. Arthroscopy also gives the possibility of evaluating secondary joint injuries.

Differential diagnosis

The differential diagnoses of PVNS on plain films with multiple subchondral cysts include degenerative joint disease, tuberculosis, amyloidosis, synovial chondromatosis and hemophilia (Goldman and DiCarlo 1988). In the rare case of a single cyst or erosion, a solitary bone tumor may be a diagnostic possibility.

Repeated intraarticular bleeding due to trauma or—uncommonly—a hemangioma may result in blood-stained joint fluid and discoloration of the synovial membrane similar to that found in PVNS, and also histologic examination sometimes cannot differ between PVNS and synovial changes secondary to repeated intraarticular bleedings.

Nonsurgical treatment

In my experience, intraarticular injection of triamcinolone-hexacetonid results in temporary but considerable relief of symptoms in many patients with both primary and recurrent PVNS of a large joint.

The response to ^{90}Y both as primary treatment and after recurrence of PVNS in the knee seems to be fairly consistent and good (Wiss 1982, Franssen et al. 1989, Gumpel and Shawe 1991), and the procedure may be repeated. Leakage of radioactivity seems low; only about 1% of the count rate measured above the knee was recorded above the inguinal lymph nodes and liver in the study by Franssen et al. (1989). Radioactive treatment is probably most effective in knees with minimal radiographic evidence of bone and cartilage destruction, in accordance with the experience in patients with rheumatoid arthritis. However, it requires proximity to the substance and a nuclear department. It is also doubtful whether the treatment should be recommended for fertile women.

Few reports exist with respect to the role of radiation treatment. Moderate dose radiotherapy (total 35 Gy in 15 fractions) seems to be effective when used after surgical removal of PVNS. O'Sullivan et al. (1995) treated 6 patients having primary and 8 having recurrent disease (with a mean of 2.5 previous surgical procedures). All patients had both intra- and extraarticular disease—i.e., type of the disease with a poor prognosis. After 6 (1–21) years' follow-up, only 1 patient showed persistence of the disease.

Surgical treatment

Synovectomy appears to be the most effective treatment for the symptomatic diffuse type of PVNS (Sim 1985). It can be accomplished efficiently with arthroscopic techniques, which reduce the morbidity associated with open synovectomy.

The PVNS hip or knee showing radiographic signs of joint destruction rapidly deteriorates to the stage requiring joint replacement. Total knee replacement offers a very good chance of relieving pain and restoring function, but the low age of these otherwise healthy patients with normal function, except in the affected joint, may result in early failure.

Total hip replacement appears to be the procedure of choice, even in young patients with advanced PVNS or after failed joint-sparing procedures.

Long-term results of surgical treatment

Patients with diffuse PVNS of the large joints vary greatly in their response to surgical treatment.

In generalized PVNS of the knee, Ogilvie-Harris et al. (1992) reported a lower recurrence rate in cases of total arthroscopic synovectomy than in subtotal synovectomy. A recurrence in only 2 patients has been reported after open surgical synovectomy of 23 knees with diffuse PVNS, followed for 5 years (Flandry et al. 1994). In a review by Schwartz et al. (1989), 99 patients with diffuse PVNS of the hip, knee, shoulder or elbow were followed for 14 (1–47) years after surgery, with 25 recurrences. The probability of recurrence-free survivorship at 25 years was 65%.

Secondary unicompartmental arthrosis of the knee has been successfully treated with upper tibial osteotomy (Gabel et al. 1992), but most commonly the PVNS knee with secondary osteoarthrosis will need total knee replacement. In 18 patients treated with total knee replacement and followed for a mean of 11 years, there were 4 failures: 3 due to aseptic loosening and 1 due to recurrence of active disease (later amputated) (Hamlin et al. 1997).

Long-term follow-up of PVNS of the ankle has shown a very high rate of recurrences, probably explained by the difficulties of obtaining a total synovectomy (Imhoff and Schreiber 1988).

Although recurrence after treatment of generalized PVNS thus seems to be fairly common, it may be delayed for a considerable period (Panagiotopoulos et al. 1993).

In all joints, it is hard to distinguish between residual disease and recurrence in a previously unaffected synovial membrane. This is of minor importance and it should be remembered that the functional results of treatment may be satisfactory, in spite of recurrence. This speaks against more aggressive treatment.

How I do it

Knee

The increasing use of arthroscopy with biopsy has resulted in more referrals of early cases, mainly with affection of the knee and my chief experience is with that joint. Nodular PVNS is sometimes unexpectedly found in connection with diagnostic arthroscopy because of suspected internal derangement of the knee. Local synovectomy (excision biopsy) will cure many of these patients, but some of them may have generalized PVNS, with uneven distribution in the joint, giving a false diagnosis of nodular PVNS.

After the biopsy has been reexamined by an experienced pathologist and the diagnosis is confirmed, I check the plain radiographs for signs of erosions or subchondral cystic lesions. If the radiographs are normal, my primary treatment is intraarticular injection of 2 mL of triamcinolone-hexacetonid. This will temporarily cure most patients, and I have found the effect to be equivalent to radiation synovectomy with ^{90}Y. Since most patients are in the third or fourth decade and fertile, and leakage of radioactivity cannot be ruled out, I have used radiation synovectomy only in men older than 35 years. The availability of the isotope is limited and secondary radiation to lymph nodes and gonads must be checked in cooperation with a radiation therapy department.

