

**ACUTE AND CHRONIC OSTEOMYELITIS: ETIOLOGY, CLINICAL
MANIFESTATIONS, PATHOPHYSIOLOGY AND MODERN TREATMENT
APPROACHES****Dr. Vikas Singhal*, Mrs. Tripti Singhal, Mr. Svayam Singhal, Dr. Singhal Homeo**

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ABSTRACT

A serious infectious condition, Osteomyelitis, can affect health severely. This health issue has a negative impact on bone tissue. It is marked by tissue necrosis, swelling and progressive structural damage. Osteomyelitis can be acute or chronic, based on various factors such as severity, duration and treatment effectiveness. A serious infectious condition, Osteomyelitis, can affect health severely. This health issue has a negative impact on bone tissue. Acute osteomyelitis, as the name indicates, is an acute form of Osteomyelitis. It develops quickly through the spread of hematogenous bacteria, direct inoculation arising after trauma or surgical contamination.

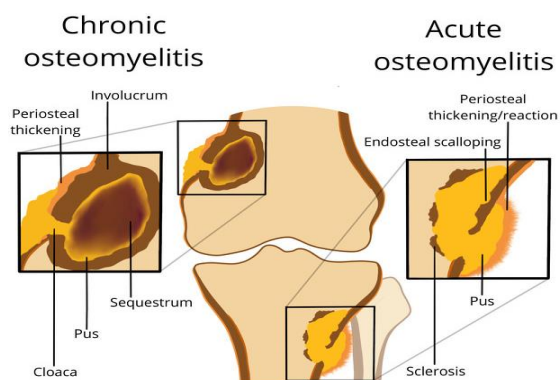
KEYWORDS: Osteomyelitis, Acute or Chronic, Etiology, Clinical Manifestations, Pathophysiology And Modern Treatment Approaches Tissue Necrosis, Swelling And Progressive Structural Damage Etc....

INTRODUCTION

A serious infectious condition, Osteomyelitis, can affect health severely. This health issue has a negative impact on bone tissue. It is marked by tissue necrosis, swelling and progressive structural damage. Osteomyelitis can be acute or chronic, based on various factors such as severity, duration and treatment effectiveness.

Acute osteomyelitis, as the name indicates, is an acute form of Osteomyelitis. It develops quickly through the

spread of hematogenous bacteria, direct inoculation arising after trauma or surgical contamination. Chronic Osteomyelitis is long-term osteomyelitis. It can occur due to persisting infection or an acute form of infection that is not treated well enough. For effective management of acute and chronic forms of Osteomyelitis, it is necessary to understand the etiology, clinical manifestations, pathophysiology and modern treatment approaches.

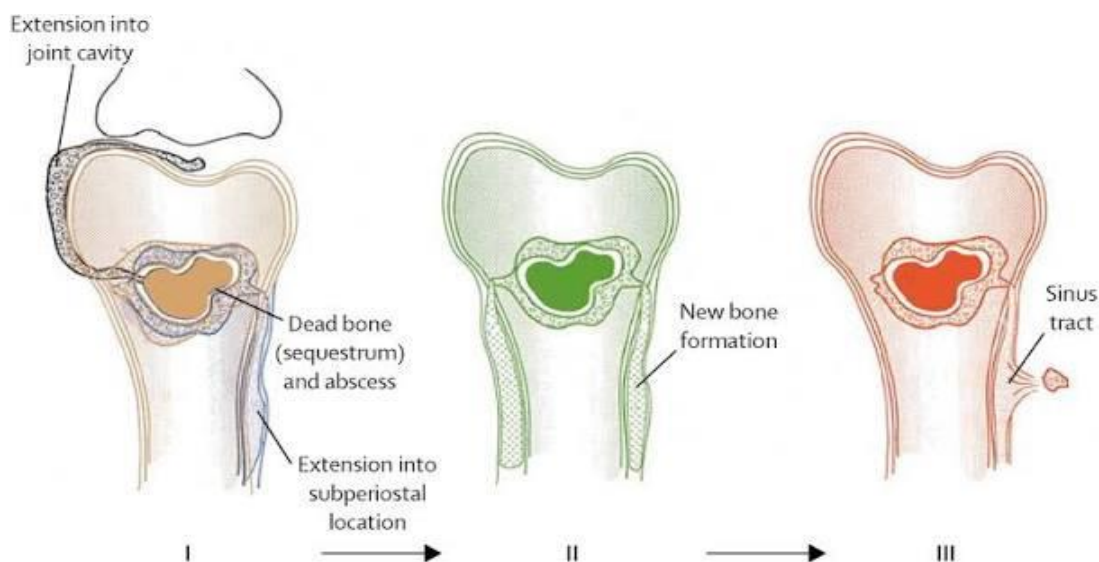


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Etiology

Osteomyelitis presents major challenges when it comes to diagnostic and therapeutic treatment. This is due to:

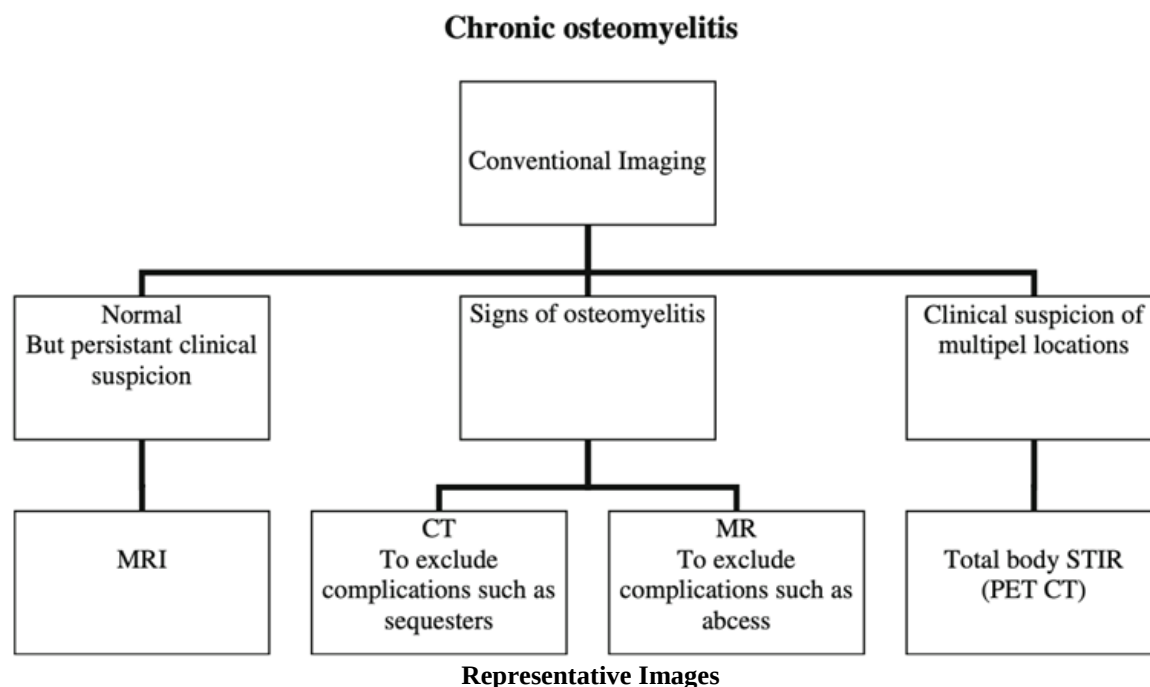
- Variable clinical manifestations,
- Recurrent infection,
- Complications like bone necrosis and biofilm formation, and
- Potential for progression



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These days, treatment outcomes have improved for Osteomyelitis. This is due to advances in diagnostic

imaging, local antibiotic delivery, antimicrobial therapy, regenerative medicine and surgical management.



Mainly, Osteomyelitis is a microbial infection of bone tissue. *Staphylococcus aureus* has been found to be the main pathogen that causes both acute and chronic forms of the condition. Often, Acute Osteomyelitis arises due to hematogenous dissemination of bacteria. This is especially seen in case of children. Infection can also arise due to surgical contamination or trauma.

In adults, the acute form of the condition is often associated to

- Surgical procedures,
- Trauma,
- Prosthetic implants,
- Contiguous spread from adjacent soft-tissue infections, and
- Invasive interventions

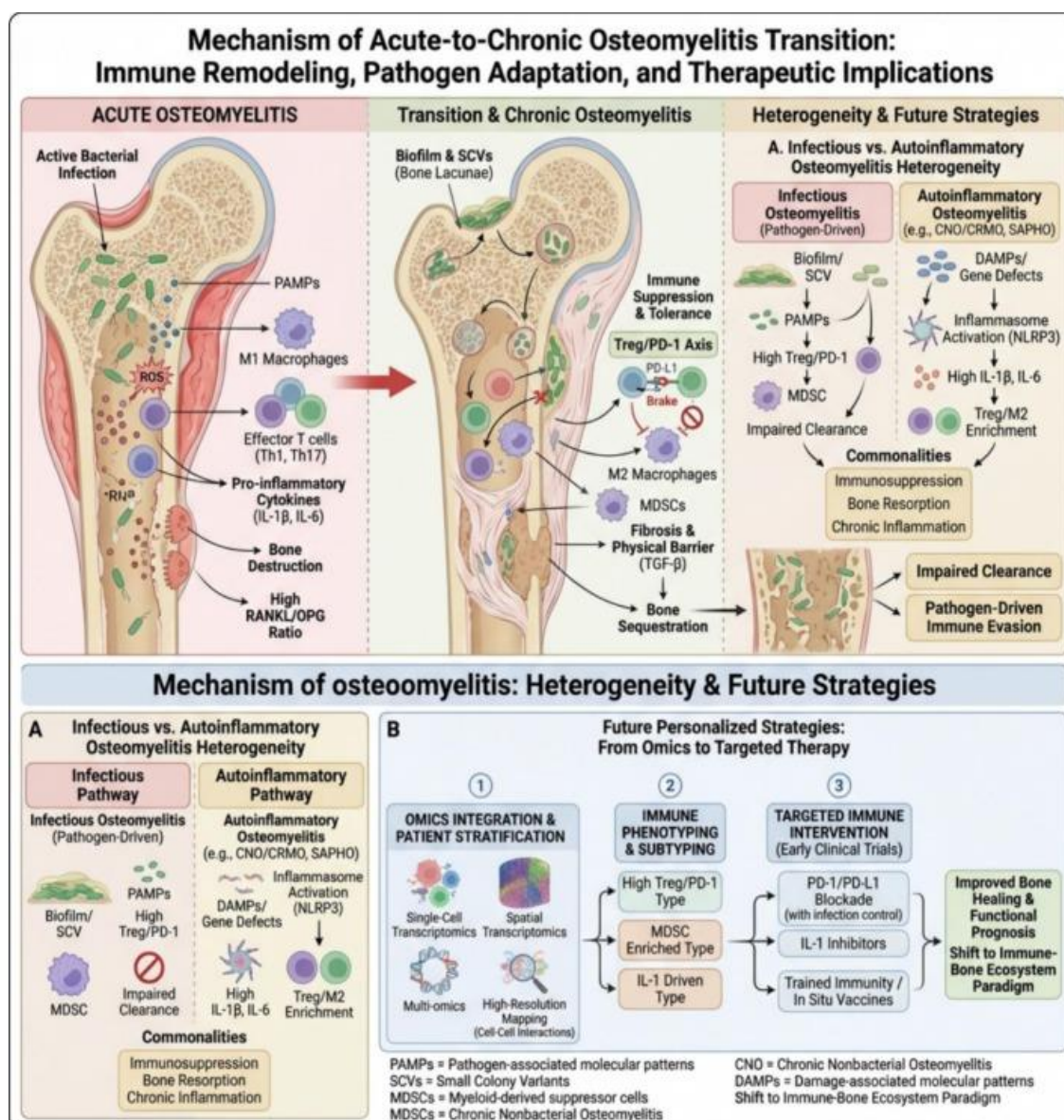
Physicians are also reporting that methicillin-resistant *Staphylococcus aureus* (MRSA) is increasingly being involved with the development of the condition. Due to

antibiotic resistance of the bacteria, treatment gets complicated.

