Septic Arthritis: A Real Emergency. Radiological manifestations. Advantages and disadvantages associated to the different types of tests based on images

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Learning objectives

Septic arthritis is one of the forms of infections of the musculoskeletal system. Septic arthritis is a medical and surgical emergency that has an impact on both the functional prognosis of the involved joint as well as the overall prognosis for the patient. Despite advances in the diagnostic and treatment, bacterial arthritis remains the most dangerous and destructive form of arthritis.

The aim of our study is to present the keys to establish a correct and early diagnosis of septic arthritis and describe the most characteristic radiographic patterns in different imaging tests.

Background

Infections of the musculoskeletal system, when compared with those occurring in the rest of the body, represents a rare entity, but its importance lies in that pose diagnostic challenges, in addition to medical and surgical difficult management and many complications that can arise.

These infections can affect different structures such as bones, joints, muscles and soft tissue, so that the demonstrations may vary depending on the structures involved. When the infection affects the joint is called septic arthritis.

INTRODUCTION

Septic arthritis is infection of the native articulation due to invasion of joint space by various microorganisms. It is a real medical emergency and that so the delay in diagnosis and treatment leads to irreversible joint damage and permanent disability (in 25-50 % of patients).

It can occur in all age groups, although it is true that there are a number of risk factors that favor the emergence and development of infectious arthritis, among which are:

- Elderly.
- Diseases such as Diabetes mellitus, rheumatoid arthritis…
- Intraarticular injections or prosthetic joints (Antecedentes de cirugía articular previa).
- Open Injuries.
• Skin infections.
• Intravenous drug abuser (IVDA)
• Immunocompromised state…

Most important, patients who are bacteremic for whatever reason are at high risk.

In general, large joints with abundant blood supply to the metaphyses are most prone to bacterial infection. The most commonly affected joints theoretically being the knee, hip and shoulder (table 1).

Table 1: Percentage of joints affected by septic arthritis

<table>
<thead>
<tr>
<th>Joint</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knee</td>
<td>50%</td>
</tr>
<tr>
<td>Hip</td>
<td>20%</td>
</tr>
<tr>
<td>Shoulder</td>
<td>8%</td>
</tr>
<tr>
<td>Ankle</td>
<td>7%</td>
</tr>
<tr>
<td>Wrist</td>
<td>7%</td>
</tr>
<tr>
<td>Others (elbow, interphalangeal, sternoclavicular, sacroiliac…)</td>
<td>1-4%</td>
</tr>
</tbody>
</table>

However, according to certain risk factors and population groups certain locations predominate (table 2).

Table 2. Joints affected by age and risk factors

<table>
<thead>
<tr>
<th>Joint</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infants and children</td>
</tr>
<tr>
<td>Intravenous drug abusers</td>
</tr>
<tr>
<td>Rheumatoid arthritis</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
</tr>
<tr>
<td>Appendicular Skeleton</td>
</tr>
<tr>
<td>Sternoclavicular, sacroiliac, acromioclavicular</td>
</tr>
<tr>
<td>Any affected joint</td>
</tr>
<tr>
<td>Foot articulation</td>
</tr>
</tbody>
</table>

Classically accepted that septic arthritis are mostly single joint (85-90%), but up to 22% of cases can affect more than one joint. Usually these cases are especially frequent in
patients with rheumatoid arthritis in the context of an outbreak of the disease and the infection of one of them, in immunocompromised patients or with prolonged or severe bacteremia. There are other organisms that may present with polyarticular presentation as viral infections.

ETIOLOGY

Infection of the joint can be produced by a variety of microorganisms (bacteria, fungi, viruses ...), but the term refers to arthritis septic infections caused by pyogenic bacteria, also known as suppurative or pyogenic arthritis, representing the most common and perhaps the most serious of joint disease, leading to a rapid deterioration of the articulation.

