IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 25, Issue 8 Ser. 1 (August. 2026), PP 28-40
www.iosrjournals.org

Endodontic Considerations In Medication-Related Osteonecrosis Of The Jaw (MRONJ): A Narrative Review

Dr. R Sumukh Bharadwaj, Dr. Anushree N, Dr. Santosh Kanwar,
Dr. Adarsh Choudhary, Dr. Prajwal M S
Consultant Endodontist, Mysuru, Karnataka
Reader, Department Of OMFS, SIDS, Shivamogga
Associate Professor, Department Of Oral Medicine & Radiology, Farooqia Dental College, Mysuru
Consultant Oral & Maxillofacial Surgeon, Mysuru
Clinical Director, Prajwal Dental Care, Pavagada, Tumkur District

Abstract
Medication-related osteonecrosis of the jaw (MRONJ) is a severe adverse event associated with antiresorptive and antiangiogenic medications commonly prescribed for osteoporosis, metastatic bone disease, multiple myeloma, and several malignancies. Since the first reports of bisphosphonate-associated osteonecrosis in 2003, understanding of the disease has expanded considerably, leading to the broader term MRONJ to include osteonecrosis associated with denosumab and angiogenesis inhibitors. Although oral surgical procedures remain the strongest precipitating factor, increasing evidence suggests that untreated odontogenic infections may play an equally important role in disease initiation.
Endodontic treatment has emerged as an essential therapeutic strategy in patients receiving antiresorptive therapy because preservation of natural teeth through nonsurgical root canal treatment minimizes the need for extraction, thereby reducing the likelihood of MRONJ. Modern endodontic protocols emphasizing minimally invasive procedures, effective canal disinfection, controlled instrumentation, and adequate coronal restoration can significantly improve treatment outcomes while preserving alveolar bone integrity.
This review summarizes the current understanding of MRONJ with special emphasis on endodontic diagnosis, treatment planning, clinical protocols, prevention strategies, and future perspectives. Current recommendations from the American Association of Oral and Maxillofacial Surgeons (AAOMS), American Association of Endodontists (AAE), and recent systematic reviews are integrated to provide evidence-based clinical guidelines for endodontists managing patients at risk of MRONJ.

Keywords: *Medication-related osteonecrosis of the jaw, MRONJ, Endodontics, Bisphosphonates, Denosumab, Root canal treatment, Osteoporosis, Antiresorptive therapy*

Date of Submission: 26-07-2026 Date of Acceptance: 06-08-2026

I. Introduction

Medication-related osteonecrosis of the jaw (MRONJ) represents one of the most challenging complications encountered in modern oral healthcare. The condition is characterized by exposed necrotic bone or bone that can be probed through an intraoral or extraoral fistula in patients receiving antiresorptive or antiangiogenic therapy, without a history of radiation therapy or metastatic disease involving the jaws. The condition was initially described as bisphosphonate-related osteonecrosis of the jaw (BRONJ); however, the terminology evolved after similar lesions were observed in patients receiving denosumab and targeted antiangiogenic medications. Consequently, the AAOMS adopted the broader term MRONJ to encompass all medication-induced osteonecrotic lesions.

The incidence of MRONJ varies considerably depending on the underlying disease, medication, dosage, duration of therapy, and concomitant systemic risk factors. Patients receiving high-dose intravenous bisphosphonates or denosumab for metastatic malignancies demonstrate substantially greater risk than patients receiving oral antiresorptive medications for osteoporosis. Despite its relatively low prevalence in osteoporosis patients, the severe morbidity associated with MRONJ—including chronic pain, persistent infection, pathologic fracture, and impaired quality of life—makes prevention a primary therapeutic objective.

Historically, tooth extraction was considered the principal precipitating event for MRONJ. However, contemporary evidence increasingly indicates that chronic odontogenic infection itself may be a major etiologic factor. Advanced pulpal disease, apical periodontitis, periodontal infection, and persistent inflammatory lesions induce local cytokine release and bone remodeling, potentially interacting with antiresorptive medications to precipitate necrosis. This paradigm shift has significantly increased the importance of conservative dental therapies, particularly endodontic treatment, in preventing MRONJ.

Root canal treatment provides an opportunity to eliminate odontogenic infection while preserving the natural dentition and avoiding extraction. Consequently, contemporary clinical guidelines strongly recommend that teeth with a favorable restorative prognosis should receive endodontic treatment whenever feasible rather than extraction. Properly performed nonsurgical root canal treatment does not involve significant osseous injury and therefore carries a substantially lower risk of inducing MRONJ than surgical extraction.

The expanding use of antiresorptive medications due to the aging population and increasing prevalence of osteoporosis has made MRONJ increasingly relevant to everyday endodontic practice. Every clinician performing root canal therapy should understand the pharmacology of these medications, patient risk stratification, diagnostic criteria, treatment modifications, and evidence-based preventive strategies.

Evolution of MRONJ

The first clinical description of jaw osteonecrosis associated with bisphosphonates was published by Marx in 2003. Initially believed to occur exclusively in patients receiving pamidronate or zoledronic acid, subsequent reports identified similar lesions in patients treated with denosumab, bevacizumab, sunitinib, and other targeted therapies. These findings prompted the adoption of the broader terminology "Medication-Related Osteonecrosis of the Jaw (MRONJ)."

Over the past two decades, the understanding of MRONJ has evolved substantially. Early management strategies emphasized conservative treatment and prolonged observation. More recent evidence supports stage-based management, with surgical intervention increasingly recognized as an effective option in selected patients. Importantly for endodontists, current concepts emphasize the elimination of odontogenic infection and preservation of teeth whenever possible as key preventive measures.

Definition

According to the 2022/2024 AAOMS Position Paper, a diagnosis of MRONJ requires all three of the following criteria:

1. Current or previous treatment with antiresorptive or antiangiogenic medications.
2. Exposed bone or bone that can be probed through an intraoral or extraoral fistula in the maxillofacial region persisting for more than eight weeks.
3. No history of radiation therapy to the jaws or metastatic disease involving the jaws.

Drugs Associated with MRONJ

Antiresorptive agents

Bisphosphonates

- Zoledronic acid
- Pamidronate
- Alendronate
- Risedronate
- Ibandronate
- Clodronate

These drugs inhibit osteoclast-mediated bone resorption and have a prolonged skeletal half-life, remaining incorporated into bone for years. This persistent effect contributes to long-term suppression of bone remodeling.

RANKL inhibitor

- Denosumab

Unlike bisphosphonates, denosumab does not bind to bone and has reversible pharmacologic effects after discontinuation. However, the risk of MRONJ remains clinically significant, particularly in oncology patients receiving high-dose therapy.

Antiangiogenic medications

Common examples include:

- Bevacizumab
- Sunitinib
- Sorafenib
- Pazopanib
- Cabozantinib
- Regorafenib

These medications impair angiogenesis, reduce vascularity, and may compromise healing following dental procedures.

Pathophysiology of MRONJ

The exact pathogenesis of MRONJ remains multifactorial. Current evidence supports several interacting mechanisms:

- Suppression of osteoclast-mediated bone remodeling
- Inhibition of angiogenesis
- Local infection and inflammation
- Impaired immune response
- Microtrauma accumulation
- Soft tissue toxicity
- Altered wound healing
- Genetic susceptibility

The jaws exhibit high bone turnover due to continual occlusal loading and frequent exposure to microbial biofilms, making them uniquely susceptible to osteonecrosis under conditions of impaired remodeling. Chronic periapical inflammation may further amplify local cytokine production, contributing to disease initiation in susceptible individuals.

Epidemiology of MRONJ

Medication-related osteonecrosis of the jaw (MRONJ) is an uncommon but potentially devastating complication of antiresorptive and antiangiogenic therapies. Its incidence varies considerably depending on the underlying systemic disease, the class of medication administered, route of administration, dosage, cumulative exposure, and associated local risk factors. Patients receiving high-dose intravenous antiresorptive agents for malignant conditions such as metastatic breast cancer, prostate cancer, multiple myeloma, and other skeletal metastases have a substantially greater risk than patients receiving low-dose oral medications for osteoporosis.

The reported prevalence among osteoporosis patients treated with oral bisphosphonates generally remains below 0.1%, although the risk increases with prolonged therapy exceeding four years, concomitant corticosteroid use, diabetes mellitus, smoking, and invasive dental procedures. Conversely, oncology patients receiving intravenous zoledronic acid or high-dose denosumab demonstrate a markedly higher cumulative incidence, reflecting the greater potency and frequency of administration.

With increasing life expectancy and widespread use of antiresorptive medications, dentists and endodontists are expected to encounter a growing number of patients at risk for MRONJ. Consequently, careful medical history taking and interdisciplinary communication have become essential components of routine endodontic practice.