Chronic Osteomyelitis often arises when acute infection is not treated or treated insufficiently. This leads to persistence or recurrence of the infection. Polymicrobial infections, which include infections arising due to anaerobic bacteria, are often associated with chronic cases that are related to chronic wounds and diabetic foot ulcers. Osteomyelitis is also being associated with:

- Postoperative complications,
- Orthopaedic procedures,
- Trauma, and
- Chronic diseases such as diabetes mellitus, mainly among immunocompromised people

Clinical Manifestations Between acute and chronic forms of Osteomyelitis, the clinical presentation varies a lot.



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Clinical Manifestations for Acute Osteomyelitis

Typically, Acute Osteomyelitis develops quickly. It is marked by various symptoms, such as:

- Localized bone pain,
- Swelling,
- Tenderness,
- Erythema, and

- Systemic manifestations like malaise, fever and other inflammatory signs

Laboratory investigations often show leucocytosis. Diagnosticians can also notice higher inflammatory markers, especially erythrocyte sedimentation rate (ESR) and C-reactive protein (CRP). There can be non-specific symptoms in the initial stages, which can make diagnosis challenging.



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Generally, Acute Osteomyelitis can be detected after a couple of weeks from the time of infection. It is possible to stop and reverse the condition if:

- Acute Osteomyelitis is detected and urgent action is taken, and
- The antibiotics used for remedy show effectiveness towards the infective microbe (the microbe cannot resist the chosen antibiotic)

6 weeks into the infection, patients usually begin to suffer from bone injury along with inflammation. Dead bone fragments begin to enter the adjoining soft tissues. Such issues are indicative of Chronic Osteomyelitis.

Clinical Manifestations for Chronic Osteomyelitis

Chronic Osteomyelitis, contrasting with Acute Osteomyelitis, is marked by progressive bone destruction and persistent inflammation. Some of the characteristic symptoms of this condition include:

- Intermittent inflammation and pain,
- Necrotic bone fragments, referred to as “sequestra”,
- Development of involucrum (new bone around the sequestrum), and
- Draining sinus or fistula tracts with purulent discharge



Representative Images

Big festering wounds can arise due to Chronic Osteomyelitis, which can lead to sepsis. Polymicrobial infection may also occur. The prognosis of Acute Osteomyelitis is typically more favourable, when it is detected and cured effectively. On the other hand, Chronic Osteomyelitis tends to recur. It is also associated with long-term morbidity.

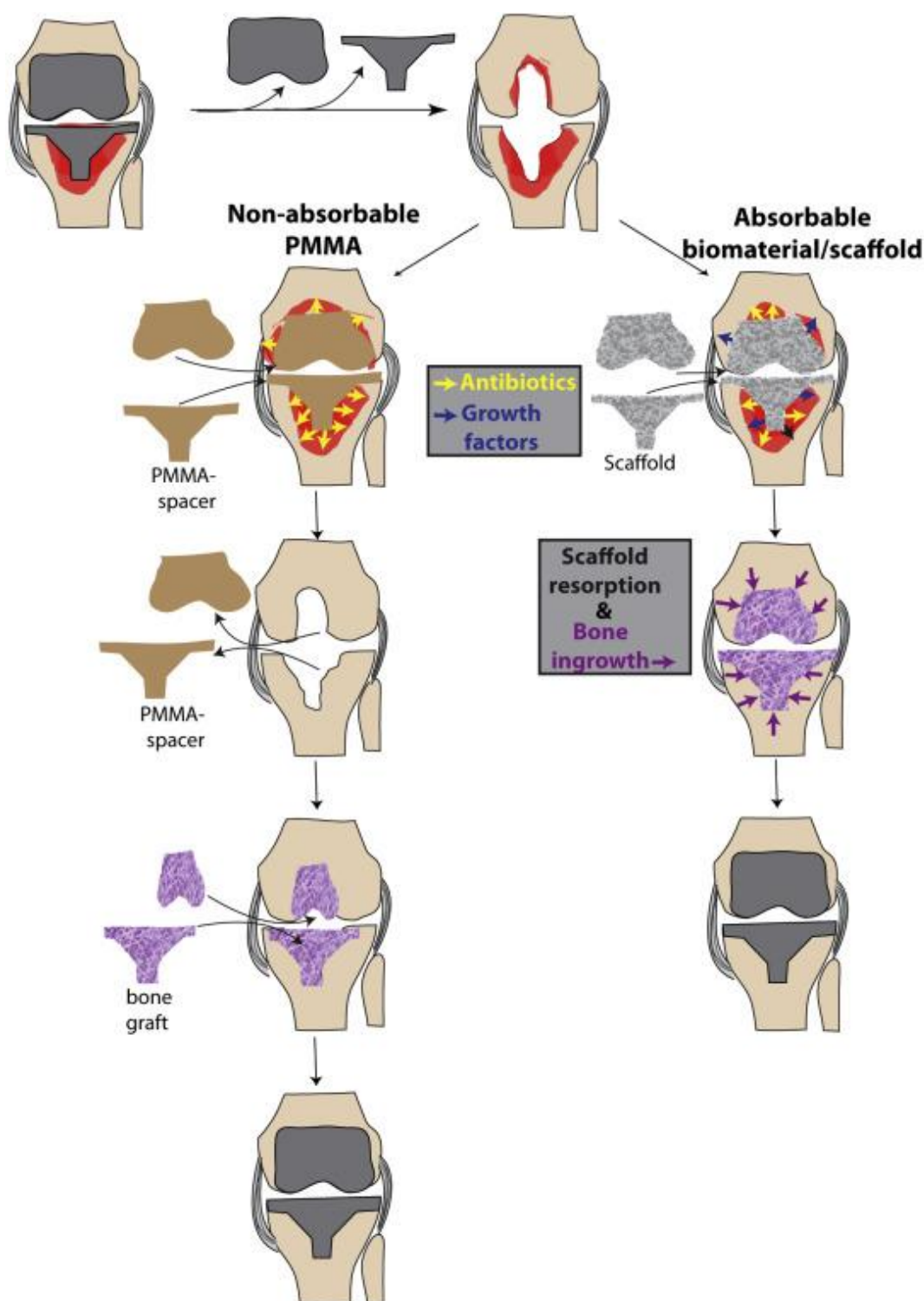
Pathophysiology

In Osteomyelitis, the pathophysiology involves an intricate interaction between:

- Host immune responses,
- Microbial invasion,
- Bone remodelling, and
- Vascular compromise

Patients begin to suffer from infection when microorganisms stick to bone matrix proteins. Eventually, these can lead to the production of extracellular polymeric substances, which result in the

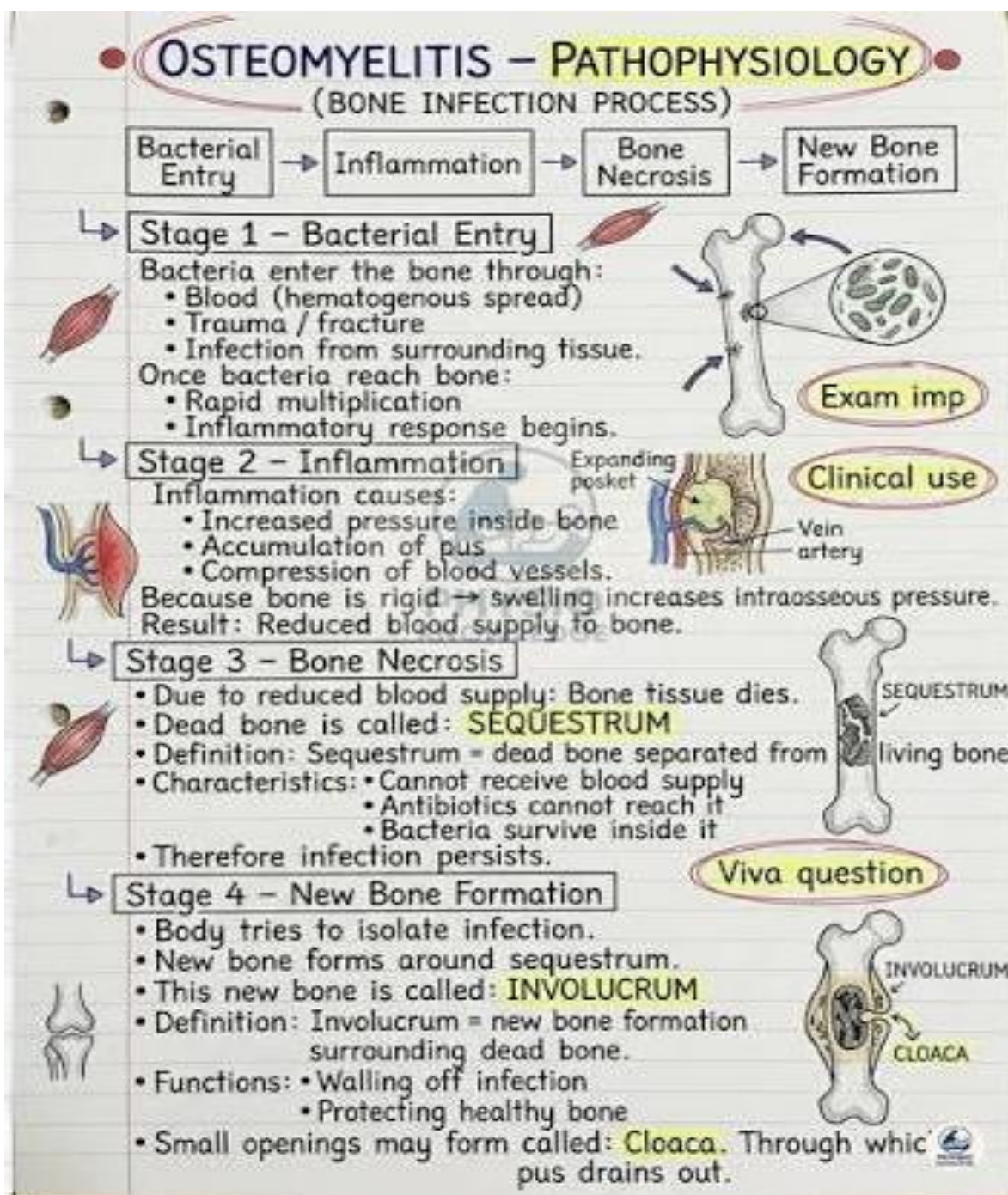
formation of protective biofilms. These biofilms protect bacteria from antimicrobial agents and immune system of host. These are regarded as essential for the shift from Acute to Chronic Osteomyelitis.



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Through adaptive and innate immune mechanisms, the host shows response. Neutrophil infiltration and cytokine release result in swelling. Collateral tissue damage can

also occur due to such responses. When there is chronic infection, osteolysis and impairment of bone regeneration can worsen due to persistent inflammation.



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Compromised vascular system in infected bone can promote tissue necrosis simultaneously. It can reduce antibiotic penetration. Thus, Chronic Osteomyelitis leads to a protective microenvironment, which is marked by:

- Biofilm formation,
- Necrotic bone, and
- Impaired vascular supply

This allows persistence of bacteria despite antimicrobial and immune activity. It can add to recurrent infection.

Modern Treatment Approaches

Modern Osteomyelitis treatment focuses on

- Early diagnosis,
- Suitable antimicrobial therapy,
- Surgery (as needed), and
- Care from various specialist medical professionals

The diagnosis of Osteomyelitis involves

- Clinical assessment,
- Advanced imaging, and
- Blood tests, such as ESR and CRP

<p>1 Early diagnosis</p>  <p>Detecting the condition early helps prevent further damage and improves outcomes.</p>	<p>2 Suitable antimicrobial therapy</p>  <p>Targeted antibiotics help eliminate infection and prevent recurrence.</p>	<p>3 Surgery (as needed)</p>  <p>Removes infected tissue, drains abscesses and restores bone health when necessary.</p>	<p>4 Care from various specialist medical professionals</p>  <p>A team approach ensures comprehensive care and better recovery.</p>
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The diagnosis of Osteomyelitis involves:

<p>1 Clinical assessment</p>  <p>Evaluation of symptoms, medical history and physical examination to identify signs of infection.</p>	<p>2 Advanced imaging</p>  <p>MRI, CT scans or bone scans help visualize the extent of infection and bone involvement.</p>	<p>3 Blood tests, such as ESR and CRP</p>  <p>These markers help detect inflammation and monitor treatment progress.</p>
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MRI helps to detect bone marrow oedema. Naturally, for early detection, it is regarded as the most sensitive imaging technique. CT scan offers a detailed view of bone destruction. This makes it especially assistive for the diagnosis of Chronic Osteomyelitis.

The main components of Osteomyelitis treatment include

- Sufficient infected and dead tissue removal,
- Wound protection,
- Filling up of dead spaces, and
- Using targeted antimicrobial therapy

Surgical Therapy:

Various debridement techniques are used for the surgical treatment of Osteomyelitis. These include:

- Dead bone removal,
- Dead tissue removal, and
- Intramedullary reaming

Orthopaedic material should also be removed when needed or possible, other than in all those cases where the material is needed to stabilize the bone. Surgical debridement may have to be done again, to get rid of all nonviable tissue. Surgeons can evaluate whether they have carried out the debridement extensively. However, it cannot be precisely measured whether the debridement has been complete.

Various methods can be used, such as placing acrylic beads that include antibacterial agents and cancellous bone grafting. In case of insufficient blood supply, endovascular stenting or vascular bypass can be used to restore blood flow. A two-stage surgical procedure may be necessary in case bone stability is impacted.

First Stage

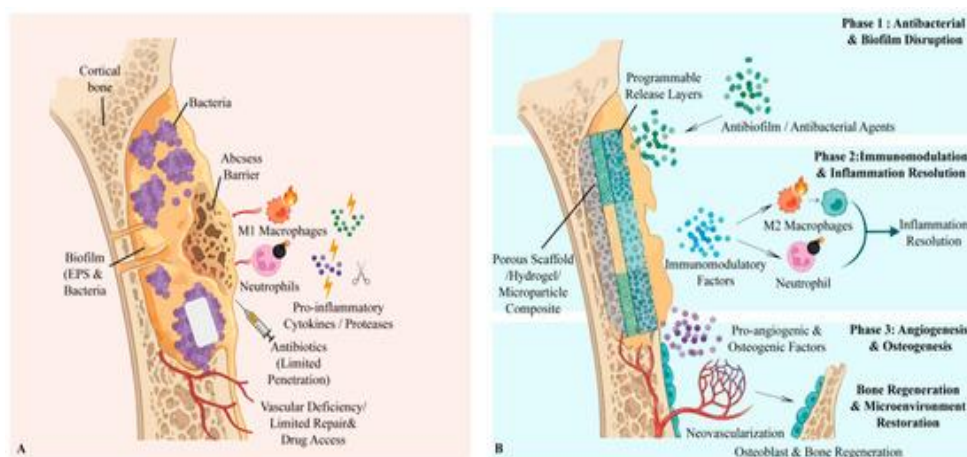
This involves

- Extensive debridement,
- Dead space management,
- Use of cement or antibiotic-containing beads (in some cases),
- Bone stabilisation with external fixation, and
- Covering wounds with dressings

Second Stage

The second stage starts after 3 weeks of antibiotic treatment. It includes

- New debridement,
- Removing cement or beads,
- Using a bone graft for filling the dead space,
- Bone stabilisation with internal fixation (with an intramedullary nail or plate), and
- Covering the soft tissue



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Gentamicin beads and other local antibiotic treatment methods are used. This offers antibiotic diffusion, which is restricted to a specific period and area. Latest evidence does not demonstrate any remission rate or other advantages due to systemic antibiotics being used during local antibiotic treatment. Using local beads can be highly unfavorable. This is because another surgery may be required for taking these out of the body.

If there is decent soft-tissue coverage, there may not be any change in a small dead space. Bigger dead spaces are filled up, which can impact stability and reduce the risks of continued infection. If the cavity cannot be filled by the surrounding soft tissue, the space can be filled up with transferred free tissue or a local muscle flap.

Following 6 – 8 weeks, autologous bone grafts generally help to improve stability. The Ilizarov fixation device can be used as a final option. These can be used for curing patients suffering from extensive Chronic Osteomyelitis - which is tough to treat. With continuous traction, which can start 10 days following the implantation of the Ilizarov fixation device, bone defects of up to 15 cm size can be bridged easily.

Surgical treatment should only be used in all those cases that cannot be improved with anti-biotherapy. Merely

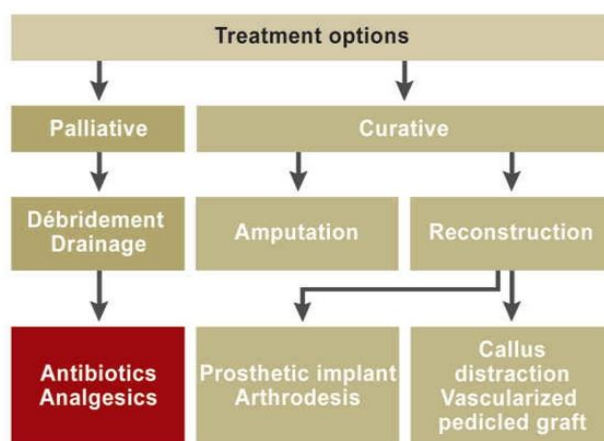
detecting an abscess does not mean that surgery is absolutely indicated. Medical treatment may be especially useful for treating abscesses that are smaller than 3 mm in size.

Antibiotic Therapy

A major part of treatment consists of antibiotic therapy. Antibiotic treatment generally persists for around 4 – 6 weeks after treatment begins for Acute Osteomyelitis. In case of Chronic Osteomyelitis, treatment may be needed for quite a few months.

Initial antibiotic treatment should be based on local data about the infectious organisms. Later, based on culture and sensitivity results, these have to be altered. It is particularly essential, given that treatment can get challenging due to MRSA and other resistant organisms.

Following debridement, the best antibiotic treatment for non-diabetic, implant-free long-bone osteomyelitis in grown-ups has not been well-defined. In most studies, it has primarily been examined which antibiotics need to be used. Their dose, duration or administration technique have not been researched enough. Generally, treating patients with a single antibiotic has been found to be sufficient.



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Not so long ago, based on empirical treatment, antibiotics were primarily administered for 4–6 weeks in a venous manner. This was followed by oral antibiotics for a number of weeks or months. With intravenous treatment, there is better penetration of antibiotics into the bone. It ensures full availability in the blood. But intravenous treatment must be limited. It can help to avoid:

- Catheter-related complications,
- Unnecessary costs, and
- Discomfort for nurses and patients

Prolonged intravenous treatment is said to be connected to around 15% of complications. Latest research has shown support for newer antibiotic treatment approaches. Many medical professionals are of the same view that after 2 weeks of intravenous treatment, it is possible to switch from intravenous to oral antibiotics.

Various types of antibiotics have displayed effectiveness when used in an oral form, including

- Clindamycin,
- Quinolones,
- Linezolid,
- Co-trimoxazole, and
- Fusidic acid combined with rifampicin

Such medicines have around 90% oral bioavailability.

Total Duration of Antibiotic Therapy

Generally, for clinical practice, antibiotic treatment duration happens to be standard in case of most organisms. There are only a few exceptions. These include Tuberculosis as well as infections caused by other mycobacteria, such as those involved in:

- Buruli ulcer,
- Fungi,
- Q fever,
- Nocardiosis, and
- Brucellosis

Longer treatment is necessary in such cases

There is an absence of documented records or clinical studies to demonstrate that an antibiotic course used for 4 to 6 weeks is better than shorter treatment duration. According to studies, remission rates are not impacted due to the total antibiotic treatment duration after debridement or the span of its initial intravenous component.

In studies, a single week of intravenous treatment was similarly successful as 2 – 3 weeks or longer. The outcome of 4 weeks of total antibiotic treatment was as impactful as 4–6 weeks or over 12 weeks. The outcome of less than 6 weeks of treatment was the same as in case of over 6 weeks. Small studies conducted on humans and animals have also shown remission with antibiotic treatment that persists from 1 - 4 weeks.

Intravenous Agents

Beta-lactam antibiotics are often used. However, these usually have low bone penetration and low oral bioavailability. Vancomycin reaches just 15–30% of its serum concentration in bone. Physicians believe minimum 20–25 mg/l serum levels to be most effectual for curing bone infections. Constant infusion leads to smaller changes in serum concentrations, as compared to intermittent treatment. However, there is no surety for better remission outcomes.

Daptomycin is effective as it causes damage to bacterial membranes. It has a fast, dose-dependent impact against bacteria. Daptomycin is only available in the form of an intravenous treatment. It is administered at a 6–8 mg/kg dose only once every day. Thus, it is apt for outpatient treatment. The effectuality of Aminoglycosides is less in bone or synovial fluid.

Oral Agents

The bioavailability of Linezolid is 100%. Thus, only an oral dose of 600 mg can be given twice, every day. But this is expensive. Also, it can lead to thrombocytopenia and other cases of reversible bone marrow suppression. Long-term treatment is needed for 2 to 4% patients who suffer from Permanent peripheral neuropathy and Optic neuropathy. When used along with monoamine oxidase inhibitors or some other antidepressant medicines, there can be severe serotonin syndrome.

As a folate antagonist, Co-trimoxazole might appear as a better option as it is low-cost. However, it can lead to acute and joint infections. This is because thymidine can be released by bacteria and damaged tissues. The anti-staphylococcal effects of sulfamethoxazole and trimethoprim, the dual components of co-trimoxazole, may be reduced due to Thymidine. Whether treatment will fail or not will depend on the number of bacteria that exists as well as the extent of tissue damage.

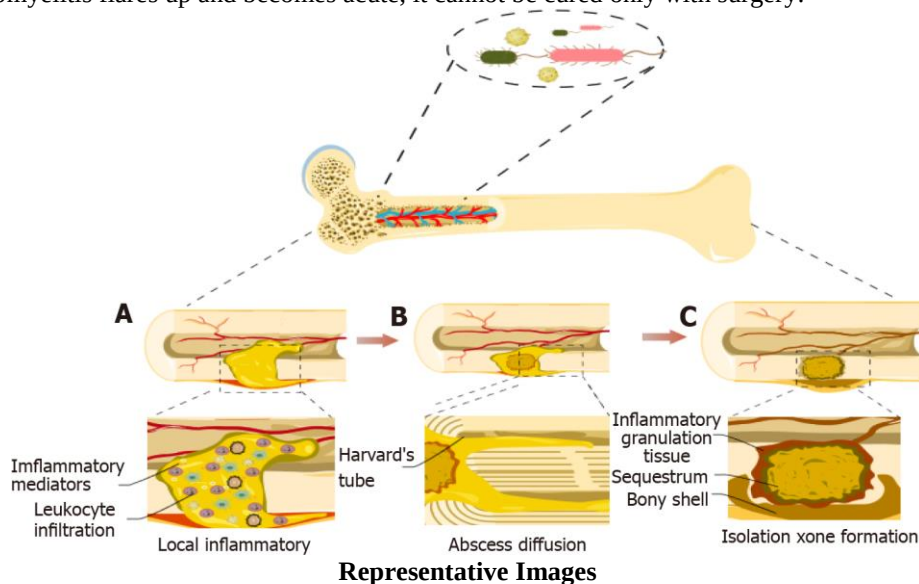
In case of Chronic Osteomyelitis, the use of 500 mg Oral fusidic acid, thrice-a-day, has been shown to be effective. However, solitary use of fusidic acid is not recommended by medical experts. Patients may develop resistance to it. Using it along with rifampin is advisable.

Using 600–900 mg clindamycin, thrice-a-day, is recommended for Osteomyelitis that arises due to clindamycin-sensitive staphylococci, streptococci or anaerobic bacteria. For anaerobic infections, Metronidazole can be effective. Gram-negative infections can be treated with quinolones.

Non-fermenting Gram-negative bacteria, such as *Pseudomonas aeruginosa*, can show resistance when doctors attempt treatment with quinolones alone. Thus, for treating pseudomonal osteomyelitis, it may be suitable to use prolonged intravenous treatment or use a quinolone along with some other intravenous drug. However, the effects of antibiotic treatment adjusted

specifically for this condition have not been researched yet.

If Chronic Osteomyelitis flares up and becomes acute, it cannot be cured only with surgery.



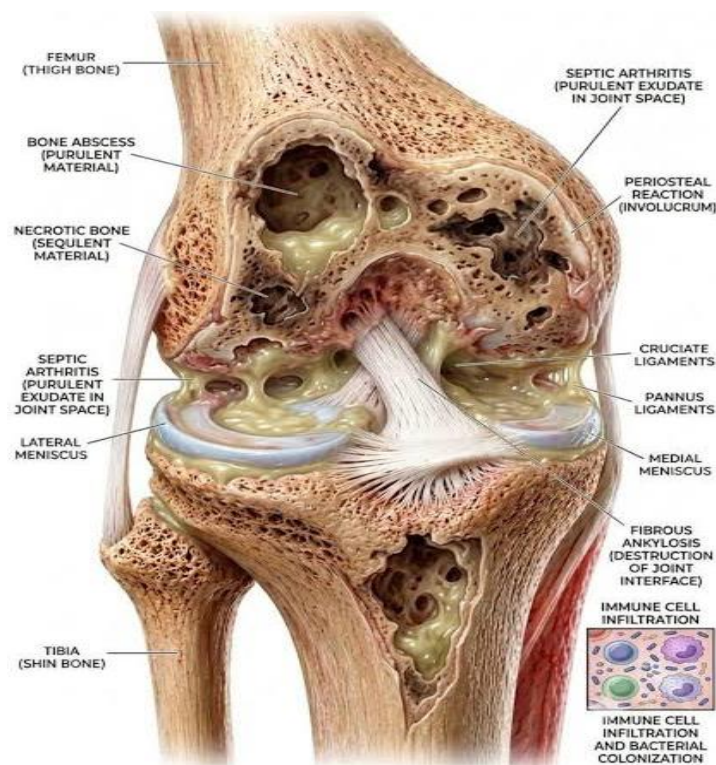
Operative procedures can lead to

- Walking problems,
- Affected mechanical stability due to extensive lesions, and
- Multiple health problems

In such cases, antibiotic treatment can have palliative effects. Physicians can use targeted antimicrobial therapy in such cases. It can be used for 10–20 days for managing the symptoms rather than ensuring treatment.

Significant resources are needed for Hyperbaric oxygen therapy. In this type of therapy, patients are provided with oxygen that supports:

- Bone formation,
- New blood vessel formation,
- Collagen production, and
- Healing in infected or ischemic or wounds



Representative Images

Despite inconsistent results, hyperbaric oxygen therapy is supposed to be useful in treating chronic osteomyelitis. It is tough to evaluate its role; the outcome of therapy may be affected by various factors such as:

- Condition of patient,
- Type of surgery used,
- Causative organism,
- Bone condition, and
- Antibiotic treatment

There is insufficient evidence to support the effectiveness of hyperbaric oxygen therapy for diabetic foot care. Despite this, patients may get reimbursed for it by some healthcare systems.

Modern and Regenerative Approaches

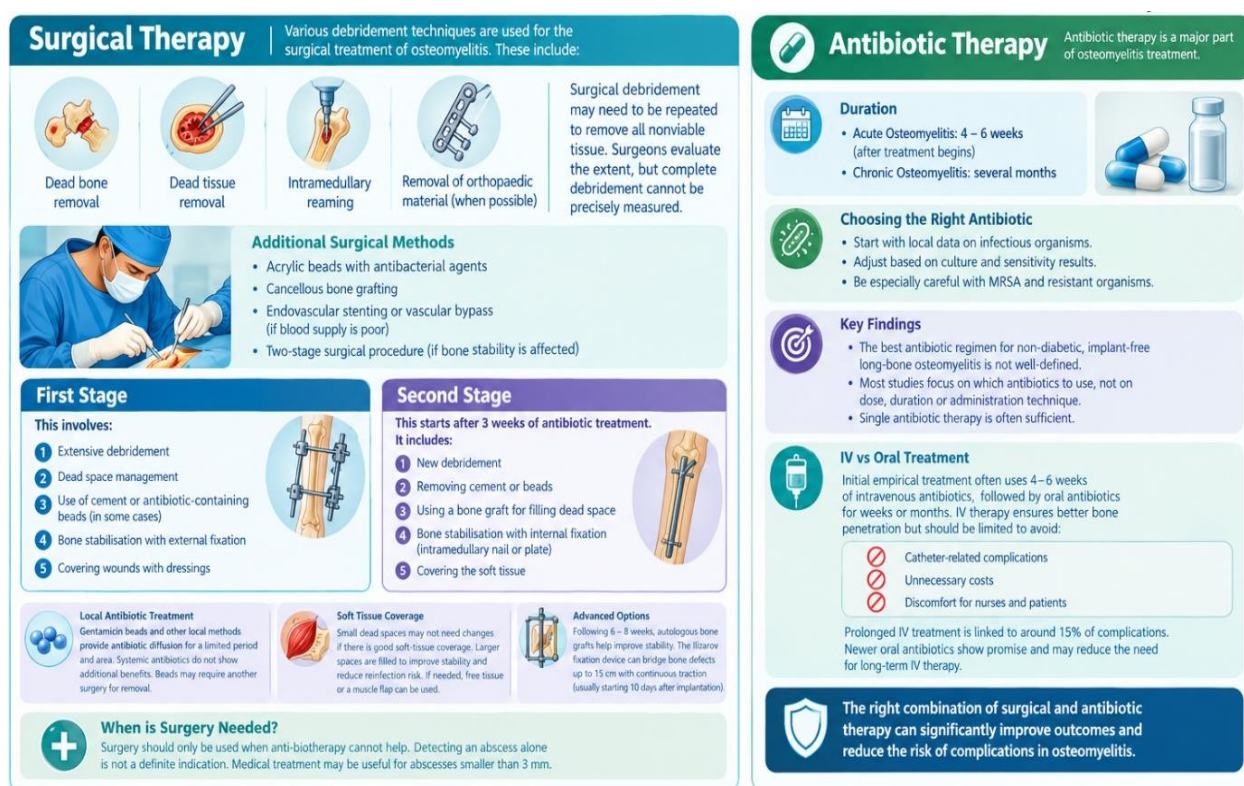
Biodegradable scaffolds, antibiotic-impregnated beads and other local antibiotic delivery systems may be a part

of modern treatment options. With such techniques, antibiotics may be administered at the infected spot in high concentrations. These can help to reduce systemic toxicity.

For cases that are complex or tough to cure, regenerative approaches can be used. These include:

- Growth-factor application,
- Stem-cell therapy,
- Vascularized bone grafting, and
- Tissue engineering

Individualized treatment, often involving various medical specialists, needs to be individualized. It is especially important to use long-term follow-up for dealing with chronic osteomyelitis. This is because, it can be highly challenging to deal with its recurrence.



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Challenges in Acute and Chronic Osteomyelitis Treatment

Generally, Acute Osteomyelitis shows a good prognosis if it is diagnosed and cured promptly. However, if diagnosis is delayed or treatment is inadequate, complications may arise. Patients may suffer from:

- Bone necrosis,
- Spread of infection, and
- Chronic osteomyelitis development

Chronic Osteomyelitis treatment can be quite complex. Physicians often have to use a multidisciplinary approach. Generally, antibiotic therapy is used for a prolonged duration. This is often done with long-term

intravenous antibiotics. Oral antibiotics are used as a follow-up.

Often, surgical intervention is used for

- Addressing tissue and bone infection,
 - Restoring bone stability, and
 - Improving blood circulation to the affected area
- Reconstructive surgery may be used in a few cases. It can help to deal with limb shortening or deformities.

It can be challenging to manage Chronic Osteomyelitis. This is because of biofilm being present, which makes it tougher to remove the infection. In a few cases, physicians may consider using advanced treatment

options. Bioactive materials or bone grafts may be used to improve healing and promote bone regeneration.

Homeopathic Medicines

An autoinflammatory disorder, Chronic recurrent multifocal osteomyelitis (CRMO) is marked by bone pain due to swelling in the bones not resulting from infection. It can take months or even years to diagnose CRMO. The homeopathic approach for the management of Chronic Recurrent Multifocal Osteomyelitis (CRMO) involves strengthening the immune system and reducing inflammation.

Some of the common homeopathic remedies used for CRMO are

- Silicea
- Hepar Sulphuris Calcareum
- Calcareo Phosphorica
- Symphytum Officinalis
- Mercurius Solubilis, and
- Pyrogenium

CONCLUSION

Overall, Acute and Chronic Osteomyelitis happen to be complex bone infections. These need to be diagnosed on-time. Physicians need to use an integrated treatment approach. Generally, Acute Osteomyelitis prognosis is more favourable when it is identified early on and managed with targeted antimicrobial therapy in an apt manner. However, it can be even more challenging to cure Chronic Osteomyelitis due to impaired vascularization, biofilm formation, necrotic bone and the risk of recurrence.

Modern management strategies have become stronger due to the use of advances in MRI and other diagnostic techniques, surgical debridement, antimicrobial therapy, local antibiotic delivery systems, regenerative medicine and vascularized bone grafts. Nonetheless, multidisciplinary and long-term care are necessary for the treatment of recurrent chronic disease and resistant infections. Early diagnosis, continued monitoring, individualized treatment and improved regenerative and biofilm-targeted therapies continue to be useful for improving treatment outcomes. Patients can expect a better quality of life.

Biography

Dr. Vikas Singhal, (drvikassinghal38@gmail.com, +91-7897178971), B.Sc., DNHE, BHMS (BFUHS), M.Sc. (Microbiology), IIHP, ABCA, LMHI, AHA, FOH (London) He is Founder Director, Homeo Saga International Pvt. Ltd. He is also Founder Director at Dr. Singhal Homeo Clinc. He is a supporter and donor member of UNICEF. He is an Classical Homeopathic Physician practicing classical homeopathy for 23+ years, he is patron of the Homeo Healers Homeopathy Worldwide. He is editor of various prestigious journal such as Sehat Evam Surat National Monthly Magazine (Indore), UK-based Journal of Practice-based

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