Classically septic or pyogenic arthritis were classified in two groups, gonococcal arthritis and no-gonococcal arthritis, currently this category has become obsolete as gonococcal arthritis is now rare in our environment. Causing bacteria vary with age and patient characteristics, thus the most common causes are the following (Table 3):

<table>
<thead>
<tr>
<th>Table 3. Frequently microorganisms depending on age and certain risk factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 5 years</td>
</tr>
<tr>
<td>H. influenza (&lt;2 a)</td>
</tr>
<tr>
<td>S. aureus</td>
</tr>
<tr>
<td>S. pneumoniae</td>
</tr>
<tr>
<td>S. pyogenes</td>
</tr>
</tbody>
</table>

*GNB: Gram-negative bacteria.

**IDA: Intravenous drug abuser

Overall Staphylococcus aureus is the most common organism in both children and adults. While it is true that in recent years we are witnessing a change in the etiology of septic arthritis, germs appeared that in the past unusually affected the joint such as coagulase negative Staphylococcus (CoNS) and anaerobic Corynebacterium or Propionibacterium as both some other part of the skin flora, and this is due to the increase in interventional procedures.
On the other hand, we have the arthritis caused by viruses, as part of a systemic infection, usually affects multiple joints and also have an acute, though not often produce long-term morbidity. And joint infections caused by mycobacterium, *Brucella spp*, *Borrelia burgdorferi* and fungi other than *Candida spp*, which will produce a slowly progressive monoarticular arthritis subacute or chronic.

**TYPES OF INFECTIOUS ARTHRITIS**

As mentioned in the previous section the articular infection can be classified according to the clinical course, presenting two groups:

### 3.1. Acute Infectious Arthritis:

Refers to arthritis caused by pyogenic bacteria having an acute clinical course and causes rapid joint destruction. These are the ones that we mean when we speak of septic arthritis.

This group would also include viral arthritis, having an acute presentation, but unlike bacterial suppurative arthritis is rare that produces long-term morbidity.

### 3.2. Subacute or Chronic Infectious Arthritis:

They are a series of single joint infections, or less often oligoarticular, that an insidious onset and indolent course, lack of symptoms and progressive joint destruction, which can cause considerable loss of joint function are characterized. Compared with acute septic arthritis are a relatively uncommon cause of joint infection.

**ETIOPATHOGENESIS**

The arrival of the microorganism to the joint can occur in different ways (figure 1):

- **Hematogenous seeding.**
- **Direct inoculation** after trauma, surgery, or percutaneous punctures.
- **Spread from a contiguous focus of infection** (bone or soft tissue).

Hematogenous spread is the most common route of arrival, the synovium is highly vascular and has no limiting basement membrane and is subject to the deposit of bacteria during bacteremia.
Bacteria ultimately served by one way or another to the joint and are deposited in the synovium causing an acute inflammatory cell response. As mentioned synovial tissue lacks limiting basement membrane, so germs can easily spend the synovial fluid and lead to purulent inflammation of the joint. In the following days a marked hyperplasia of the synovial membrane occurs. Furthermore inflammatory cells release cytokines, proteases and other inflammatory products, which results in the hydrolysis of collagen and proteoglycan essential causing cartilage degradation and inhibit its synthesis. To this is added the specific properties of each pathogenic microorganisms.

As the continuous destructive process begins forming synovial granulation tissue (pannus) and cartilage erosion in the lateral margins of the joint is produced. Large joint effusions prevent the blood supply and have consequences as aseptic necrosis of bone.

All of these destructive processes, which are those that occur in bacterial septic or suppurative arthritis, may occur early in the course of the untreated infection. Hence, septic arthritis is considered a medical emergency (figure 2).

All these pathological changes have a radiological correlation (Table 4)

**Table 4. Septic arthritis: radiological pathological correlation**

<table>
<thead>
<tr>
<th>Pathological Changes</th>
<th>Radiographic Abnormalities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Edema and hypertrophy of the synovial membrane</td>
<td>Joint Effusion</td>
</tr>
<tr>
<td>Production of liquid</td>
<td>Soft tissue augmentation</td>
</tr>
<tr>
<td>Hyperemia</td>
<td>Osteoporosis</td>
</tr>
<tr>
<td>Inflammatory pannus with chondral destruction</td>
<td>Joint space narrowing</td>
</tr>
<tr>
<td>Bone destruction by pannus</td>
<td>Central and marginal bone erosions</td>
</tr>
<tr>
<td>Fibrous or bony ankylosis</td>
<td>Bony ankylosial</td>
</tr>
</tbody>
</table>

**DIAGNOSIS**

Joint infection in most cases poses a major diagnostic challenge, and both this and the treatment requires a multidisciplinary approach in which they will intervene different specialties. To make a proper diagnosis we will have to be based on:

1. **Clinical Manifestations.**
2. Analytical results.
3. Microbiological testing

4. Imaging Techniques.

But none is specific enough by itself, except for the etiologic diagnosis of microbiological samples for diagnosis of septic arthritis. Hence the need of integration of each to make a proper diagnosis.