Why the Jaws Are Particularly Susceptible

Unlike other skeletal sites, the maxilla and mandible exhibit a unique biological environment characterized by:

- Continuous exposure to oral microbial biofilms
- High rates of physiological bone remodeling
- Frequent functional loading during mastication
- Thin mucosal covering over osseous structures
- Constant risk of microtrauma from occlusion and prostheses
- Close proximity of teeth and periodontal tissues to alveolar bone

These characteristics explain why osteonecrosis associated with antiresorptive therapy is almost exclusively confined to the jaws.

Risk Factors Relevant to Endodontists

Understanding patient-specific risk factors is fundamental for appropriate treatment planning. These may be categorized as follows:

Medication-Related Factors

- Intravenous bisphosphonates
- Long duration of therapy (>4 years)
- High cumulative dose
- Potent nitrogen-containing bisphosphonates
- Denosumab administered for malignancy
- Concurrent antiangiogenic medications
- Combination therapy

Higher potency and longer exposure correlate with increased suppression of bone remodeling and greater susceptibility to osteonecrosis.

Local Oral Factors

Among all local risk factors, chronic odontogenic infection has gained increasing recognition as a significant contributor to MRONJ pathogenesis.

Important local factors include:

- Apical periodontitis
- Necrotic pulp
- Chronic periapical abscess
- Vertical root fractures
- Advanced periodontal disease
- Ill-fitting dentures
- Peri-implantitis
- Dental extractions
- Endodontic surgery
- Traumatic occlusion
- Poor oral hygiene

Recent evidence suggests that chronic periapical inflammation may itself initiate osteonecrosis in susceptible individuals, emphasizing the importance of early endodontic intervention.

Systemic Risk Factors

Several systemic conditions impair healing and may potentiate the effects of antiresorptive medications:

- Diabetes mellitus
- Immunosuppression
- Long-term corticosteroid therapy
- Rheumatoid arthritis
- Chemotherapy
- Smoking
- Advanced age
- Malnutrition
- Chronic renal disease
- Vitamin D deficiency
- Anemia

These factors should be documented during treatment planning.

Pathogenesis: Current Concepts

The exact pathogenesis of MRONJ remains multifactorial and incompletely understood. Current evidence supports the interaction of several biological mechanisms rather than a single causative pathway.

1. Suppression of Bone Remodeling

Bisphosphonates inhibit osteoclast-mediated bone resorption by disrupting the mevalonate pathway, leading to apoptosis of osteoclasts. Denosumab, a monoclonal antibody against receptor activator of nuclear factor kappa-B ligand (RANKL), prevents osteoclast formation and activity. Both mechanisms suppress normal bone turnover, reducing the ability of alveolar bone to repair routine microdamage.

2. Local Infection

Microorganisms associated with pulpal necrosis and apical periodontitis induce a chronic inflammatory response characterized by the release of cytokines such as interleukin-1β, tumor necrosis factor-α, and prostaglandin E2. These mediators contribute to local bone destruction and may interact with antiresorptive therapy to precipitate necrosis.

3. Angiogenesis Inhibition

Several medications impair vascular endothelial growth factor (VEGF)-mediated angiogenesis, reducing blood vessel formation and compromising tissue repair.

4. Soft Tissue Toxicity

Experimental studies suggest that bisphosphonates impair proliferation and migration of oral epithelial cells and fibroblasts, delaying mucosal healing following trauma.

5. Immune Dysregulation

Altered macrophage function, impaired neutrophil activity, and chronic inflammatory changes may predispose to persistent infection and delayed healing.

Clinical Presentation

Patients may initially remain asymptomatic, making early diagnosis challenging.
Common presenting features include:

- Delayed socket healing
- Persistent pain
- Exposed necrotic bone
- Purulent discharge
- Gingival swelling
- Mobile teeth
- Halitosis
- Orocutaneous fistula
- Paresthesia
- Sinus tract formation
- Pathological fracture in advanced disease

Importantly, Stage 0 MRONJ may present solely with unexplained odontogenic pain without exposed bone.

AAOMS Staging System

At Risk

- No apparent necrotic bone
- History of antiresorptive therapy
- Requires preventive dental care

Stage 0

- No exposed bone
- Nonspecific symptoms
- Odontalgia
- Dull mandibular pain
- Radiographic sclerosis
- Thickened lamina dura

Stage 1

- Exposed necrotic bone
- No pain
- No infection

Stage 2

- Exposed bone
- Pain
- Secondary infection
- Erythema
- Purulent discharge

Stage 3

- Extensive necrosis
- Pathological fracture
- Oro-antral communication
- Extraoral fistula
- Extensive osteolysis

For endodontists, recognizing **Stage 0** is particularly important because patients may present with symptoms mimicking irreversible pulpitis or apical periodontitis, potentially leading to unnecessary dental procedures.

Importance of Medical History

Every patient scheduled for root canal treatment should be questioned regarding:

- Osteoporosis medications
- Cancer history
- Intravenous bisphosphonate therapy
- Denosumab injections
- Targeted cancer therapies
- Duration of medication use
- Previous jaw surgery
- History of exposed bone
- Previous diagnosis of MRONJ
- Concurrent corticosteroid therapy
- Smoking status

A thorough medication history enables risk stratification and appropriate treatment planning.

Why Endodontics Plays a Crucial Role

Historically, extraction was the definitive treatment for teeth with pulpal necrosis or extensive periapical disease. In patients receiving antiresorptive therapy, however, extraction may significantly increase the risk of developing MRONJ due to direct osseous injury and delayed healing.

Modern endodontics offers a biologically conservative alternative that preserves the natural dentition while eliminating infection. Successful nonsurgical root canal treatment avoids surgical trauma to the alveolar bone, maintains occlusal function, and reduces the need for future extractions. Consequently, current expert recommendations favor endodontic treatment over extraction whenever the tooth is restorable and has a favorable periodontal prognosis.

Endodontic Diagnosis in Patients at Risk of MRONJ

Accurate diagnosis is fundamental to successful management of patients receiving antiresorptive or antiangiogenic medications. Because MRONJ may mimic common odontogenic conditions such as symptomatic apical periodontitis, chronic apical abscess, periodontal abscess, or even irreversible pulpitis, clinicians must distinguish odontogenic disease from medication-related bone pathology before initiating treatment.

A comprehensive diagnostic work-up should include:

- Detailed medical history
- Medication history (drug, dose, duration, indication)
- Dental history
- Previous dentoalveolar surgery
- Clinical examination
- Periodontal examination
- Pulp vitality testing
- Periapical radiography
- CBCT where indicated

Pain in patients receiving bisphosphonates should never automatically be attributed to pulpal disease. Stage 0 MRONJ frequently presents with vague jaw pain despite the absence of exposed bone.

Medical History

Every endodontic consultation should begin with identification of medications known to increase MRONJ risk.

Questions should include:

- Are you taking medicines for osteoporosis?
- Have you received injections for osteoporosis?
- Are you receiving treatment for cancer involving the bones?
- Have you received intravenous bisphosphonates?
- Are you receiving denosumab?

- Have you taken these medications for more than four years?
- Are you taking corticosteroids?
- Have you ever had delayed healing after a tooth extraction?
- Have you experienced exposed bone inside your mouth?

If uncertainty exists regarding the medication, communication with the patient's physician or oncologist is recommended before treatment.

Clinical Examination
The intraoral examination should assess:

Soft tissues
- Mucosal ulceration
- Exposed bone
- Swelling
- Sinus tract
- Purulent discharge
- Erythema

Hard tissues
- Caries
- Fractured restorations
- Cracked teeth
- Tooth mobility
- Attrition
- Root fracture

Periodontal assessment
- Pocket depth
- Furcation involvement
- Bleeding on probing
- Gingival recession
- Plaque accumulation

Pulp Vitality Testing
Vitality testing is indispensable because many patients complain of pain that may not originate from the pulp.

Recommended tests include:
- Cold test
- Electric pulp testing
- Heat test
- Test cavity (rarely indicated)

Interpretation should be combined with:
- Percussion
- Palpation
- Bite test
- Periodontal probing

Differential Diagnosis
Conditions that may resemble MRONJ include:
- Chronic apical periodontitis
- Vertical root fracture
- Osteomyelitis
- Chronic osteitis
- Chronic periodontal abscess
- Maxillary sinusitis
- Odontogenic cysts

- Cemento-osseous dysplasia
- Osteoradionecrosis
- Metastatic jaw lesions

A systematic approach minimizes the risk of unnecessary treatment.

Radiographic Evaluation

Intraoral Radiographs

Periapical radiographs remain the first-line imaging modality.

Possible findings include:

- Widened periodontal ligament space
- Loss of lamina dura
- Periapical radiolucency
- Diffuse sclerosis
- Sequestra
- Thickened trabeculae
- Non-healing extraction socket

However, early MRONJ may demonstrate minimal radiographic changes.

Cone Beam Computed Tomography (CBCT)

CBCT has become invaluable in evaluating suspected MRONJ because conventional radiographs often underestimate disease extent.

Advantages include:

- Three-dimensional visualization
- Cortical bone evaluation
- Sequestrum identification
- Detection of sinus involvement
- Assessment of mandibular canal proximity
- Identification of occult osteolysis

Typical CBCT findings include:

- Patchy sclerosis
- Cortical disruption
- Sequestration
- Thickened lamina dura
- Persistent socket defects
- Osteolytic areas
- Periosteal reaction
- Maxillary sinus involvement

CBCT also assists in treatment planning by identifying teeth with questionable prognosis that may otherwise require extraction.

Treatment Planning

Management should focus on **preserving natural teeth whenever possible**.

The following hierarchy is generally recommended:

1. Preventive care
2. Restorative treatment
3. Endodontic treatment
4. Periodontal therapy
5. Extraction only when unavoidable

Whenever a tooth is considered restorable, root canal treatment should generally be preferred over extraction.

Treatment Objectives

The goals of endodontic treatment are to:

- Eliminate infection
- Preserve alveolar bone
- Prevent extraction

- Reduce inflammatory burden
- Maintain function
- Improve quality of life

Case Selection
Root canal treatment is indicated when:
- Tooth is restorable
- Adequate periodontal support exists
- Root fracture is absent
- Patient can maintain oral hygiene
- Long-term prognosis is favorable

Extraction should be reserved for teeth that are:
- Non-restorable
- Vertically fractured
- Grossly mobile
- Associated with severe periodontal destruction
- Hopeless from a restorative perspective

Treatment Modifications
Patients at risk for MRONJ require several procedural modifications.

Appointment Planning
Long appointments should be avoided in medically compromised patients.
Stress reduction protocols may be considered for oncology patients.
Adequate pain control should be achieved before instrumentation.

Local Anaesthesia
Conventional local anaesthesia is generally safe.
Avoid unnecessary multiple injections into inflamed tissues.
Profound anaesthesia minimizes treatment time and patient discomfort.

Rubber Dam Isolation
Rubber dam use is mandatory.
Benefits include:
- Reduced bacterial contamination
- Improved visibility
- Prevention of irrigant accidents
- Better infection control

Clamp selection should minimize gingival trauma.

Access Cavity Preparation
Modern minimally invasive access cavities are recommended provided adequate canal location is achieved.

Objectives include:
- Maximum preservation of tooth structure
- Avoidance of cervical weakening
- Reduced fracture risk
- Improved long-term prognosis

Care should be taken to avoid unnecessary extension into furcation areas.

Working Length Determination
Electronic apex locators combined with radiographic confirmation provide accurate working length.

Over-instrumentation beyond the apical constriction should be avoided because extrusion of debris may provoke unnecessary periapical inflammation.
Maintenance of apical patency should be gentle and conservative.

Root Canal Instrumentation

Current evidence supports conservative mechanical preparation combined with effective irrigation.
Recommended principles include:

- Glide path establishment
- Controlled rotary or reciprocating instrumentation
- Maintenance of original canal anatomy
- Prevention of transportation
- Minimal apical enlargement when appropriate

Excessive enlargement increases the risk of irrigant extrusion and postoperative inflammation.

Instrument Selection

Nickel-titanium rotary systems offer:

- Better centering ability
- Reduced procedural errors
- Improved efficiency
- Less canal transportation

Hand instrumentation remains useful in calcified canals.

The choice of instrumentation system should be based on clinician experience rather than the assumption that one file system specifically reduces MRONJ risk.

Prevention of Apical Extrusion

Every effort should be made to minimize extrusion of:

- Debris
- Sodium hypochlorite
- Bacteria
- Intracanal medicaments

Apical extrusion may increase postoperative inflammation, although a direct association with MRONJ development has not been conclusively established.

Irrigation Protocols in Patients at Risk of MRONJ

The primary objective of irrigation during root canal treatment is the elimination of microorganisms, disruption of biofilms, dissolution of organic tissue remnants, and removal of the smear layer. In patients at risk of MRONJ, irrigation assumes even greater importance because complete disinfection of the root canal system reduces the persistence of periapical infection, thereby minimizing chronic inflammatory stimuli that may contribute to osteonecrosis.

Although no irrigation regimen has been shown to directly prevent MRONJ, meticulous chemo-mechanical debridement aimed at reducing the microbial burden is recommended. Clinicians should avoid excessive apical pressure during irrigation to minimize extrusion of irrigants into periapical tissues.

Sodium Hypochlorite

Sodium hypochlorite (NaOCl) remains the irrigant of choice because of its broad-spectrum antimicrobial activity and ability to dissolve necrotic tissue. Concentrations ranging from **2.5% to 5.25%** are commonly used. In MRONJ-risk patients, the emphasis should be on safe delivery rather than increasing concentration.

Clinical recommendations include:

- Side-vented irrigation needles
- Placement of the needle 1–2 mm short of the working length
- Passive irrigation without binding
- Slow, controlled delivery
- Frequent replenishment of fresh irrigant
- Adequate volume throughout instrumentation

Extrusion of NaOCl beyond the apex should be strictly avoided because it can induce severe soft tissue injury and exacerbate local inflammation.

Ethylenediaminetetraacetic Acid (EDTA)

A final rinse with **17% EDTA** is recommended to remove the inorganic component of the smear layer, facilitating penetration of disinfectants and improving sealer adaptation. EDTA is typically used for one minute, followed by a final flush with NaOCl to maximize canal cleanliness.

Chlorhexidine

Two percent chlorhexidine has broad antimicrobial activity and substantivity but lacks tissue-dissolving capacity. It may serve as an adjunct in selected cases or in patients with sodium hypochlorite intolerance. Direct mixing of chlorhexidine with sodium hypochlorite should be avoided because it produces a precipitate that may interfere with canal cleanliness.

Irrigant Activation

Activation techniques improve irrigant penetration into canal irregularities. Methods include:

- Passive ultrasonic irrigation (PUI)
- Sonic activation
- Negative-pressure irrigation
- Laser-activated irrigation

Passive ultrasonic irrigation is supported by evidence demonstrating enhanced removal of debris and biofilm. Laser-assisted activation is an emerging approach that may improve cleaning efficiency, although its specific role in MRONJ-risk patients remains to be established.

Intracanal Medicaments

Calcium Hydroxide

Calcium hydroxide remains the preferred intracanal medicament because of its antimicrobial properties, high pH, and ability to inactivate bacterial endotoxins. In patients with extensive periapical lesions or persistent exudation, inter-appointment placement of calcium hydroxide for one to four weeks is a reasonable approach.

Potential benefits include:

- Reduction of bacterial load
- Suppression of inflammatory mediators
- Neutralization of endotoxins
- Promotion of periapical healing

Complete removal of the medicament before obturation is essential to ensure optimal sealer adaptation.

Antibiotic Pastes

Routine placement of intracanal antibiotic pastes is not recommended. Their use should be limited to specific regenerative procedures or selected refractory infections because of concerns regarding bacterial resistance and tooth discoloration.

Obturation Considerations

A three-dimensional obturation is essential to prevent reinfection. The choice of obturation technique should be based on the clinician's experience and the canal anatomy rather than the patient's MRONJ risk alone.

Commonly used techniques include:

- Cold lateral compaction
- Warm vertical compaction
- Continuous wave obturation
- Carrier-based obturation
- Single-cone obturation with hydraulic calcium silicate–based sealers

Bioceramic sealers are increasingly favored because of their dimensional stability, bioactivity, and excellent sealing ability. They are well suited to conservative canal preparations and may support favorable periapical healing.

Overfilling should be avoided, as extrusion of sealer into periapical tissues may provoke an inflammatory response.

Coronal Restoration

Long-term success depends on an effective coronal seal. Following root canal treatment, the tooth should receive a definitive restoration as soon as possible to prevent coronal leakage.

Clinical principles include:

- Cuspal coverage for posterior teeth when indicated
- Reinforcement of weakened tooth structure
- Elimination of occlusal trauma

- Maintenance of periodontal health
- Regular follow-up

Because extraction carries an increased risk of MRONJ, preserving the restored tooth is of paramount importance.

Surgical Endodontics

Periapical surgery (apicoectomy) should be considered only when nonsurgical retreatment is not feasible or has failed and the tooth has a favorable long-term prognosis. Surgical intervention involves direct manipulation of alveolar bone and therefore requires careful risk assessment in patients receiving antiresorptive or antiangiogenic medications.

When surgery is unavoidable:

- Coordinate care with the patient's physician or oncologist.
- Minimize flap reflection and bone removal.
- Achieve atraumatic soft tissue handling.
- Ensure primary wound closure where possible.
- Provide close postoperative follow-up.

Routine endodontic surgery is generally avoided in patients receiving high-dose intravenous antiresorptive therapy because of the potential risk of impaired osseous healing.

Intentional Replantation

Intentional replantation may occasionally be considered when conventional retreatment and surgery are not feasible. However, extraction and replantation inevitably traumatize the periodontal ligament and alveolar socket, and the procedure should be reserved for exceptional circumstances. Careful case selection and informed patient consent are essential.

Antibiotic Considerations

The use of systemic antibiotics should not be routine for all endodontic procedures in patients at risk of MRONJ. Antibiotics are indicated when there is evidence of spreading infection, cellulitis, systemic involvement, or other accepted clinical indications. Their use should follow principles of antibiotic stewardship.

Postoperative Care and Follow-Up

Regular clinical and radiographic review is important to monitor healing and detect early complications.
Suggested follow-up schedule:

- 1–2 weeks: assessment of symptoms and soft tissue healing (if indicated)
- 6 months: clinical examination and periapical radiograph
- 12 months: radiographic assessment of periapical healing
- Annual review thereafter for teeth with large preoperative lesions or in high-risk patients

Patients should be advised to report persistent pain, swelling, exposed bone, delayed healing, or purulent discharge promptly.

Clinical Decision-Making Algorithm

1. Identify patients receiving antiresorptive or antiangiogenic medications.
2. Obtain a comprehensive medical and dental history.
3. Perform clinical examination, vitality testing, and appropriate imaging.
4. Prioritize preservation of restorable teeth through nonsurgical root canal treatment.
5. Employ meticulous infection control and atraumatic techniques.
6. Reserve surgical procedures for carefully selected cases.
7. Provide definitive coronal restoration and long-term follow-up.

Future Directions

Future research should focus on:

- Prospective cohort studies evaluating endodontic outcomes in patients receiving antiresorptive therapy.
- Biomarkers for early diagnosis of MRONJ.
- Artificial intelligence–assisted risk prediction models.
- The role of photobiomodulation and laser therapy in promoting healing.
- Regenerative approaches for compromised alveolar bone.
- Standardized clinical protocols for endodontic treatment in medically complex patients.

II. Conclusion

Medication-related osteonecrosis of the jaw remains a significant clinical challenge, particularly as the use of antiresorptive and antiangiogenic therapies continues to increase worldwide. For the endodontist, the emphasis has shifted from managing established osteonecrosis to preventing its occurrence through early recognition of at-risk patients, elimination of odontogenic infection, and preservation of natural teeth.

Nonsurgical root canal treatment represents the preferred management strategy for restorable teeth in most patients receiving these medications. Careful diagnosis, meticulous chemo-mechanical debridement, appropriate irrigation and obturation, and durable coronal restoration can reduce the need for extraction and thereby help minimize the risk of MRONJ. Interdisciplinary collaboration among endodontists, oral and maxillofacial surgeons, physicians, oncologists, and primary care providers is essential for optimizing patient outcomes.

Although current recommendations are based largely on observational studies, expert consensus, and clinical experience, future high-quality prospective research is needed to refine treatment protocols and strengthen the evidence base. Until then, a conservative, evidence-informed, patient-centered approach remains the cornerstone of endodontic care in individuals at risk of MRONJ.

References:

[1]. Ruggiero SL, Dodson TB, Aghaloo T, Carlson ER, Ward BB, Kademani D. American Association Of Oral And Maxillofacial Surgeons' Position Paper On Medication-Related Osteonecrosis Of The Jaws—2022 Update. J Oral Maxillofac Surg. 2022;80(5):920-943.

[2]. Ruggiero SL, Dodson TB, Fantasia J, Goodday R, Aghaloo T, Mehrotra B, Et Al. American Association Of Oral And Maxillofacial Surgeons Position Paper On Medication-Related Osteonecrosis Of The Jaw—2014 Update. J Oral Maxillofac Surg. 2014;72(10):1938-1956.

[3]. Ruggiero SL, Dodson TB, Assael LA, Landesberg R, Marx RE, Mehrotra B. American Association Of Oral And Maxillofacial Surgeons Position Paper On Bisphosphonate-Related Osteonecrosis Of The Jaws. J Oral Maxillofac Surg. 2007;65(3):369-376.

[4]. Ruggiero SL, Dodson TB, Assael LA, Landesberg R, Marx RE, Mehrotra B. American Association Of Oral And Maxillofacial Surgeons Position Paper On Bisphosphonate-Related Osteonecrosis Of The Jaw—2009 Update. J Oral Maxillofac Surg. 2009;67(Suppl 5):2-12.

[5]. Marx RE. Pamidronate (Aredia) And Zoledronate (Zometa)-Induced Avascular Necrosis Of The Jaws: A Growing Epidemic. J Oral Maxillofac Surg. 2003;61:1115-1117.

[6]. Marx RE, Sawatari Y, Fortin M, Broumand V. Bisphosphonate-Induced Exposed Bone (Osteonecrosis/Osteopetrosis) Of The Jaws: Risk Factors, Recognition, Prevention And Treatment. J Oral Maxillofac Surg. 2005;63:1567-1575.

[7]. Woo SB, Hellstein JW, Kalmar JR. Narrative Review: Bisphosphonates And Osteonecrosis Of The Jaws. Ann Intern Med. 2006;144:753-761.

[8]. Migliorati CA, Casiglia J, Epstein J, Jacobsen PL, Siegel MA, Woo SB. Managing The Care Of Patients With Bisphosphonate-Associated Osteonecrosis. J Am Dent Assoc. 2005.

[9]. Khan AA, Morrison A, Hanley DA, Felsenberg D, Mccauley LK, O'Ryan F, Et Al. Diagnosis And Management Of Osteonecrosis Of The Jaw: A Systematic Review And International Consensus. J Bone Miner Res. 2015.

[10]. Khan AA, Morrison A, Kendler DL, Et Al. Case-Based Review Of Osteonecrosis Of The Jaw (ONJ) And Application Of The International Recommendations. J Clin Densitom. 2017.

[11]. Saad F, Brown JE, Van Poznak C, Ibrahim T, Stemmer SM, Stopeck AT, Et Al. Incidence, Risk Factors, And Outcomes Of Osteonecrosis Of The Jaw: Integrated Analysis From Three Phase III Trials In Cancer Patients With Bone Metastases. Ann Oncol. 2012.

[12]. Filleul O, Crompot E, Saussez S. Bisphosphonate-Induced Osteonecrosis Of The Jaw: A Review Of 2400 Patient Cases. J Cancer Res Clin Oncol. 2010.

[13]. Otto S, Pautke C, Van Den Wyngaert T, Niepel D, Schiødt M. Medication-Related Osteonecrosis Of The Jaw: Prevention, Diagnosis And Management In Patients With Cancer And Bone Metastases. Cancer Treat Rev. 2018.

[14]. Schiødt M, Otto S, Fedele S, Et Al. Workshop Of European Task Force On Medication-Related Osteonecrosis Of The Jaw—Current Challenges. Oral Dis. 2019.

[15]. Yarom N, Shapiro CL, Peterson DE, Van Poznak CH, Bohlke K, Ruggiero SL, Et Al. Medication-Related Osteonecrosis Of The Jaw: MASCC/ISOO/ASCO Clinical Practice Guideline. J Clin Oncol. 2019.

[16]. Patel S, Durack C, Abella F, Roig M, Shemesh H, Lambrechts P, Et Al. European Society Of Endodontology Position Statement: The Use Of CBCT In Endodontics. Int Endod J. 2019.

[17]. European Society Of Endodontology. Quality Guidelines For Endodontic Treatment. Int Endod J. 2006.

[18]. Zehnder M. Root Canal Irrigants. J Endod. 2006;32:389-398.

[19]. Haapasalo M, Shen Y, Wang Z, Gao Y. Irrigation In Endodontics. Br Dent J. 2014.

[20]. Siqueira JF Jr, Rôças IN. Clinical Implications And Microbiology Of Bacterial Persistence After Root Canal Treatment Procedures. J Endod. 2008.

[21]. Nair PNR. On The Causes Of Persistent Apical Periodontitis: A Review. Int Endod J. 2006.

[22]. Hülsmann M, Peters OA, Dummer PMH. Mechanical Preparation Of Root Canals: Shaping Goals, Techniques And Means. Endod Topics. 2005.

[23]. Schilder H. Cleaning And Shaping The Root Canal. Dent Clin North Am. 1974;18:269-296.

[24]. Torabinejad M, Walton RE, Fouad AF. Endodontics: Principles And Practice. 6th Ed. St. Louis: Elsevier; 2020.

[25]. American Association Of Endodontists. Guidance On The Management Of Patients Receiving Bisphosphonates And Other Antiresorptive Medications. Chicago: American Association Of Endodontists.