In case of primary severe hypertrophy of the synovial membrane or radiographic signs of subchondral cysts or secondary arthrosis, as well as in patients with rapid recurrence of symptoms after intraarticular corticosteroids, I prefer open surgical synovectomy, performed as radically as possible. Curettage of the cartilage-bone border and subchondral cysts is always done and the joint is left with intraarticular drainage for the first 24 postoperative hours. Recently, I have used tranexamic acid in one or two doses to reduce postoperative bleeding. The rehabilitation is similar to that after synovectomy for any other disease.

Patients having a recurrence after surgical synovectomy are managed with repeated steroid injections or arthroscopic resynovectomy. Patients with severe radiograpic cartilage or bone destruction are offered total knee replacement, which will eradicate the disease in almost every case.

On the basis of recent experience by O'Sullivan et al. (1995) of the effectiveness of moderate-dose radiotherapy in patients with intra- and extraarticular PVNS, I shall, in future, use radiation therapy for patients with primary voluminous and/or extraarticular PVNS of the hip or knee, as well as patients having a recurrence after synovectomy or total joint replacement.

Other joints

Patients with PVNS of the hip are primarily offered intraarticular corticosteroids in connection with arthroscopy. PVNS in the hip sometimes extends outside the joint, sometimes with intrapelvic extension, and MRI is always done. In my experience, it is impossible to achieve a radical synovectomy of the hip, either arthroscopically or with open technique. In young patients with limited disease, however, synovectomy is primarily performed. Probably due to the low compliance of the hip joint capsule, radiographic signs of joint destruction occur at an early stage (Rydholm 1987, Cotten et al. 1995) and the treatment for patients not responding to intraarticular corticosteroids or synovectomy will therefore, sooner or later, be total hip replacement. It seems that extraarticular PVNS disappears or at least stops growing after total joint replacement of both the hip and knee.

PVNS of the ankle and shoulder is uncommon and the principles of treatment follow those for the knee.

I have seen several cases with recurrence of the disease after several decades, and all patients are always informed about this possibility. Late recurrence in the knee has sometimes an extraarticular component and, in this group, radiation therapy seems more attractive than repeated surgery.

Conclusions

PVNS must always be suspected in young adults with repeated swelling in a single joint, to avoid the nowadays common long delay between onset of disease and diagnosis. The rarity of the process, the different forms of the disease and the different behavior in various anatomic sites, as well as the scarcity of long-term follow-up reports, however, make it difficult to give recommendations for treatment.

Pain relief and restoration of normal mechanics of the joint, whether by chemical, radioactive or surgical removal of the diseased synovial membrane, is the goal of treatment. When the diagnosis is made, there is, however, sometimes already such extensive carti-

lage and bone destruction that joint replacement becomes necessary.

The high recurrence rate after synovectomy reflects the chronicity of the disease. It might be that radiation therapy will result in a lower rate of recurrence, making it possible to avoid or at least postpone the need for total joint replacement.

The treatment of PVNS should be centralized, to give an orthopedic surgeon enough experience. A controlled prospective trial of different treatment modalities seems desirable but, even if performed as a multicenter study, the data on a sufficient number of patients would take many years to accumulate.

Acknowledgment

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Two typical cases are described below.

Case 1

A now 47-year-old woman had problems in her right knee since 1983. The clinical diagnosis was a meniscal injury and lateral meniscectomy was performed in the same year, followed by medial meniscectomy in 1986. Because of persisting synovitis and joint effusion, a synovectomy was done later in 1986. Histologic examination of synovial biopsies showed PVNS. The patient experienced continuous pain on motion and at weight bearing, with some loss of joint mobility, until referral in 1995. She presented with diffuse periarticular swelling, with 15° extension deficit and flexion limited to 90°, partly due to a large Baker's cyst. Radiographs (Figure 5) showed a reduction of the joint space and a large subchondral cyst in the lateral femoral condyle. MRI (Figure 6) showed the joint to be filled with synovial masses and also the extent of the osteolytic lesion in the lateral femoral condyle. The radiographic findings were considered too advanced to justify repeat synovectomy and a total knee replacement (Figure 7) was performed. At the 2-year follow-up, she had only minor symptoms in her right knee, which had full extension and limitation of flexion to about 100°, but no clinical signs of recurrent PVNS.

