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Review

Rapidly progressive joint infection: A multidisciplinary review of septic arthritis

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	Abstract
Published on: 04 Aug 2025	Septic arthritis is a fast-growing joint disease that causes severe inflammation and possibly joint destruction due to microbial infection of the synovial space. Even with improvements in antimicrobial treatments and diagnostic instruments, septic arthritis still carries a high morbidity and mortality rate, particularly in high-risk groups. This study offers a thorough summary of the causes, symptoms, risk factors, clinical characteristics, methods of diagnosis, and treatment of septic arthritis. It also discusses historical turning points in our knowledge of the illness and emphasizes how crucial early detection and vigorous treatment are to avoiding long-term consequences. The article also discusses the problems that arise from inadequate or delayed treatment and points out the importance of physical therapy in joint recovery. Traditional ethnobotanical treatments, in addition to current therapy, have demonstrated promise in reducing joint infection and inflammation. The epidemiology, pathophysiology, diagnosis, and treatment of septic arthritis are summarized in this review, which also highlights promising phytotherapeutic options as supplements to holistic care approaches.
Published by: Futuristic Publications 2025 All rights reserved.  Creative Commons Attribution 4.0 International License.	Keywords: Infectious arthritis, pyogenic arthritis, septic arthritis, joint infection, traditional medicine, joint aspiration, Joint effusion, osteoarthritis, pediatric arthritis.

INTRODUCTION

Septic arthritis is the most rapid and destructive joint disease. It is also referred to as Infectious arthritis, Bacterial arthritis, and Pyogenic arthritis. Infection from direct puncture wounds or secondary to joint aspiration is rare; it generally arises from haematogenous dissemination from diseases of the skin or upper respiratory tract.^[1] Among the general population, the incidence is 2–10 per 100,000, while among people who already have joint illness or joint replacement, it is 30-70 per 100,000. Despite advancements in antimicrobial therapy, septic arthritis still has a mortality rate of roughly 10% and is linked to considerable morbidity. The most significant risk factor for death is as people age.

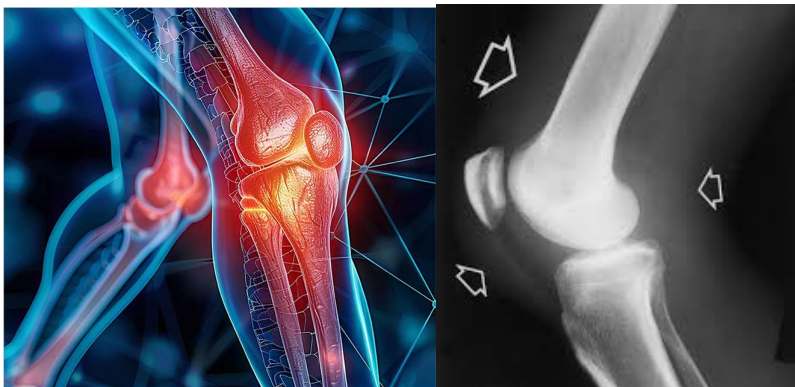


Fig 1: Septic arthritis

The term "Septic arthritis" (SA) represents a microbial infection of the joint space, generally caused by bacteria, which causes inflammation and articular cartilage degradation. This medical emergency has a high rate of morbidity and the potential to cause serious long-term impairment. In order to maintain joint integrity and to prevent systemic sepsis, early detection and treatment are important. SA has been known for ages and still presents difficulties for diagnosis and treatment in both developed and underdeveloped environments.^[2,3]

Historical Background

Early in the 20th century, Walter Whitehead is credited with providing one of the earliest known clinical reports of septic arthritis in 1902. He highlighted the importance of drainage in severe cases and promoted open surgical management of complex septic arthritis of the knee. In terms of present surgical intervention, this was a landmark moment.^[4] Early in the 20th century, more information became readily accessible, such as Nathan P.W.'s 1917 experimental and clinical studies on deforming arthritis, which advanced our knowledge of inflammatory joint diseases.^[5]

