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Management of Infected Orthopedic Joint Implants: Pertinent Information for Family Medicine Physicians

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Abstract

Periprosthetic joint infections (PJIs) are one of the most devastating complications after total joint replacement. An early diagnosis can improve the outcome of treating PJI, and the first steps for diagnosing PJI are often conducted by a family doctor or a general practitioner.

When a patient presents with a suspicion for PJI, the steps that must be followed are based on the clinical practice guideline by the American Academy of Orthopedic Surgeons (AAOS). Clinical symptoms, such as pain, are the main complaint that alerts physicians to a potential PJI, along with other symptoms such as erythema, warmth and tenderness around the surgical wound. These patients should receive x-rays of the affected joint, and laboratory tests such as erythrocyte sedimentation rate and C-reactive protein should be drawn. Physicians should actively avoid starting antibiotic therapy, obtaining nuclear medicine imaging, sending patients to infectious disease, or prescribing physical therapy. Finally, patients with a suspicion for PJI must be referred to an orthopedic surgeon who can establish the final diagnosis and conduct appropriate treatment.

Keywords: Joint implants; Family medicine; Physicians

Introduction

Total joint arthroplasty (TJA) is one of the most successful elective procedures in medicine. They are cost effective and offer a positive impact on the quality of life of patients [1,2], improving function and range of motion, while reducing pain. Survival of total hip arthroplasties (THAs) at 10 year follow up is greater than 95% [3], and at 25 year follow-up is up to 81% [4]. THAs and total knee arthroplasties are considered successful procedures in up to 90% of the patients even 20 years after the procedure [5]. This affirms Dr. Mark Coventry's famous statement in 1991; "THA, indeed, might be the orthopedic operation of the century" [6,7]. Currently, more than 500,000 TJAs are performed each year in the USA and UK [8,9]. By 2030, these values are expected to rise by 174% for THA and 673% for primary TKA [9].

Unfortunately, TJA is not exempt from complications, including periprosthetic joint infections (PJIs). It is the main cause for revision surgery and readmission during the first 90 days after surgery [10]. The incidence of PJI is 0.46% for total knee arthroplasty (TKA) and 0.33% for THA [11]. The development of PJI leads to complicated revision surgery, can compromise the functional outcome of the patient [12], and can dramatically increase health care costs. Currently, the cost of treating PJI is 4.8 times greater than the cost of THA [13]. By 2015, hospital charges for all revisions are projected to increase by 450%, up to $4.1 billion dollars [14].

Many patients presenting with PJI are initially assessed by a family practice physician or a general practitioner. Thus, these physicians are at the forefront of diagnosing PJI and can prevent complications associated with mismanagement of treating these patients. The purpose of this review is to elucidate the correct steps to be followed when faced with a potential case of PJI to minimize and to enhance patient treatment.

Clinical Symptoms of PJI

The most common presenting symptom in the setting of PJI is pain. For THA, the pain is generally located in the groin, and occasionally radiates to the buttocks. In TKA patients, these patients often experience global knee pain. Increased pain at night and limping due to pain are additional signs. Ordinarily, pain is constant and is unrelated to changes in physical activity. The presence of erythema, warmth and tenderness around the surgical wound do not necessary mean that a patient is infected. However, these symptoms should alert the clinician to a possible PJI. On the other hand, the presence of a draining sinus around the surgical wound is a major diagnosis criteria for PJI and must be treated as such [15]. These patients should be sent to an orthopedic surgeon immediately.

In patients with PJI, there is usually no fever or systemic compromise, unless there is an acute infection from hematogenous seeding of bacteria. Generally, PJI are frequently caused by low virulence, slow growing microorganisms [16]. These joint implant infections are often not life-threatening; however, these infections are very difficult to eradicate as bacteria form a protective coating around the implant, called a biofilm. This is developed as a defense mechanism used by certain pathogens to protect themselves and increase resistance to antibiotics.