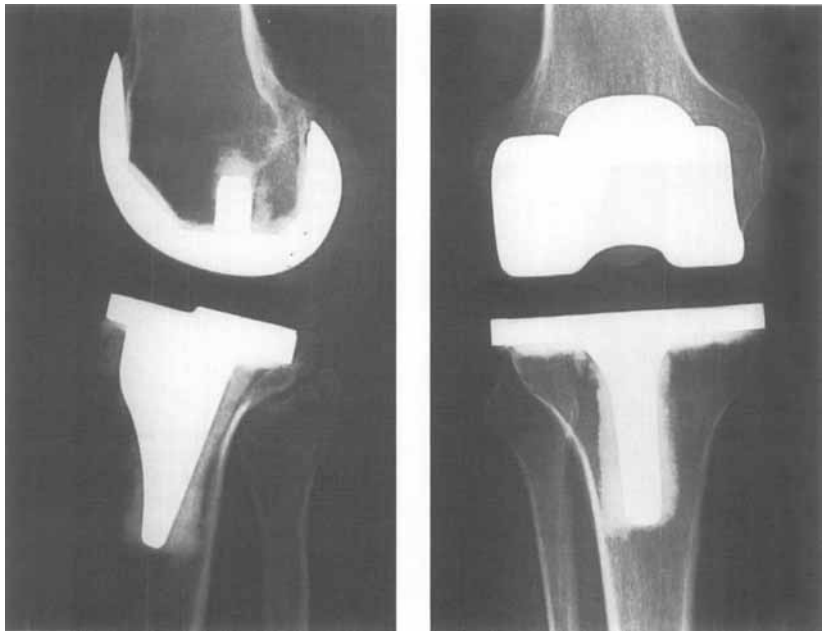


Figure 7. Case 1. After total knee replacement. No recurrence after 2 years.

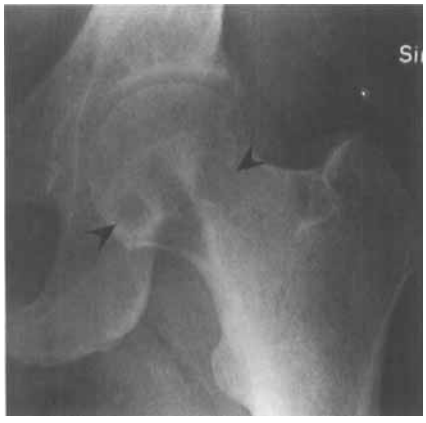


Figure 8. Case 2. Plain film radiography, showing cyst-like changes in the femoral head and neck (arrows).

Case 2

A now 24-year-old woman had a 5-year history of pain from her left hip. The first radiographs were taken after 4 years (Figure 8). In spite of radiographic findings with features typical of PVNS, she was given a diagnosis of nonspecific inflammatory hip disease and treatment with antiinflammatory drugs made her pain-free. After an asymptomatic period of half a year, she experienced pain again and MRI (Figure 9) showed findings typical of PVNS. At referral, she had minor pain on weight-bearing and maximal inward rotation, which was slightly reduced. At arthroscopy, the synovial mebrane showed red-brown discoloration (Figure 10). Synovial biopsies were sent for histological examination, which confirmed the diagnosis of PVNS (Figures 1–4). The patient is on the list for open synovectomy.

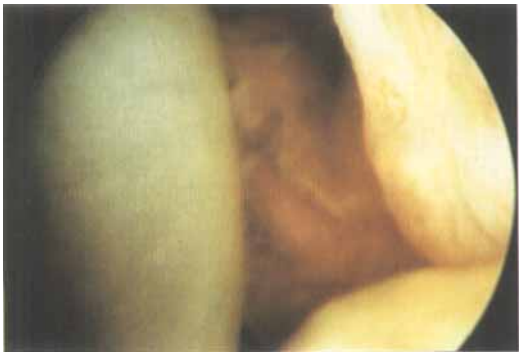
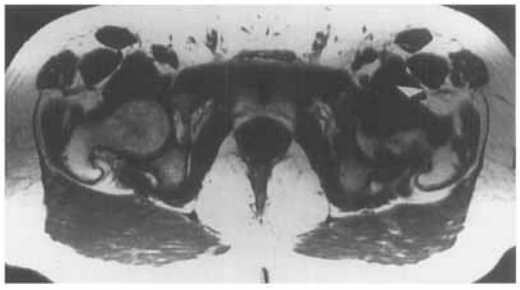
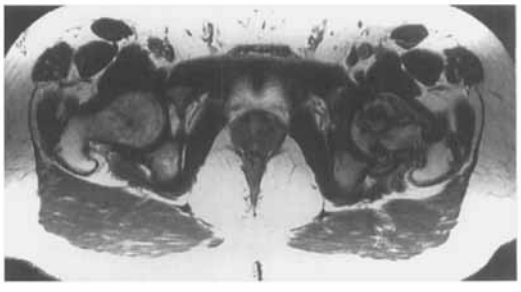


Figure 9. Case 2.



Axial T1-weighted MR image of both hips. The lesion has low signal intensity and erodes the femoral head and neck (arrow).



T1-weighted image after intravenous injection of Gd-DTPA. There is a moderate increase in signal intensity in the lesion, but areas of low signal intensity are present.

T2-weighted, fat saturated MR image. Mixed signal intensity in the lesion is apparent, although the inflammatory high-signal area dominates. The areas with low signal intensity indicate presence of hemosiderin in the synovia.

Figure 10. Case 2.
Arthroscopic view. Femoral head is to the left and the red-brownish synovial membrane surrounding the *teres ligament* is seen centrally. Synovial biposies were taken from this tissue and the microscopic appearance is shown in Figures 1–4.