Problems in Family Practice

Knee Effusions

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There are many questions concerning knee effusions and the basic diagnostic approach to them. The case of a young female with gonococcal arthritis presenting to the Emergency Room with an isolated knee effusion is discussed. From the errors in diagnosis of this case, a basic outline in the approach and work-up of a knee effusion is detailed, including history and physical examination, and the use of synovial fluid analysis as a further diagnostic aid. Procedural instructions and contraindications for knee arthrocentesis are given, as well as data related to interpretation of pertinent laboratory findings of synovial fluid in disease states.

Knee effusions are often of a definite and obvious etiology, such as those associated with trauma. However, the clinician must have a logical approach in dealing with knee effusions and, thus, not overlook less obvious causes of the swollen knee, such as illustrated below.

Case Report

A 16-year-old white female presented to the Emergency Room with a complaint of a swollen right knee of five days' duration. The patient was on a camping trip and reported that she bent down to pick up an object and heard a pop in her right knee. When she stood up she reported inability to flex her knee. She was initially seen in another Emergency Room where the physician examined her and wrapped her knee in an Ace wrap. He told her to seek medical attention, as needed, for her "sprained knee" when she arrived home. Subsequently, the patient came to our Emergency Room complaining of persistence of pain, swelling, and limited range of motion of the right knee. She gave no history of fever, chills, or arthralgia. She gave no history of previous infection within the past month and no history of any sexual contact. She had had no similar episodes previously. Her review of systems was generally unremarkable.

Physical examination revealed a well-developed white female in moderate distress from right knee pain. Temperature was 100.2 F. Examination of the right knee showed that she had a moderate effusion. The knee was not warm and was without erythema. There was diffuse medial tenderness which did not increase with stress of the knee. Range of motion of the knee was from 0 to 30 degrees. McMurray's test could not be performed because of pain. The knee was stable, both to medial and lateral stress, as well as to anterior and posterior stress.

Laboratory data revealed a serum white blood cell count of 10,900/cu mm with 11 percent non-segmented cells, 58 percent segmented cells, 23 percent lymphocytes, and 7 monocytes. X-ray of the knee showed a moderate effusion without evidence of any other disease process. A knee tap was performed and 100 cc of cloudy green fluid was obtained. Fluid analysis from the knee showed a white blood cell count of 58,800/cu mm, with 92 percent polymorphonuclear cells and 8 percent monocytes. There were 657 red blood cells per cu mm in the fluid. Synovial fluid protein was 5.8 gm percent, while serum protein was 7.6 gm percent. Synovial fluid glucose was 50 mg percent and simultaneous serum glucose was 110 mg percent. Sedimentation rate was 101 mm/hr. A VDRL was non-reactive and ANA from the serum was negative. Tuberculosis cultures were taken and later shown to be negative. Cultures obtained from the knee did, however, grow out 3+ Neisseria gonorrhoea.

After obtaining the green synovial fluid, a further physical examination revealed a normal female except for pelvic examination. This revealed a white discharge from the cervical os. In addition, bimanual examination revealed bilateral adenexal tenderness with the right being greater than the left. There was exquisite pain with motion of the cervix. Gram stain of

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Table 1. Synovial Joint Fluid Findings

	Normal	Non-Inflammatory	Inflammatory	Septic
Color	Clear	Yellow	Yellow to Green	Yellow to Green
Clarity	Transparent	Transparent	Transparent to Opaque	Opaque
Viscosity	High	High	Low	Variable
WBC/mm^3	<200	200–2,000	2,000–150,000	15,000–200,000
Polymorphonuclear Cells	<25%	<25%	>50%	>75%
Mucin Clot	Good	Good	Good to Poor	Poor
Culture	Negative	Negative	Negative	Usually Poor
gm% Protein	<3.5	<3.5	>3.5	>3.5
Example Disease		Osteoarthritis, Systemic Lupus Erythematosus, Osteochondritis Dissecans, Early or Subsiding Inflammation	Rheumatic fever, Rheumatoid arthritis, Juvenile Rheumatoid Arthritis, Gout, Reiter's Syndrome, Ankylosing Spondylitis, Pseudogout	Bacterial Infection, Acute Tuberculosis, Cocci

the cervix revealed gram-negative intracellular diplococci, although cervical cultures were negative.

After a complete physical examination, the patient was again questioned concerning any history of sexual intercourse. She reported that she had had intercourse with several different partners in the previous six months, as well as a therapeutic abortion nine months previously.

In the hospital she was treated with high dosage of intravenous penicillin. Aqueous penicillin was continued for a total of five days and then the patient was switched to oral penicillin before discharge. The patient was completely afebrile after four days. Pain of the knee was markedly improved by the fifth day after admission. Sedimentation rate had decreased from 101 mm/hr on admission to 72 mm/hr by the sixth day of hospitalization.

Clinic follow-up, six weeks after discharge, revealed that the patient had no pain and was ambulating without problems. The range of motion of her knee at that time was recorded as 0 to 100 degrees of flexion. There were no x-ray changes of her knee at that time.

Discussion

This case is presented to demonstrate the value of a knee arthrocentesis, whether used for diagnostic purposes or for relief of pain. It is found that in a case of definite trauma to the knee, the patient will often appreciate a therapeutic tap to obtain relief. As seen in this case, a gonococcal infected knee was originally treated with an Ace wrap and crutches because the diagnosis was missed. This would not have happened if an arthrocentesis had been performed. The case presented is an isolated incident, but points to the confusion that exists concerning knee effusions. Some of the confusion and questions are: "What are the pertinent physical findings to look for in a patient with a knee effusion?" "Should an arthrocentesis of the knee be performed?" and finally, "What should be done with the synovial fluid once obtained?"

As with most medical problems, evaluation first includes a history. History as to associated mechanism of injuries sustained, the time sequence, and the rate of formation of effusion is important. Questions concerning mechanical blocks of the knee with motion, such as locking and clicking, should always be asked. These symptoms may be indicative of internal derangements of the knee. The history should include a probe into possible infection or other systemic manifestations of multisystem disease. These may include questions concerning

fever and chills, involvement of other joints, possible recent sexual contact, associated back pain, and a quick review of systems, as indicated. However, as seen in this case, with initial unreliable information from the patient, even the most compulsive questioner may have to rely on other modalities for diagnosis.

Next, a physical examination of the knee is performed. The physician first inspects the knee, noting any deformities or scars. The knee is gently palpated for any areas of point tenderness (the joint line may be tender with meniscal tears). The physician feels for associated warmth in the extremity (with joint sepsis, the knee is usually warm, but occasionally in early sepsis this may not be so, as illustrated by the case presented).[1] The range of motion of the knee is recorded. A check for pain on stress of the knee in both varus and valgus positions is done. Pain medially with valgus stress is indicative of medial collateral involvement, while pain laterally with varus stress is indicative of lateral collateral involvement. However, it has also been shown that not only do the collateral ligaments play a role in varus and valgus stability of the knee, but also the joint capsule and cruciate ligaments contribute to this stability.[2] Examination of the knee in terms of anterior and posterior stability is performed in the form of a drawer sign. This is done with the knee flexed to 90 degrees with the examiner's hands in the popliteal fossa behind the tibia. The tibia is then moved in an anterior and posterior direction with the femur and the foot stabilized. Laxity of the knee in terms of anterior and posterior movement, in comparison with the opposite knee, may be indicative of cruciate injury. Slocum has modified this basic drawer sign to test also for rotatory instability of the knee.[3] Laxity with the anterior drawer sign performed with the tibia in 30 degrees of internal rotation, is indicative of posterior or lateral capsule disease. The second part of Slocum's test is also a modified drawer maneuver, but with the tibia in 15 degrees of external rotation. Laxity is indicative of injury to the posterior medial capsule of the knee. A McMurray's test is performed with the knee brought from 90 degrees of flexion to full extension with the tibia first externally rotated, then internally rotated.[4] This test is positive if a click is felt or heard on the joint line if associated with pain. This is usually indicative of meniscal tear.

The patella is next examined for possible pathology. Usually accumulation of fluid in the knee is obvious on inspection. However, in cases where only a small amount of fluid is present, by milking the suprapatellar pouch with one hand and compressing the patella against the femur with the other hand, balloting of the patella may become more obvious. This is usually indicative of a knee effusion. Crepitance of the patella may be indicative of fracture of the patella, chondromalacia of the patella, or osteochondromal fragments.[4] An apprehension test of the patella may be used to test for possible patella subluxation or dislocation.[5] It is done with lateral stress of the patella with the knee stable and in extension. It is positive if pain is produced and/or patella subluxation occurs. Finally, a neurovascular check of the extremity should always be made.

After physical examination, x-rays are always obtained of the knee. These should include routine standing anteroposterior (AP) and lateral views of the affected knee, as well as intracondylar and sunrise views. It is necessary to obtain a full complement of x-rays to rule out vertical patella fractures, osteochondromal fragments, and other injuries or deformities of the patella, femoral, and tibial joint surfaces.[6]

As clinically indicated, an arthrocentesis of the joint may be performed. As pointed out in the literature, the incidence of introducing an infection with arthrocentesis is less than one in 20,000 procedures if performed correctly.[1] Precautions must be taken when tapping the knee since some authors have indicated that cellulitis, bacteriemia, or bleeding tendencies are strict contraindications for performing arthrocentesis.[7] When performing a knee tap, the procedure is as follows: the knee is prepped with povidone-iodine (Betadine) alone, or with Betadine then alcohol, for ten minutes. The site of the tap is 2 cm medial to the anterior aspect of the patella. The skin is then infiltrated with one percent lidocaine (Xylocaine) using a 25-gauge needle with an 18 or 19-gauge needle used for the joint tap. If this is done carefully, the patient will experience very little discomfort.