There is no objective measure that can replace clinical suspicion as the starting and main point for the diagnosis of PJI. It must be combined with a thorough physical examination: evaluation of the surgical site, drainage or fistulas, and local signs of infection (redness,

swelling, local erythema, pain and loss of function). Assessment of the patient's range of motion, presence of pain, and gait pattern are all important and play a role in the diagnosis of PJI. Occurrence of limb length discrepancy without surgical intervention may be a late finding in chronic infection due to implant collapse. Clinical findings must be complimented with appropriate sets of tests and images.

A uniform definition of PJI was developed by the Musculoskeletal Infection Society (MSIS), which gathered experts in the field including orthopedic surgeons and infectious disease specialists. PJI occurs when there is one of two major criteria, or 4 of 6 minor criteria (Table 1) [15]. It is important to note that PJI may be present with less than 4 minor criteria, clinical judgment and individualization of each case is critical in identifying patients with PJI.

Major criteria:
Organisms cultured from two separate sites
Draining sinus track
Minor criteria:
Elevated erythrocyte sedimentation rate and serum C-reactive protein
Elevated joint synovial white blood cell count from joint aspirate
Elevated joint neutrophil percentage
A single positive culture of periprosthetic tissue
Elevated neutrophil count on periprosthetic tissue histologic analysis
Intra-articular purulence

Table 1: MSIS definition of PJI

Laboratory Tests

Even with standardized criteria, the laboratory diagnosis of PJI remains a challenge since there is no gold standard for diagnosis. Erythrocyte sedimentation rate (ESR) and C-reactive protein (CRP) have long been the initial screening tests for the diagnosis of PJI. These lab tests are cost-effective, technically non-demanding, and have good sensitivity for detecting deep infection. The sensitivity and specificity of the ESR varies from 64% to 100% and 56% and 87%, respectively [16-19]. The sensitivity of ESR was reported to be 75% and the specificity 70% using a cut-off value of 30 mm/hr [20]. CRP has a sensitivity ranging from 71% to 94% and specificity from 71% to 86% [17-20]. As a result, these are tests used to "rule out" infection and when both tests are negative, the likelihood of infection is very low (negative likelihood ratio 0 to 0.06). If both tests are positive, the probability of infection is not negligible (positive likelihood ratio 4.3 to 12.1) [21] and the patient requires further investigation by a specialist. Unfortunately, several inflammatory pathologies can alter the results and lead to false positives. The routine use of CRP and ESR are used to rule out infection and are strongly recommended for aiding in the diagnosis of PJI [21].

Serum white blood cell (WBC) and specifically polymorphonuclear (PMN) cell count have been found to lack value in the diagnosis of PJI. In fact, these laboratory tests are not taken into consideration for the definition of PJI, nor the clinical practice guideline for the diagnosis of PJI from the American Academy of Orthopaedic Surgeons (AAOS) [21]. Many systemic diseases and inflammatory conditions may alter the results and therefore skew the test. The sensitivity for WBC is 55% and specificity is 66%. PMN sensitivity is 52% and specificity is 75%. These tests are not considered useful in the diagnosis or monitoring of PJI, and are not recommended as part of workup [22].

Radiographs

It is recommended that a set of plain x-rays are ordered, including anterior-posterior and lateral views of the affected joint when weight-bearing. It is also helpful to take a pelvis x-ray in THA patients. These radiographs are important to obtain but will not be the sole method of diagnosis. The purpose of obtaining x-rays is to assess the overall state of the implant and the bone surrounding it. Radiographic findings consistent with chronic cases of PJI are loosening, loss of bone stock, new bone reaction, endosteal scalloping, and migration of the components (Figure 1A and 1B). Radiographs are also important as a follow-up tool to compare to previous x-rays. While radiographs are not as helpful for diagnosing infection, they can rule out other causes of joint pain, including fractures or dislocations. There is no need for additional imaging in the primary care setting, and CT scans or MRI is not recommended to be ordered for diagnosing PJI [21,23].