1. Clinical manifestations

Clinical manifestations vary depending on the age and condition of each patient. But classically septic arthritis is characterized by a typical triad of acute onset and with an average duration of 1-2 weeks, which presents with:

- **Fever**, usually low grade without chills
- **Painful joint** and
- **Lack of mobility**

On examination the peripheral joints have swelling, redness and heat. In deep joints such as the hip, these findings may be less obvious.

2. Analytical Results

Complementary laboratory tests usually show elevated ESR and CRP although both findings are relatively nonspecific, and that may be elevated in other causes of non-infectious arthritis, and may have greater utility for monitoring response to treatment.

The peripheral blood leukocyte count is usually increased in older children, but can be normal in adults and neonates. While the count in the joint fluid with the determination of the percentage of polymorphonuclear is the main diagnostic information pending microbiological results.

3. Microbiological Analysis

To determine the etiological diagnosis is based on positive Gram stain, culture of synovial fluid or synovial membrane and in the presence of a compatible clinical picture associated with two or more positive blood cultures for the same organism. In patients with involvement of the axial joints (sternoclavicular, costochondral, sacroiliac and symphysis
pubis) in which a significant accumulation of fluid does not occur and cannot get sample for culture, the diagnosis is based on positive blood cultures, along with other diagnostic tests such as imaging studies.

4. Imaging Techniques

These imaging findings will vary depending on the technique used:

- RX simple
- Ultrasound
- CT
- MRI

Images for this section:

Fig. 1: Different mechanisms arrival of the microorganism to the joint.
Fig. 2: Figure 2: (a) Illustration of synovial joint shows joint fluid (f) and articular cartilage (c). (b) Illustration show inflammatory arthritis, synovitis, and pannus (P) causing cartilage destruction. Marginal erosions (arrows) are seen where subchondral bone plate is exposed to intraarticular synovitis. f = Fluid.
Findings and procedure details

IMAGING TECHNIQUES

Radiological studies of the joints and periarticular structures affected by bacterial arthritis, will provide useful information for diagnosis and to evaluate the complications of infection. These imaging findings will vary depending on the technique used.

Conventional Radiograph

Conventional radiograph still remains as the initial imaging approach, but it has low sensitivity and specificity for acute infection. In early stages the simple radiograph can be normal and this does not rule out infection (figure 3).

Among the findings that can be found in the Early Stages are (figure 4-5):

- Soft tissue edema
- Joint effusion, seen as capsular distension or displacement of the articular structures.
- Increased joint space in early stages may be due to the presence of joint effusion
- Periarticular Osteoporosis.

In Delayed Stages we can find in plain films (figure 6-8):

- Bone erosion
- Destruction of subchondral bone (bone surface irregularity)
- Joint space narrowing: by the destruction of articular cartilage
- Periosteal reaction, it indicates osteomyelitis associated
- Subluxation and luxation
- Ankylosis

Ultrasonography (US)

US is very sensitive in detection of joint effusion and may be particularly helpful in the hip, wrist or shoulder where physical examination is less reliable and radiographics are often normal in the acute setting.

- The sonographic features of joint effusion may be the presence of liquid inside the anechoic both joint hypo-or hyperechoic and with septa
and detritus. So neither the quantity nor the spill echogenicity, serve to distinguish between an infectious origin versus other etiologies (figures 9-14). A small joint effusion may be masked by excessive compression with the transducer.

- There may be an increased vascularization color Doppler surrounding soft tissues (figures 15)

US is an excellent imaging modality for guidance of arthrocentesis and may reduce the risk of contamination of other anatomic compartments, especially in the hand, wrist, or foot.

The major disadvantage of ultrasound is its limitation to assess adequately the bony structures and articular cartilage, plus no longer an exploration operator dependent.

**Computed Tomography (CT)**

With the advent of MDCT, today this diagnostic test provides great advantages for both the diagnosis and treatment of septic arthritis, particularly in deep joints such as the hip or sacroiliac joints. It allows us to assess the extent of bone destruction and soft tissue, and a guide part make punctures, especially in joints where ultrasound is not as accessible as are the sacroiliac.

The major disadvantage of this test image is the emission of ionizing radiation and presents limited by partial evaluation of soft tissue or articular cartilage compared with magnetic resonance imaging (MRI).

Radiographic findings that can be found in the study of CT are (figures):

- **Early sings:**
  - Thickening of the synovial
  - Joint effusion
  - Small Bone erosion
  - Soft tissue Swelling

- **Late Sings:**
  - Irregularity
  - Joint space narrowing
• **Bone erosion**
• **Bone Destruction**
• **New bone formation**
• **A fat-fluid level**: can be a specific sign in the absence of trauma

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**Magnetic Resonance Imaging (MRI)**

MRI is the best imaging technique for the diagnosis of septic arthritis. It is the most sensitive of all radiological tests with a near 100% and allows early diagnosis of joint infection, as 24 hours of the onset of infection. Furthermore, MR allows simultaneous assessment of bone, cartilage, and soft tissue. Detect minimal joint effusion, assess the extent of the infectious process and it is a technique that does not emit ionizing radiation.

Despite having sensitivity for the diagnosis of septic arthritis, the limitation of MRI is its low specificity (77%), so like other imaging tests, among the alterations found, none of them is sufficiently specific for the diagnosis of infectious arthritis.

The basic protocol for the evaluation of septic arthritis should include:

- T1-weighted FSE sequences,
- FSE T2-weighted,
- STIR sequences,
- Administration of intravenous paramagnetic contrast with T1-weighted sequences with fat saturation.

The findings can be found are: (figures)

- **Synovitis**: Hypointense in T1
  - Hyperintense in T2
  - Synovial membrane enhancement in T1 Fat Sat with gadolinium
- **Joint effusion** Hypointense in T1
  - Hyperintense on T2 but may vary depending on contents (blood, pus ...)
- **Perisonovial edema** Hyperintense in T2-weighted sequences
- **Reactive bone edema** Appears limited at both sides of the joint, with a patchy and poorly defined areas of low signal in T1 and T2 high signal.
- **Destruction of articular cartilage and/or bone erosions** Marginal defects subchondrales with high low intensity on T1 and T2
• **Periarticular abscesses** Hypointense in T1

Variables in T2

Ring enhancement contrast, thick-walled and poorly defined borders.

**EVOLUTION**

As we mentioned before septic arthritis is an acute process that requires early diagnosis to establish proper treatment quickly, because in absence or delay of the same septic arthritis can result in irreversible joint damage within 48 hours of the onset of infection.

It is estimated that up to 50% of adult cases present some kind of sequel. Among the factors that favor the poor performance of the joint infection are age above 60 years, rheumatoid arthritis, involvement of certain joints such as the shoulder or hip or positive synovial fluid culture after 7 days of antibiotic treatment.

Among sequela and complications that can arise from septic arthritis we find subluxation and dislocation articular epiphyseal destruction, osteonecrosis, secondary osteoarthritis, osteomyelitis, partial or complete bony fusion and destruction of adjacent structures as capsule, tendons, soft tissue ...

**Images for this section:**

*Fig. 8:* Figure 8: A) anteroposterior projection and B) axial with hip joint space narrowing, subchondral bone sclerosis, bone erosion and Flattening and fragmentation of the right femoral epiphysis.
Fig. 3: Figure 3: 6 year old boy with septic arthritis of the right shoulder with a normal radiograph.
Fig. 4: Infant of 4 months with limited movement of the right leg with swelling and pain since three days ago. Increased joint space, with dislocation of the right femur and soft tissue increased and lytic lesion in proximal metaphysis of the right femur.
Fig. 5: Figure 5: Children under 4 years with affection oligoarticular juvenile idiopathic arthropathy, with local pain in right knee. Soft tissue increase with increased joint space by the presence of joint effusion. No bone abnormalities are observed.
**Fig. 6**: Figure 6: 75 years old male, with pain in left hip. Joint space narrowing with subchondral bone sclerosis

![Image](image1.png)

**Fig. 7**: Figure 7: 9 year old boy with septic arthritis of the hip. A) anteroposterior projection and B) axial with hip joint space narrowing and subchondral bone sclerosis

![Image](image2.png)

**Fig. 9**: Figure 9: 4 year old, with local pain in right knee, having small joint effusion, anechoic without septa inside. It is accompanied by synovial thickening

![Image](image3.png)
Fig. 10: Figure 10: 72 year old woman with shoulder arthritis. In ultrasonography abundant notes anechoic fluid surrounding the right humeral head
Fig. 11: Figure 11: 10 years old male, with moderate joint fluid echogenic with synovial thickening

Fig. 12: Figure 12: In this patient also synovial thickening and irregularity in the femoral epifisis

Fig. 13: Figure 13: 6 years old male with the presence of intra-articular fluid with internal echoes.
**Fig. 14:** Figure 14: In this other case líquido moderado lla shown in suprapatellar bursa with some internal echoes. No synovial thickening is observed.

**Fig. 15:** Figure 15: Ultrasound of right shoulder with arthritis 15 days of evolution, in which a marked thickening synovial and periarticular synovial hyperemia was observed.
**Fig. 16:** Figure 16 y 17: 45 years old male, with local pain in right ankle. Ankle CT in coronal(16) and sagittal(17) plane, where bone destruction distal fibula, tibia, talus and calcaneus, with lytic areas, kidnappings and bone deformity bone is observed. Subchondral geodes and destruction of the articular interline, all in conjunction with septic arthritis and osteomyelitis.

![Ankle CT images](image)

**Fig. 17:** Figure 16 y 17: 45 years old male, with local pain in right ankle. Ankle CT in coronal(16) and sagittal(17) plane, where bone destruction distal fibula, tibia, talus and calcaneus, with lytic areas, kidnappings and bone deformity bone is observed. Subchondral geodes and destruction of the articular interline, all in conjunction with septic arthritis and osteomyelitis.
Fig. 18: Figure 18: 3 year old affection of septic arthritis of the right knee. Coronal T1 (a), STIR (b and c) and T1 with gadolinium, axial T1 (e), STIR (f) and gadolinium T1 SPIR is observed joint effusion, synovial thickening and marked enhancement after gadolinium administration iv and hyperintensity and enhancement in the periarticular soft tissues and distal portions of the quadriceps muscle. Marrow involvement, hyperintense on STIR and gadolinium enhancement iv located in metaphysis - epiphysis most posterior portion of lateral femoral condyle
Fig. 19: 78 year old man with left hip pain. Coronal T1 (a), STIR (b) and PD Fat Sat with gadolinium (c) and axial T2 (d), STIR (e) and PD Fat Sat gadolinium (f). Alterations in signal intensity femoral head and neck. Destruction of the upper anterior portion of the left femoral head. Joint space narrowing by cartilage destruction. Small joint effusion, soft tissue swelling. After administration of contrast enhancement in the femoral head and acetabulum is observed.
**Fig. 20:** Figure 20: Males 45 years with local pain in right ankle. Coronal T1 (a), T2 (b), STIR (c) and T1 with gadolinium (d). T1 sagittal planes (e) and DP Fat Sat (f). Alteration of signal and important bone destruction with formation of necrotic cavities with associated soft tissue mass. Edema in the subcutaneous tissue. Findings consistent with septic arthritis of ankle osteomyelitis.

**Fig. 21:** Figure 21: Poor outcome of arthritis of the right hip in 10-year, with the appearance of sequelae such as loss of height, sclerosis, necrosis and subchondral bone destruction.
Conclusion

The infectious arthritis requires an early diagnosis and treatment. It represents a real emergency, so that the knowledge of the radiologic findings is extremely important.

The diagnosis requires a multidisciplinary approach. The conventional radiograph is the initial imaging approach, although the MRI is the most sensible technique to the evaluation of this pathology. There is no injury specific enough in imaging tests for the diagnosis of AS

Personal information

References