Table 2. Laboratory Data That May Be Obtained on Synovial Fluid

Tube 1 (Sterile)
Culture and Gram Stain (Fungus and Tuberculosis Culture, if indicated)
Tube 2 (Heparinized)
Cell Count and Differential
Tube 3 (Clotted)
Glucose, Protein (ANA, C_3, C_4, if indicated)

The fluid obtained should always be analyzed. Even if there is an obvious history and physical examination compatible with a traumatic effusion and a frankly bloody tap is obtained, it is wise not to discard the fluid. It must be remembered that bloody taps may be obtained not only with a traumatic effusion, but also with hemophilia, synovioma, neuropathic joints, pigmented villonodular synovitis, and occasionally, in patients on oral anticoagulants.[7] As much fluid should be obtained as possible without causing discomfort to the patient. With bloody taps from traumatic knee, 10 to 15 cc of one percent lidocaine is injected into the knee joint through the arthrocentesis needle. This has been found to be extremely helpful when re-examining the knee. Before the tap, the traumatic knee may be too painful to examine. However, after the tap and the injection of the lidocaine, the pain in the knee is

Table 3. Etiologies of Knee Effusions

Trauma
- Meniscus injury
- Ligament tear (partial or complete)
- Capsule or synovium injury
- Fracture with intra-articular involvement

Polyarthritis of Unknown Etiology
- Rheumatoid arthritis
- Juvenile rheumatoid arthritis
- Ankylosing spondylitis
- Psoriatic arthritis
- Others

Connective Tissue Disorders
- Systemic lupus erythematosus
- Dermatomyositis
- Scleroderma
- Reiter's syndrome
- Others

Degenerative Joint Disease
- Primary
- Secondary

Infections
- Bacterial
  - Staph, strep, pneumococcus
  - Gonococcus
  - Mycobacterium tuberculosis
  - Others
- Viral
- Fungal

Metabolic or Biochemical
- Gout
- Hemophilia
- Chondrocalcinosis
- Hemoglobinopathies
- Scurvy
- Others

Tumors
- Pigmented villonodular synovitis
- Primary juxta-articular bone tumors
- Metastatic
- Leukemia
- Multiple myeloma
- Others

Allergy and Drug Reactions
- Arthritis due to specific allergens (ie, serum sickness)
- Arthritis due to drugs

Miscellaneous
- Rheumatic fever
- Sarcoidosis
- Neuroarthropathy
- Osteochondritis dissecans
- Others

decreased, and, therefore, the examination of the knee is much improved. Usually gross tears of the ligaments of the joint can be recognized upon re-examination of the knee at this time, and can be confirmed by stress films.

If the tap of the joint is clear or cloudy, then routine tests are obtained. These tests include: (1) gram stain and culture, which are sent to the laboratory in a sterile tube; (2) a cell count and differential, which are placed in a heparinized tube; and (3) a clot tube for glucose and protein. The synovial fluid may also be examined for crystals with a polarized light. If gonococcal infection or gonococcal arthritis is suspected, due to the sensitivity and difficulty of growing the organism, then immediate plating should be done. The appropriate medium for this is either chocolate agar, Thayer-Martin, or transgrow medium.

In terms of analysis of synovial fluid, the fluid can be divided into four basic groups. These groups include normal fluid, non-inflammatory fluid, inflammatory fluid, and septic fluid. Normal fluid is usually clear and transparent with a very high viscosity and a good mucin clot. It usually has less than 200 white blood cells per cu mm and, of these, usually less than 25 percent are polymorphonuclear cells. Table 1 gives a short synopsis of the synovial fluid findings in various disease states.

Two other points should be made. First, if a recurrent effusion of the knee occurs with associated increased white cell count, then the fluid should be cultured for fungus and tuberculosis. Secondly, if a rheumatological work-up is indicated by the history and physical findings, additional laboratory work consisting of C_3 and C_4, (complement) is obtained in a clotted tube. Simultaneous C_3 and C_4, as well as protein, is obtained from the serum. Also, ANA and rheumatoid factor are helpful diagnostic tests which are obtained from the serum (Table 2). Briefly, synovial fluid complement in normal synovial fluid is approximately ten percent of serum complement.[8] However, with bacterial inflammation the complement activity usually increases as compared to the serum activity.[7] This is thought to be secondary to the enhanced joint permeability obtained with an inflammatory response within the joint. This elevated complement activity has not only been found in bacterial infection but also in gout, pseudogout, psoriatic arthritis, and ankylosing spondylitis.[7] However, some reports from the literature show occasionally low levels of complement have been found in bacterial arthritis and gout.[9,10] Theories accounting for this low complement most often propose an early disease state with intense phagocytosis or activation of the complement system.[7,9,10] In some rheumatological diseases such as rheumatoid arthritis or systemic lupus erythematosus, immune complexes are thought to fix complement within the joint.[9-12] Therefore, in these diseases, complement level is low. Table 3 gives a detailed but not fully complete list of possible etiologies of knee effusions.

In summary, careful attention must be given to both the history and physical examination, and at times the laboratory findings, in all patients with a knee effusion. An outline of the approach to a work-up of a patient with a knee effusion has been presented.

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