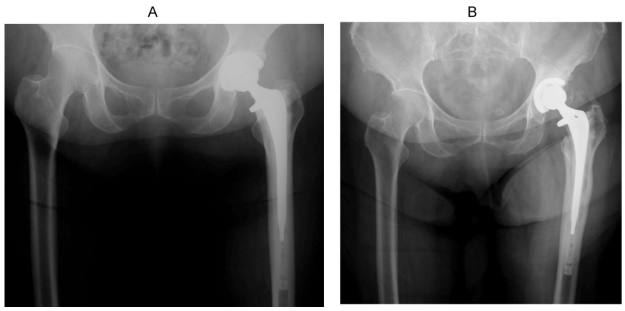

Figure 1A and 1B: Radiographic changes found in periprosthetic joint infection. Loosening of the prosthesis and bone resorption can be seen in the femur around the prosthesis

What not to do

Do not underestimate the patient's symptoms

Pain may be the only presenting clinical sign for acute or chronic cases of PJI. Classic symptoms of infection are not always present in the early stages of PJI. Night pain, continuous oppressive pain, rest pain, and pain either in the groin, thigh, or knee are all reasons to suspect a PJI, whether or not obvious symptoms of infection are present. Screening laboratory tests for infection using CRP and ESR should be done, as well as radiographs of the involved joint. If the results of ESR and CRP are negative for infection, the likelihood of PJI is very low. If the laboratory tests are elevated without a cause for infection, patients should be referred to an orthopedic surgeon. In addition, surgical options and the future of the joint should be addressed by an orthopedic surgeon.

Do not give antibiotics

Antibiotics should not be given as soon as PJI is suspected, as this mistake could prevent patients from receiving a reliable diagnosis of infection. The administration of antibiotics can lead to negative cultures from aspirations and deep cultures, hindering the final

diagnosis of PJI [24]. In fact, preoperative antibiotics may decrease the sensitivity of cultures from 76.9% to 41.2% [23]. Negative cultures pose a challenge to the interdisciplinary team treating patients with PJI, as these patients are not able to receive targeted antibiotic therapy and usually receive broad-spectrum antibiotics or more than one antibiotic against common pathogens. Broad-spectrum treatment is associated with complications, including diarrhea (3-8%), pseudomembranous colitis (1%), delayed hypersensitivity reaction (11%), nephrotoxicity (due to vancomycin 1%), leukopenia (1%), and skin discoloration (due to minocycline, 1%) [25-27]. Thus, we encourage that antibiotics not be administered prior to seeing an orthopaedic surgeon and receiving treatment, so that the correct organism can be identified and tailored antibiotic treatment may be provided to the PJI patient.

Only order essential tests

Initial screening test recommendations by the AAOS Clinical Practice Guidelines include CRP, ESR, and a set of anterior-posterior and lateral radiograph views of the affected joint. This adds to the risk of stratification of each patient [21]. However, clinical judgment is paramount for guiding the diagnosis of PJI.

Further imaging beyond x-rays is not recommended. Nuclear medicine scans are an option, only when the diagnosis of PJI is confounding. It is important to note that nuclear medicine images may remain positive in the first postoperative year, and could be the source of false-positive results. Nuclear medicine tests can be helpful for ruling out infection, although a positive test may not add much to the work up. MRI and CT have limited use in the diagnosis of PJI and are often not included in the workup due to insufficient evidence to support these other imaging modalities [21].

Do not refer patients to infections disease

Once the initial screening of PJI is done, and the likelihood for infection is high, the next step is to refer the patient to an orthopedic surgeon. An orthopedic surgeon should be the team leader for treating PJI in an infected patient, and he/she should be the final person to diagnose PJI and provide subsequent treatment. Management of PJI patients should be a multidisciplinary approach, and infectious disease specialists play a central role in the treatment of PJI for determining the type, duration and length of antimicrobial treatment. The patient's referral to an infectious disease specialist should be a decision from the orthopaedic surgeon managing the patient.

Do not prescribe physical therapy

A potential mistake is to treat the symptoms of pain without first knowing the underlying cause. Postoperative pain in a joint replacement is common in the first few months, and tends to improve after the first month. A trend is to order physical therapy in order to relieve non-specific pain, even after the first 6 postoperative months. This may be ineffective, since the physical recovery after a joint replacement is often achieved around 6 to 8 months after surgery [28]. If a patient's recovery is abnormal, a complication must be suspected and a potential cause is a joint-related infection [10].

What to do

The following is a brief summary of the first recommendations from AAOS Clinical Practice Guidelines [21]. The guide provides a concise and simple workflow to diagnose PJI, but it should never replace a physician's clinical judgment.

The first goal is to determine whether the patient has a low or high risk for PJI. This is performed by adding patient's symptoms, risk factors, physical examination, and radiographic findings together (Table 2 and Figure 2).

Presenting Symptoms	**Pain around the prosthetic joint and or stiffness**
Evidence based Risk Factors	Prior infected joint, associated infection around the prosthetic joint, high BMI, operative time over 2.5 hours, associated immune deficiency.
Consensus based Risk Factors	Bacteremia or candidemia occurring one year preoperatively, simultaneous PJI, dermatologic pathologies*, intravenous drug abuse.
Physical Exam Findings	Local inflammation signs: warmth, swelling or effusion. Draining sinus
Other findings	Loosening occurring in less than 5 years postoperatively due to loosening. Seen in radiographs (Figure 1)
*Dermatologic pathologies: psoriasis, chronic cellulitis, lymphedema, chronic venous stasis, and skin ulcers	

Table 2: Factors for Risk Stratification. Modified from AAOS: The Diagnosis of Periprosthetic Joint Infections of the Hip and Knee: Guideline and Evidence Report

Figure 2: Patients stratified into higher or lower probability of infection

If a patient has a high suspicion of PJI, the next step is to order serum CRP, serum ESR, and a set of plain radiographs of the involved joint. If these values are elevated without another source of infection, or if there are changes found on radiograph, these patients should be referred to an orthopedic surgeon. Ideally, patients should see the orthopedic surgeon that performed their index procedure. Secondarily, patients should be referred to an adult reconstructive surgeon who is well equipped for treating PJIs. These patients will then get joint aspirations, either under fluoroscopy or ultrasound for THA or in the clinic for TKA. If patients are determined to be infected, they will be taken to surgery and treated depending on the duration and presentation of their symptoms (Figure 3).

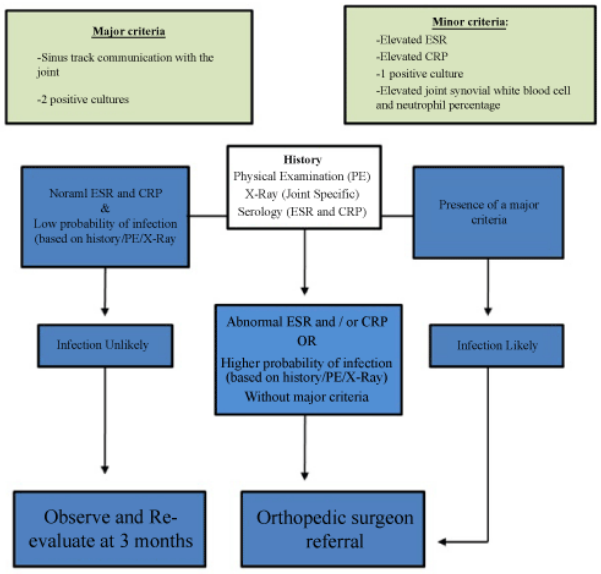

Figure 3: Algorithm for workup for periprosthetic joint infection

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