In the same year, Captain W. Rankin focused on surgical management strategies for septic arthritis, especially in post-traumatic and military contexts.^[6] A. Mackenzie Forbes's description of the first recorded case of septic arthritis in an infant in 1923 marked a significant breakthrough by emphasizing the disease's potential to impact pediatric populations. The microbiological foundation of the illness was further elucidated at this time, and streptococci were found to be the causal agents in 1924.^[7,8] In the same year, Robert N. Nye established the fundamentals for the microbiological validation of septic arthritis by developing culture methods for both blood and synovial fluid, furthering diagnostic procedures.^[9]

Ethiology

Although there are many other causes of septic arthritis in children, *Staphylococcus aureus* is the most prevalent cause overall. While neonates are more frequently infected by Group B Streptococcus, *S. aureus*, *Neisseria gonorrhoeae*, and gram-negative bacilli, *Kingella kingae* is more prevalent in children under three years old. In adolescents who indulge in sexual activity, gonococcal arthritis is a major problem. *Pseudomonas aeruginosa* is linked to puncture wounds or injectable medication usage, while Salmonella species are commonly linked to children with sickle cell disease.

Neisseria gonorrhoeae is the most frequent cause of non-traumatic monoarthritis among young, sexually active people, but *S. aureus* continues to be the most prevalent cause in adults, followed by *Streptococcus pneumoniae*. Although less often (~5%), polymicrobial infections can develop after trauma or intra-abdominal infections. Mycobacterial and fungal arthritis manifest more subtly and are diagnosed by synovial biopsy. Susceptibility is increased by risk factors such as intravenous drug use, leukemia, and pre-existing joint diseases (like rheumatoid arthritis), with the knee and hip being prominent targets.

Bacteria spread from another site of infection.

1. The highly vascular synovium is invaded by hematogenously distributed microorganisms.
2. White blood cell (WBC) enzymes cause necrosis of synovium, cartilage, and bone.
3. Extensive joint damage is rapid if infection is not treated with suitable intravenous (IV) antibiotics and drainage of necrotic debris.^[10-15]

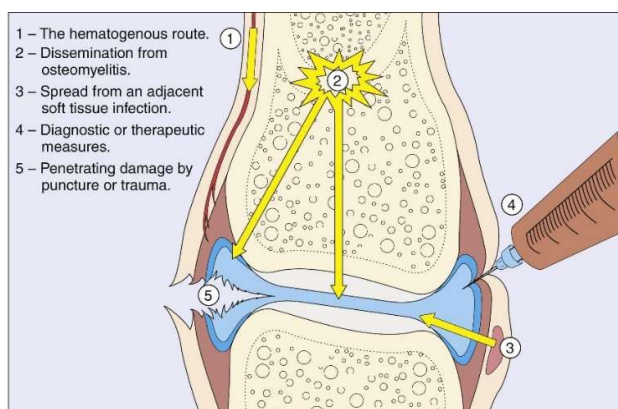


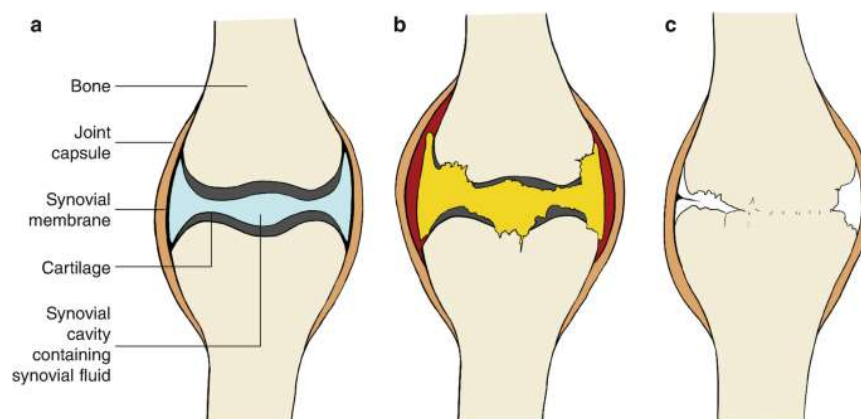
Fig 2: Routes by which bacteria can reach the joint.

Global disease profile

With a 2:1 male preponderance, septic arthritis affects 2–6 out of every 100,000 persons and is more frequent in children, particularly those ages 2–3. Hemophiliacs, immunocompromised children (e.g., HIV, sickle cell), neonates, and children undergoing chemotherapy are considered high-risk children. Among the risk factors for adults are diabetes, rheumatoid or osteoarthritis, age more than 80, recent joint injections or surgeries, joint prostheses, skin infections, HIV, and gonococcal infections.^[16,17]

Pathogenesis

Increased neovascularization and adhesion molecule expression in the synovial membrane, which promote bacterial colonization, make joints that have already been harmed by diseases like rheumatoid arthritis especially susceptible to infection. Certain infections, most notably *Staphylococcus aureus*, have surface adhesion proteins (MSCRAMMs) that increase their affinity for synovial tissue by binding to substances like collagen, fibronectin, and prosthetic materials.^[18] In adults, osteomyelitis can spread into the joint space due to vascular connections between the synovium and epiphysis. The main consequence of bacterial invasion is the loss of articular cartilage, which is brought on by the host's inflammatory response, which includes cytokine-mediated breakdown of collagen and proteoglycans, as well as bacterial enzymes, such as *S. aureus* chondrocyte proteases.



Septic arthritis – pathophysiology Normal (a). In the acute stage (b), there is an acute synovial inflammation with a purulent joint effusion. Soon articular cartilage is damaged by proteolytic enzyme secreted from bacteria and cells. If the infection is not controlled, the cartilage may be completely destroyed and subcortical bone is eroded. Healing may occur with irregular joint space narrowing and bony ankylosis (c)

Fig 3: Pathophysiology of Septic arthritis

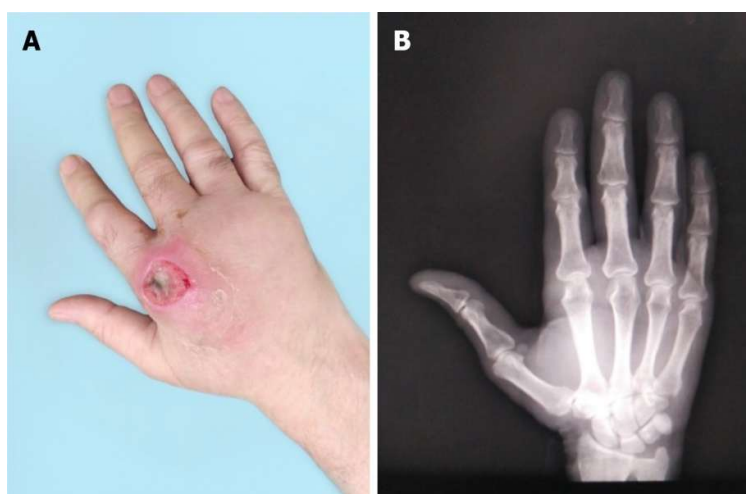
Conversely, *Neisseria gonorrhoeae* infections usually result in less severe joint damage and discomfort. As the infection worsens, peripheral cartilage degradation and pannus development take place. Compromised blood flow in situations of large effusions, especially in the hip, can result in aseptic bone necrosis, which frequently occurs within three days of an untreated infection. Furthermore, as observed in hepatitis B, parvovirus B19, and lymphocytic choriomeningitis virus infections, viral arthritis can result from immune complex deposition or direct invasion (e.g., rubella).^[19,20]

Risk factors

There are some risk factors that may raise the chance of developing septic arthritis in children, even though it only affects healthy kids and teenagers without any comorbid medical conditions. For instance, some hematological conditions, immune-suppressive diseases, and children with renal osteodystrophy or renal bone disease are risk factors for childhood septic arthritis.

Depending on the underlying medical condition and the features of the joint, the incidence of septic arthritis might range from 4 to 29 instances per 100,000 person-years. Of those who have a septic joint, 59% have a prior joint disease, and 85% have an underlying medical issue. The chance of developing septic arthritis is significantly increased when many risk factors are present.

Septic arthritis is more likely to occur in people with specific health and lifestyle conditions. Growing older, especially after the age of 80, greatly increases vulnerability. Increased vulnerability is also a result of chronic illnesses such diabetes mellitus, extensive liver disease, and end-stage renal disease that necessitates hemodialysis. Because microorganisms may be introduced, the presence of a prosthetic joint—especially in the knee or hip—or a recent joint-related surgery raises the risk of infection. Other concerns include recent intra-articular corticosteroid injections or a personal history of septic arthritis.



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Fig 4: Septic arthritis of the hand

The risk is further exacerbated by immunocompromised conditions such as HIV/AIDS, hypogammaglobulinemia (which can make people more susceptible to infections like *Mycoplasma*), and late complement-component deficits (which are linked to a higher risk of contracting *Neisseria* infections). Intravenous drug usage, skin infections, underlying cancers, and hematologic or genetic conditions including sickle cell disease and hemophilia are further contributing factors. When taken as a whole, these variables call for increased clinical attention in order to identify and treat septic arthritis in at-risk groups as soon as possible. Some of the risk factors like

- Joint trauma
- Skin fragility
- Having an artificial joint
- Weak immune system
- Existing joint problems
- Taking medications for rheumatoid arthritis ^[21-24]

Clinical features

Fever and acute or subacute monoarthritis are the typical manifestations. Typically, the joint is red, hot, and swollen, and it hurts to move and to rest. Lower limb joints like the knee and hip are most frequently targeted, though any joint may be impacted. Multiple joint involvement may be evident in patients with pre-existing arthritis. *Staphylococcus aureus* is the most probable organism in adults, especially in those with diabetes and A. In sexually active, young adults, gonococcus may be the cause. Approximately 3% of people with untreated gonorrhea develop a disseminated gonococcal infection. Before an oligo- or monoarthritis develops, this typically manifests as tenosynovitis, low-grade fever, and migratory arthralgia. There may also be painful, pustular skin sores.^[25]

Diagnosis

The majority of diagnoses are clinical. Usually, the patient is a young person. The most frequently affected joint is the knee. The elbow, shoulder, hip, and so forth are examples of other joints. A young child with septic arthritis typically exhibits significant throbbing, pain, swelling, and redness of the afflicted joint in this acute type. Malaise and high-grade fever are linked to this. The afflicted limb is unable to be touched by the child. Parents may observe that their child is preventing others from touching the joint when it is in its subacute stage. A lower limb that hurts can be the first thing people observe. It could be connected to a low-grade fever. The child is typically very toxic during evaluation, exhibiting tachycardia and a fever. The afflicted joint is kept in an easy position and is enlarged. Increased temperature, pain, and effusion are palpable. The joints' ability to move in all directions is severely limited. Any attempt at active or passive movement results in excruciating pain and spasms in the muscles. There may be some joint mobility in subacute types.^[26]

Physical Examination:

- ✓ **General:** Fever, tachycardia
- ✓ **Inspection:** rash involving overlying skin, erythema
- ✓ **Palpation:** Joint effusion, Warmth
- ✓ **Range of motion:** pain and/ or restriction of active and passive motion.

Synovial fluid analysis:^[27]

Table 1: Synovial fluid analysis

Synovial Fluid	Color	Clarity	WBC (mL)	PMN (%)	Crystals	Culture
Normal	Clear	Transparent	<200	<25	Negative	Negative
Noninflammatory	Straw to yellow	Transparent	2000	<25	Negative	Negative
Inflammatory	Yellow	Translucent	2000–50,000	>70	May be positive	Negative
Septic	Variable	Opaque	>50,000	>90	May be positive	85-95% positive ^b
Hemorrhagic	Red	Bloody	200–2000	50–75	Negative	Negative

PMN, Polymorphonuclear neutrophil; WBC, white blood cell count.

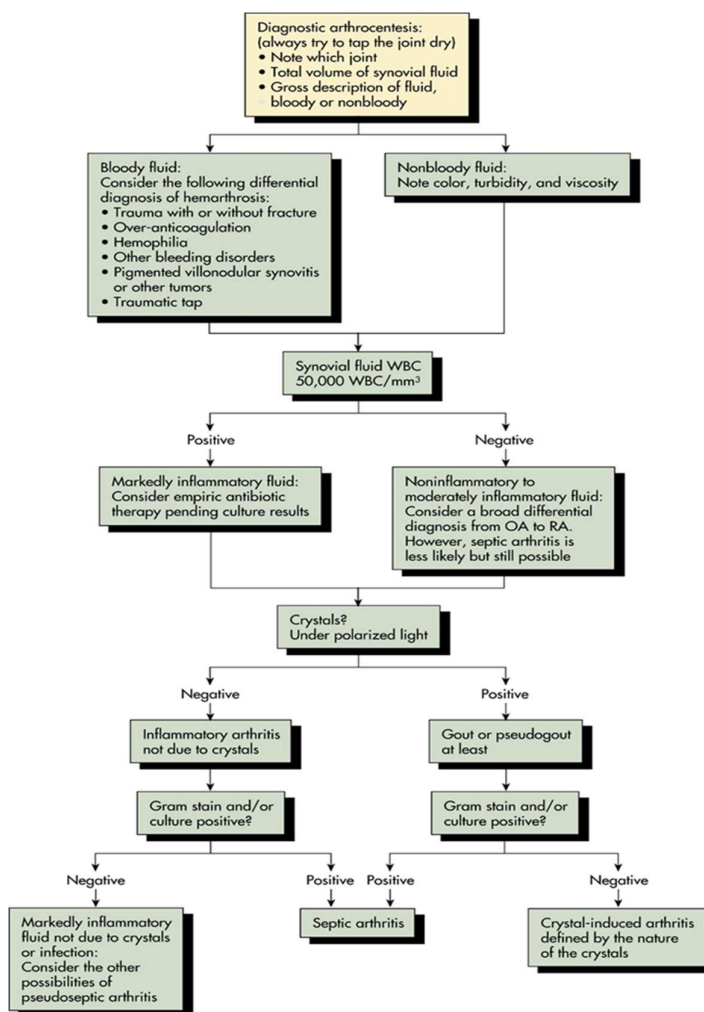


Fig 5: Algorithm for synovial fluid analysis in Septic arthritis

Investigations

- **Radiological examination:** Early diagnosis is essential. A close examination of the X-ray might show more joint space and a soft tissue shadow that corresponds to the joint's enlarged capsule. When it comes to identifying accumulation in deep joints like the hip and shoulder, ultrasound examination is helpful. If discovered, the fluid could be aspirated and sent for the infection-causing organism to be cultured. The joint space narrows in the later stage. It's possible that the joint margins are irregular. There may occasionally occur joint dislocation or subluxation.
- **Blood:** It exhibits leukocytosis of neutrophils. The ESR is noticeably higher. The causative bacterium may be grown in a blood culture.
- **Joint aspiration:** It is the most effective and fastest way to diagnose septic arthritis. Acute septic inflammation symptoms could be present in the fluid. Until the culture reports are obtained, Gram staining gives a hint as to the sort of organism.^[26]

Treatment

A proper diagnosis and vigorous therapy can prevent irreversible damage to a joint in its early stages, before any X-ray evidence of joint deterioration shows up. Joint aspiration must be used to confirm or rule out the diagnosis of septic arthritis whenever it is suspected. Parenteral administration is the best way to begin using broad-spectrum antibiotics. Ceftriaxone and Cloxacillin are typically administered together in the proper dosages. Based on aspirate culture and sensitivity reports, these are then substituted with particular antibiotics. It is necessary to rest the joints in traction or a splint.

Table 2: Empirical Antibiotic Therapy for Septic Arthritis and the Most Likely Infecting Organism

Age	Likely Organism	Initial Antibiotic Regimen
Neonate	<i>Staphylococcus aureus</i> , group B streptococcus	Oxacillin + gentamicin
Child <5 years	<i>S. aureus</i> , group A streptococcus, <i>Streptococcus pneumoniae</i> , <i>Haemophilus influenzae</i>	Second-generation cephalosporin
5 years to adolescence	<i>S. aureus</i>	Oxacillin
Adolescence to adulthood	<i>Neisseria gonorrhoeae</i>	Ceftriaxone
Older adults	<i>S. aureus</i>	Oxacillin or cefazolin + aminoglycoside

The joint should always be opened (arthrotomy), cleaned, and suction-drained whenever pus is aspirated. It is now possible to do the same arthroscopically. The patient's overall health improves, fever and localized inflammation go down, and the joint gradually becomes mobilized as the inflammation is reduced. The duration of antibiotics is six weeks.

It is impossible to anticipate joint mobility in late instances due to radiological damage of the joint borders, subluxation, or dislocation. In these situations, the joint is immobilized in its optimal function position following an arthrotomy and thorough debridement, causing ankylosis to develop in that location as the illness recovers.^[25,26,28]

Complications

Similar to osteomyelitis, these can be classified as either general or local. These local consequences result from inadequate early therapy.

Deformity and stiffness: Intra-articular and peri-articular adhesions cause the joint to become rigid. Ankylosis may develop from total destruction of the articular cartilage in cases of severe illness. The typical result of a neglected septic arthritis is bony ankylosis.

Pathological dislocation: The joint capsule and supporting ligaments stretch as the joint fills with inflammatory exudate. The disease-related muscle spasm may cause the joint to dislocate pathologically. Triple displacement of the knee and posterior dislocation of the hip occur.

Osteoarthritis: Even with relatively early treatment for septic arthritis, some long-term alterations in the articular cartilage take place, leading to early osteoarthritis a few years later.^[26]

Management of Suspected Septic Arthritis: A Clinical Approach

Hospital Admission and Initial Assessment

Patients presenting with suspected septic arthritis should be admitted promptly for thorough evaluation and urgent intervention. Early diagnosis and management are critical to prevent joint destruction and systemic complications.

Diagnostic Investigations

Joint Aspiration:

Urgent synovial fluid aspiration is essential for diagnostic confirmation. The fluid should be sent for Gram stain, culture, and sensitivity testing. If aspiration is challenging, imaging guidance (e.g., ultrasound or fluoroscopy) may be employed to ensure accurate sampling.

Laboratory Tests:

In addition to synovial analysis, blood samples should be collected for:

- Blood cultures
- Routine haematology and biochemistry
- Inflammatory markers such as C-reactive protein (CRP) and erythrocyte sedimentation rate (ESR)

Depending on the patient's history and clinical presentation, additional cultures (e.g., urine, throat swabs, or wound swabs) may be necessary to identify the primary source of infection.

Antimicrobial Therapy

Empirical Intravenous Antibiotics:

Empirical antibiotic therapy should be initiated immediately after obtaining diagnostic samples. Choices include:

- **Flucloxacillin** 2 g IV four times daily as the first-line treatment

- **In penicillin-allergic patients:**
 - **Clindamycin** 450–600 mg IV four times daily (particularly in younger individuals)
 - **Vancomycin** 1 g IV twice daily (preferably in patients over 65 years)

Coverage for Gram-negative Pathogens:

In cases where there is a high risk of Gram-negative sepsis, antimicrobial regimens should include agents effective against both *Staphylococcus aureus* and local Gram-negative organisms.

Pain Management

Adequate analgesia is essential for patient comfort and rehabilitation:

- Use a combination of oral and/or intravenous analgesics
- Application of local ice packs may also be beneficial in reducing joint swelling and discomfort

Joint Drainage

Repeated Aspiration:

Serial joint aspiration to dryness should be performed 1–3 times daily or as clinically indicated to remove purulent material and reduce intra-articular pressure.

Surgical Intervention:

If needle aspiration proves inadequate or technically difficult, arthroscopic lavage or open surgical drainage should be considered.

Physiotherapy and Rehabilitation

Early involvement of physiotherapy is vital for functional recovery:

- Initiate passive range-of-motion exercises once the acute pain is controlled and there is no significant re-accumulation of joint effusion
- Progress to active joint movements as tolerated. [16,18,29]

Traditional Use and Bioactive Mechanisms of Ethnobotanical Remedies for Arthritis and Septic Arthritis

In many cultures, a number of medicinal plants have been traditionally utilized to treat joint infections, including septic arthritis, and arthritis. Key bioactive processes have been identified in recent pharmacological research, which have started to validate these ethnomedicinal claims. The following table lists common plants, their historical uses, and the data proving their immunomodulatory and anti-arthritic properties: [30-32]

Table 3: Plants used for the treatment for arthritis/septic arthritis

Plant (Common Scientific Name)	Traditional Use for Arthritis/Septic Arthritis	Bioactive Mechanism / Evidence
<i>Boswellia serata</i> (Shallaki)	Traditional resin used to treat inflamed, swollen joints	Inhibits COX-2, LOX, MMP-9, TNF, IL-1, IL-6
<i>Curcuma spp.</i> (Turmeric)	Widely used in Ayurveda & folk medicine to treat septic arthritis	Anti-oxidant, anti-inflammatory; suppress cytokines/coagulation pathways.
<i>Calotropis gigantea/procera</i>	Used by various tribes for rheumatism and infection-related arthritis	Folk reported antimicrobial, anti-inflammatory activity
<i>Cleome gynandra</i> (Spider flower)	African tribal remedy for rheumatic inflammation and joint swelling	Anti-inflammatory, antioxidant effects in pain models.
<i>Nyctanthus arbortristis</i>	Tribal/rural use for rheumatism and swollen joints	Used in decoctions for relief of inflammation and pain.
<i>Saussurea costus</i>	Himalaya tribal remedy for joint pain and rheumatic conditions	Applied as root paste or internal decoction
<i>Strobilanthes callosa</i>	Tribal use in India for rheumatic/inflammatory joint disorders	Lupeol compounds with anti-arthritic activity confirmed
<i>Terminalia chebula</i> (Haritaki)	Ayurvedic and tribal use in Tamil Nadu for joint infection/ inflammation	Reduces cytokines (TNF- α , IL-6, IL-1 β)
<i>Trigonella foenum-graecum</i> (Fenugreek)	Used broadly, including tribal use in rheumatoid/septic arthritis	Lowers ESR, CRP; antioxidant, anti-inflammatory in animal models.
<i>Withania somnifera</i> (Ashwagandha)	Ayurvedic & tribal use for arthritis and infected joint swelling	Reduces TNF- α , IL-1 β , NF-K β ; immunomodulatory

Effective General Phytoconstituents for Septic Arthritis ^[33-36]

Numerous bioactive phytochemicals, such as alkaloids, flavonoids, terpenoids, steroids, and phenolic compounds, are responsible for the therapeutic benefits of numerous medicinal plants against rheumatoid and septic arthritis. These substances help regulate the systemic and local signs of joint infections by their anti-inflammatory, antioxidant, immunomodulatory, and antibacterial properties:

Table 4: Phytoconstituents effective against Septic arthritis

Class of Compound	Representative Phytoconstituents	Mechanism of Action in Septic Arthritis	Source Plants
Triterpenoids	Boswellic acids (AKBA, KBA)	Inhibit 5-lipoxygenase (5-LOX), reduce leukotriene synthesis, suppress TNF- α and IL-1 β	<i>Boswellia serrata</i>
Diarylheptanoids	Curcumin	Inhibits NF- κ B and COX-2; downregulates IL-1 β , IL-6, TNF- α ; possesses strong antioxidant properties	<i>Curcuma longa</i>
Withanolides	Withaferin A, Withanolide D	Immunomodulatory; suppresses pro-inflammatory cytokines (TNF- α , IL-1 β)	<i>Withania somnifera</i>
Flavonoids	Quercetin, Kaempferol, Luteolin	Antioxidant; reduces oxidative stress and inflammatory mediators (e.g., cytokines, prostaglandins)	<i>Cleome gynandra</i> , <i>Terminalia chebula</i>
Saponins	Diosgenin	Anti-inflammatory and immunomodulatory; reduces joint swelling in arthritic models	<i>Trigonella foenum-graecum</i> (Fenugreek)
Phenolic Compounds	Gallic acid, Ellagic acid	Scavenge free radicals; suppress cytokines (e.g., TNF- α , IL-6); prevent tissue damage	<i>Terminalia chebula</i> , <i>Nyctanthus arbor-tristis</i>
Alkaloids	Costunolide	Analgesic and anti-inflammatory; inhibits inflammatory cell infiltration and cytokine production	<i>Saussurea costus</i>
Steroidal Compounds	Calotropagenin, Gigantin	Exhibit antimicrobial and anti-inflammatory activity; used traditionally for infected joint conditions	<i>Calotropis procera</i> , <i>Calotropis gigantea</i>

CONCLUSION

Septic arthritis remains a critical medical emergency needing immediate recognition, aggressive treatment, and thorough follow-up. Modern approaches including early joint aspiration, IV antibiotics, and surgical intervention are essential for reducing long-term complications. Traditional herbal medicine, supported by growing pharmacological evidence, may offer complementary benefits via anti-inflammatory and immunomodulatory pathways, especially in regions with limited access to modern healthcare.

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