Abstract
Bisphosphonate drugs are a commonly utilized therapy in prevention and treatment of osteoporosis and treatment of bone lesions in certain cancers. Bisphosphonates are used in these conditions because of their ability to increase skeletal bone mass. However, these drugs also affect healing of bone, particularly in the dentoalveolar region. The most commonly accepted theories explaining this effect are osteoclast inhibition and antiangiogenic properties of bisphosphonates. Bisphosphonate osteonecrosis of the jaws may occur in patients exposed to bisphosphonate drugs who have dental disease, experience soft tissue trauma, or require dental surgery. This side effect involves exposure of bone and a lack of normal healing which may result in pain, purulence, formation of sequestra, and in severe cases pathologic fracture. Fortunately these complications can often be avoided by following clinically accepted protocols focused on optimizing oral health prior to drug initiation, weighing risk factors prior to invasive procedures, and using conservative, atraumatic techniques when surgery is needed. All dental professionals should be aware of this condition when reviewing medical histories and making treatment decisions, and must remain updated in the constantly evolving science related to treatment protocols and to other non-bisphosphonate drugs which exhibit similar side effects.

Educational Objectives
Upon completion of this course, the clinician will be able to do the following:
1. List several bone modifying drugs, how they work, and what medical conditions they are used for.
2. Describe what bisphosphonate osteonecrosis of the jaws (BONJ) is and what causes it.
3. List common signs and symptoms of BONJ.
4. Describe a protocol for preventing BONJ.
5. Describe a protocol for treatment of existing BONJ.

Author Profile
David A. Lazarchik, DMD
Associate Professor / Assistant Dean for Patient Care and Clinical Education, College of Dental Medicine, Western University of Health Sciences.
Dr. Lazarchik received his dental degree at University of Florida and a GPR certificate at University of Alabama at Birmingham. His primary practice focus has been hospital dentistry, academics, and private practice. Currently he is responsible for the clinical education program and the operations of The Dental Center at Western University of Health Sciences. His research/clinical interests include medically complex patients, dental erosion & GERD, and the plaque control potential of carbamide peroxide. He can be reached at dlazarchik@westernu.edu.

Author Disclosure
David A. Lazarchik, DMD has no potential conflicts of interest to disclose.
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Abstract
Bisphosphonate drugs are a commonly utilized therapy in prevention and treatment of osteoporosis and treatment of bone lesions in certain cancers. Bisphosphonates are used in these conditions because of their ability to increase skeletal bone mass. However, these drugs also affect healing of bone, particularly in the dentoalveolar region. The most commonly accepted theories explaining this effect are osteoclast inhibition and anti-angiogenic properties of bisphosphonates. Bisphosphonate osteonecrosis of the jaws may occur in patients exposed to bisphosphonate drugs who have dental disease, experience soft tissue trauma, or require dental surgery. This side effect involves exposure of bone and a lack of normal healing which may result in pain, purulence, formation of sequestra, and in severe cases pathologic fracture. Fortunately these complications can often be avoided by following clinically accepted protocols focused on optimizing oral health prior to drug initiation, weighing risk factors prior to invasive procedures, and using conservative, atraumatic techniques when surgery is needed. All dental professionals should be aware of this condition when reviewing medical histories and making treatment decisions, and must remain updated in the constantly evolving science related to treatment protocols and to other non-bisphosphonate drugs which exhibit similar side effects.

Introduction
Bisphosphonate drugs have become a valuable tool in helping to prevent skeletal complications of osteoporosis and of bone metastases of certain types of cancer. Unfortunately these drugs can also have detrimental effects in those whose oral health is not optimal or who require dental surgery. These effects resemble those of osteoradionecrosis, which results from radiation exposure to the mandible or maxilla during the treatment of head and neck cancers. However, osteonecrosis related to bisphosphonate drugs does not respond like other forms of osteonecrosis to traditional treatments such as debridement. Although the science related to bisphosphonate osteonecrosis of the jaws (BONJ) is continuing to develop, and many aspects of this subject await more conclusive study, clinical protocols for the prevention and treatment of BONJ have been developed and are generally accepted empirically. Because of the widespread use of these drugs and their potentially devastating effects on the oral cavity, it is necessary for every dentist to be aware of this topic and the implications for everyday clinical practice.

What are bisphosphonate drugs?
Bisphosphonate drugs, sometimes called antiresorptive or bone modifying agents, are synthetic analogs of pyrophosphate. Oxygen atoms in bisphosphonates bind to calcium and the drugs then become concentrated in bone, and become part of the mineralized structure of bone. Normal bone is continually undergoing a remodeling process in order to repair physiologic micro-fractures that result from the stresses of normal daily activities or damage caused by trauma. As part of the remodeling process, osteoclasts dissolve damaged bone and also stimulate processes which result in osteoclasts depositing fresh normal bone in the repairing area. Bisphosphonate drugs remain in bone until the bone is remodeled. During remodeling, bisphosphonates that are locked in bone are released and then phagocytized by osteoclasts, resulting in osteoclast cell death. This disrupts the normal balance of bone dissolution and deposition, resulting in less bone breakdown and therefore greater bone mass. Bisphosphonate disruption of bone resorption can thus be effectively used for prevention or treatment of conditions causing loss of bone mass.

What are these drugs used for?
The use of bisphosphonate drugs in the U.S. is widespread with over 36 million prescriptions written in 2010. They are used to increase bone mass in patients with osteoporosis and to minimize the effects of bone metastatic lesions of certain types of cancer. The most common oral forms of bisphosphonates include alendronate (Fosamax®), etidronate (Didronel®), ibandronate (Boniva®), risedronate (Actonel®), and tiludronate (Skeld®). The oral forms are primarily used for prevention and treatment of osteoporosis in women after menopause or osteoporosis related to corticosteroid medications, and to treat Paget’s disease of bone (tiludronate). Ibandronate (Boniva IV®) is also available in an intravenous (IV) form administered every 3 months to treat postmenopausal osteoporosis. IV only forms of bisphosphonates include the drug pamidronate (Aredia®), which is used to treat hypercalcemia of malignancy, Paget’s disease of bone, and osteolytic bone lesions related to breast cancer and multiple myeloma. Zoledronate (Zometa®) is also an IV only form used to treat the same conditions. An IV form of zoledronate (Reclast®) is used in annual administration to treat osteoporosis in postmenopausal women.

A nonbisphosphonate drug with antiresorptive effects was approved for use in the U.S. in 2010. Denosumab (Prolia®, XGEVA®) is used to treat postmenopausal women with osteoporosis at high risk of experiencing skeletal fractures and to prevent fractures in cancer patients with bone metastases. Denosumab is a monoclonal antibody to a key mediator of
osteoclast formation, function, and survival and thus inhibits osteoclast activity. Several cases of denosumab related osteonecrosis of the jaws have recently been reported.\(^5,6\) Other nonbisphosphonate drugs have been implicated in osteonecrosis of the jaw. These include the anti-angiogenic agents bevacizumab (Avastin\(^\text{®}\)) and sunitinib (Sutent\(^\text{®}\)), both of which affect the growth of blood vessels which are essential for rapid growth of tumors and are used to treat solid tumors such as metastatic colorectal and lung cancers.\(^7,8\)

**What is BONJ and what causes it?**

In simplistic terms, BONJ is delayed healing of the alveolar bone of the maxilla or mandible, related to bisphosphonate administration and not to radiation therapy of the head and neck. A number of terms have been used to describe this condition, including BONJ, bisphosphonate related osteonecrosis of the jaws (BRONJ), and more recently anti-resorptive agent related osteonecrosis of the jaws (ARONJ), in recognition of non-bisphosphonate drugs such as denosumab that have a similar effect on bone metabolism and also cause osteonecrosis. A definition of BONJ that is frequently used in the literature is that proposed by the American Association of Oral and Maxillofacial Surgeons (AAOMS) in which BONJ is considered to be present when all 3 conditions occur:

1. Current or previous treatment with bisphosphonates
2. Exposed bone in the maxillofacial region that has persisted for more than 8 weeks
3. No history of radiation therapy to the jaws

The cumulative incidence of BONJ related to intravenous forms of bisphosphonate drugs is 0.8% to 12% depending on the particular study cited. For oral forms, the risk is considerably less, 0.01 to 0.06%, with the risk increasing in patients exposed to bisphosphonates for 3 years or more. The risk is increased in patients over 65 years old, in smokers, and in those who are debilitated by concomitant neoplastic disease, or who have accompanying dental disease such as periodontal or periapical disease, or have generalized poor oral health.\(^9\)

Although BONJ can occur spontaneously, it is more commonly related to dental extractions or other types of surgery involving alveolar bone such as periodontal surgery or implant placement, or to ill-fitting dental prostheses which can cause local soft tissue trauma and ultimately bone exposure. The mandible is more frequently involved (60 to 80%) than the maxilla. Areas of bone covered by thin mucosa, such as the lingual or mylohyoid area, are especially prone to development of initial lesions. The early stages are often asymptomatic and show no radiographic signs. The initial symptoms may be mild discomfort and a feeling of roughness related to an area of bone protruding through soft tissue. As the lesion develops, larger areas of bone become exposed as soft tissue recedes and patients may experience pain, swelling, and purulent secretion. (Figure 1) Sinus tracts may form and exit in the oral cavity or to the skin. Continued progression of osteonecrosis leads to extensive areas of bone exposure, dehiscence, formation of bony sequestra, chronic pain, and in extreme cases pathologic fracture. Beyond the initial stages, the radiographic appearance of lesions is similar to chronic osteomyelitis, with a mixed radiolucent and radiopaque mottled appearance with indistinct margins.\(^2,10,11\) (Figures 2 – 6) The AAOMS 2009 position paper proposed a staging system based on symptoms. Stage 0 consists of no clinical evidence of bony necrosis, but the presence of nonspecific signs and symptoms. Stages 1 through 3 progressively include exposed and necrotic bone, signs of infection like erythema, pain, and purulence, pathologic fractures, extraoral fistulae, and oral/antral nasal communications.

The first cases of BONJ were documented in 2003 in patients receiving pamidronate or zolendronate primarily for hypercalcemia related to breast cancer and multiple myeloma. It was noted that only bone in the jaws was affected and that often the exposure of bone began with a tooth extraction. Also noted was the fact that other bones of the body were not affected. It was proposed that this occurred because of the presence of teeth in the jaws, resulting exposure to the external environment and because of frequent inflammation or infection related to periodontal disease or dental abscesses. The author of this first report suggested that since osteoclasts are necessary for the induction of mesenchymal stem cells to differentiate into bone forming osteoblasts, bisphosphonate mediated inhibition of osteoclasts.

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**Figure 1.** 78 year old female with 5+ year history of alendronate (Fosamax\(^\text{®}\)) use. Spontaneous exposure of lower left lingual bone (no history of tooth extraction or other dental surgery in the area).
caused formation of an acellular bone unable to heal itself.\textsuperscript{12} This has been termed “remodeling suppression”.\textsuperscript{13} Since that time a number of theories as to the cause of BONJ have been described. A commonly cited cause is the anti-angiogenic effect of bisphosphonates through a variety of biochemical pathways, resulting in avascular bone that cannot heal itself when exposed to trauma or surgical procedures.\textsuperscript{14} A mucosal toxicity theory proposes that destruction of the oral mucosal barrier through both systemic and direct bone exposure of epithelium to bisphosphonates, is the initiating lesion in BONJ. Evidence for this is the fact that esophagitis is a common side effect of bisphosphonates and that sunitinib has a strong potential to cause mucositis. These same authors suggested that local immune malfunction induced by these drugs may allow microorganism infection (especially Actinomyces) and resulting osteonecrotic lesions.\textsuperscript{15} Others have proposed that the presence of oral bacteria (specifically Fusobacterium nucleatum) suppresses growth factors required for epithelial healing and, in combination with bisphosphonate drugs, causes nonhealing bone necrosis.\textsuperscript{16}

Interestingly, it has been noted that alveolar bone turnover is quite rapid, thus the rate of uptake of bisphosphonate drugs in alveolar bone is greater than that of other areas of the body. Therefore, the potential for breakdown and lack of healing is greater because of bisphosphonate induced interruption of normal bone remodeling functions.\textsuperscript{17} Also, the alveolar bone is potentially subject to repeated trauma from oral hygiene and dental procedures and from dental prostheses, which may impact soft tissue coverage of bone. Thus it is understandable that bisphosphonate osteonecrosis is restricted in location to the jaws.

Route of administration is an important consideration when estimating the risk of dental complications. Oral forms of bisphosphonates are not well absorbed and thus have a lesser concentration in bone and lesser effect on osteoclasts and overall bone turnover rates than IV forms. For oral forms, the time over which the drug is taken is a critical factor in its incorporation into bone matrix and thus its overall effect on bone remodeling and healing. BONJ is not typically seen in patients taking oral forms for less than 3 years. Severity of BONJ increases after 3 years, and most cases occur after 5 years. IV forms, on the other hand, are administered in higher and more frequent doses and result in more concentrated accumulation in bone, with a higher risk of osteonecrosis.\textsuperscript{18}

How can BONJ be prevented?
The guidelines for preventing BONJ are similar to those for preventing osteoradionecrosis. Establishing optimal oral health prior to initiation of bisphosphonate therapy is key to prevention. Several studies have demonstrated a significant reduction in incidence rate of BONJ in cancer patients treated with intravenous bisphosphonates who received a standardized preventive dental program.\textsuperscript{19,20,21} Ideally every patient would receive a dental exam prior to initiation of bisphos-
phonate therapy in order to identify existing periodontal and periapical infection, ill-fitting dental prostheses, or other conditions which may contribute to soft tissue trauma. Patient education about the potential risk of BONJ, the signs and symptoms of BONJ, as well as oral hygiene procedures and the importance of maintaining good oral health, through regular professional care, is important. