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COMMENTARY

Synovial fluid sedimentation in the immobile patient: a commentary on modern septic arthritis and the addition of a new variable confounding diagnosis

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Abstract: Septic arthritis is a serious cause of morbidity and mortality. Despite recent advances, monoarticular and polyarticular septic arthritis (SA) have a mortality rate of approximately 11% and 30%, respectively. SA has a 40% risk of permanent loss of joint function. Diagnosis of SA is difficult, given that no rapidly available individual test proves 100% sensitive or 100% specific. There are no previous reports on the phenomenon of synovial fluid sedimentation in an immobile patient, although the occurrence has been identified in vitro. This commentary also presents an extended report of a patient who had been immobile and supine for 24 hours before her right knee was aspirated and treated for septic arthritis. Due to her immobilization, the synovial fluid had settled. The color and opacity of the sequential aliquots from one arthrocentesis was noted to change from light straw-colored, to thick opaque purulent material. Laboratory reports showed increasing white cell counts (WCCs), from 2.6×10^9 to 78×10^9 between the sequential samples. This demonstrates a newly identified phenomenon of sedimentation. This might have led to a diagnostic difficulty, had the knee not been fully aspirated. Aspiration serves as a diagnostic tool, because it collects a sample, but it also serves as a treatment measure, because it removes purulent material. Complete aspiration of the joint should be performed for full therapeutic benefit and to avoid the potential diagnostic confusion of a falsely low WCC due to this newly identified phenomenon of synovial fluid sedimentation in the immobile patient.

Keywords: septic arthritis, inflammatory arthritis, joint, sedimentation, orthopedic

Introduction

Septic arthritis continues to be a serious cause of morbidity and mortality among the general population. It has an estimated incidence of between four and 29 cases per 100,000 person-years, with geographic, ethnic, socioeconomic, and preexisting medical factors all being influential.[1–3]

Despite recent advances in diagnosis, including magnetic resonance imaging, polymerase chain reaction, serum procalcitonin,[4] and advancing antimicrobials; monoarticular and polyarticular septic arthritis still have a mortality rate of approximately 11% and 30%, respectively.[1,5] These mortality rates rise to 33% when patients with coexisting medical comorbidities and immune suppression are involved.[6] Septic arthritis also has a high associated morbidity, with a 40% risk of permanent loss of joint function.[7]

Serum procalcitonin has more recently been shown useful for differentiating bacterial from noninfective causes of inflammation. Recent prospective studies and

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meta-analysis have shown it to have a sensitivity of between 53% and 88%, and a specificity of up to 100%.[8–10] While not particularly sensitive, like C-reactive protein (CRP), serum procalcitonin is the only serum marker available with a high specificity, making it a very useful addition to investigation for diagnosis.

Rapid diagnosis, removal of purulent material, and commencement of antibiotics are critical in treating SA.[11] Diagnosis of SA is difficult, given no individual test proves 100% sensitive. Clinicians must be highly suspicious of any joint inflammation encountered in the patient's history or upon physical examination.

A serum white blood cell count (WCC) greater than 11,000 mm^{-3} and an erythrocyte sedimentation rate greater than 20 mm/H each have a sensitivity of 75%, but low specificities.[12] CRP also proves useful in both diagnosis and monitoring treatment response, but is not a gold standard either, given its poor specificity.[13] Positive pathogen culture from joint aspiration is the only test 100% specific for diagnosis of SA. Unfortunately, the result of this test becomes available only days later, after incubation, whereas treatment should be initiated immediately, or an alternate source of the patient's condition sought.

Joint aspiration should be routinely performed and the joint fluid examined, at collection, for its macroscopic appearance. Within the laboratory, it should be microscopically assessed with gram staining, and with cell differential for synovial fluid white cell count (sWCC), and analyzed for microcrystalline arthropathy and culture, as aforementioned. A benefit has also been shown of placing part of the specimen into blood culture bottles for successfully culturing pathogens.[14]

Extensive review of the current literature does not show any previous report on the phenomenon of synovial fluid sedimentation. The process by which larger molecules and macroscopic particles become concentrated at the base of a solution, with smaller, more buoyant particles becoming more concentrated on the surface, is possible provided the mixture is left undisturbed. Hypothetically, this is possible in synovial fluid with an immobile patient in bed, resisting all joint movement because of the pain associated with septic arthritis. This phenomenon necessitates the importance of fully aspirating all of the fluid within the knee joint when performing an arthrocentesis; to qualify this hypothesis of synovial fluid sedimentation, a clinical example is used below.

Extended report

An 89-year-old woman was brought by ambulance into the emergency department of our hospital after being found by her son, confused and incontinent, lying on the floor of her home. She had been lying on the floor for approximately 12 hours prior to being discovered.

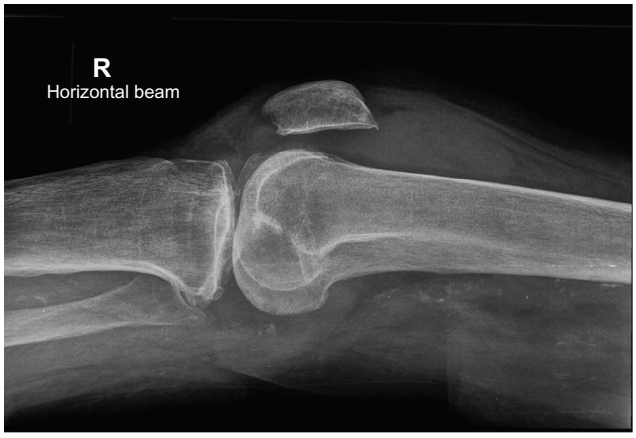

Figure 1 Lateral radiograph of affected knee.

On arrival at the emergency department, she was found to be delirious, dehydrated, and in rapid atrial fibrillation. She was also noted to have a swollen, painful right knee, although she was known to have osteoarthritis of this knee.

Laboratory investigations revealed her to have a degree of rhabdomyolysis with a creatine kinase level of 5010 IU/L, acute chronic renal failure with a creatinine level of 205 μmol/L, and urea at 16.5 mmol/L. Measurement of inflammatory markers showed a CRP of 250 mg/L and a WCC of 12.9×10^9/L.

Initially, no source of the raised CRP and WCC was found. It was noted that the patient had received a steroid injection to her arthritic right knee one week prior to admission. Repeat examination revealed it to be hot and swollen, with an exquisitely painful, passive range of motion and a large

Figure 2 Synovial fluid specimens collected sequentially, left to right.

Table 1 Laboratory results of collected specimens

	sWCC × 10^9/L	% neutrophils	Microscopy	Culture
Pot 1	2.6	86%	A few gram-positive cocci	*Staphylococcus aureus*
Pot 2	23.2	77%	Moderate number – positive cocci	*S. aureus*
Pot 3	78.0	85%	Moderate number – positive cocci	*S. aureus*

Notes: Pot 1 is the first of the three samples taken and is from the surface of the effusion. Pot 3 is the last of the three samples taken, reflecting fluid with the greatest amount of sediment.
Abbreviation: sWCC, synovial fluid white cell count.

effusion present. A radiograph of the knee was taken and the orthopedic team was consulted to investigate her knee as a potential cause of her deterioration. The radiograph demonstrated a large effusion, as shown in Figure 1.

The patient had been immobile and supine for 24 hours when her right knee was aspirated by the on-duty orthopedic registrar. One hundred milliliters of fluid were aspirated through a lateral suprapatella arthrocentesis. Fluid was drawn off in 25 mL aliquots, the first 3 mL of each aliquot was placed into a separate sterile specimen jar, as pictured in Figure 2, and labeled Pot 1, Pot 2, and Pot 3.

The color and opacity of the sequential aliquots was noted to change, from light straw-colored synovial fluid to thick opaque purulent material (Figure 2). Each pot was sent for laboratory analysis (results shown in Table 1).

The selective diagnosis of septic arthritis was made based on the sWCC count of Pot 3. Intravenous flucloxacillin was commenced, and the patient was taken for prompt arthroscopic washout and debridement of the knee. She required one further arthroscopic washout. *Staphylococcus aureus* was cultured from the initial aspirates and she was treated with 6 weeks of intravenous antibiotics followed by 6 weeks of oral antibiotics to treat the infection, as guided by the hospital's infectious disease unit.

Discussion

Aspiration of a potentially infected joint serves two purposes. It serves as a diagnostic tool because it collects a sample, but it also serves as a treatment measure, since it removes purulent material. The initial treatment of this patient with needle aspiration has been shown to be comparable with surgical treatment as an initial mode of drainage.[15] As such, the treatment of this patient was supported as best practice by the literature.

While this patient was supine with her knee immobilized due to pain for 24 hours prior to aspiration, sedimentation of the synovial fluid took place. This phenomenon in vivo has not been identified elsewhere in the literature. There are, however, reports of in vitro centrifugal sedimentation of synovial fluid for biochemical analysis, and as such, this report is in agreement with this already documented in vitro occurrence.[16,17]

In the above case, it was fortuitous that the joint was completely aspirated. If only the initial 25 mL had been taken, the initial diagnosis may have been misguided by the low sWCC of 2.6×10^9/L, and septic arthritis not suspected.

It has been demonstrated that sWCC becomes more specific for septic arthritis at higher values. Values greater than 25×10^9/L, compared to 100×10^9/L, yield specificities of 77% versus 99%, respectively.[18] Given the role joint aspirations have in treatment, along with the clinical importance of sWCC in diagnosis and the potential for a misleading value due to improper technique, one must be sure to fully aspirate the joint when an arthrocentesis is performed. This will avoid the confounding effect of synovial fluid sedimentation and is in keeping with the best practice described for treating septic arthritis.

Conclusion

Septic arthritis continues to be a disease of high morbidity and mortality, with the associated difficulty of accurate diagnosis. Diagnosis is further complicated by the newly identified phenomenon of synovial fluid sedimentation in the immobile patient. Based on our review of synovial fluid sedimentation practice and identification, we advise that prompt and complete aspiration of suspected joints be performed.

Disclosure

The authors report no conflicts of interest in this work.

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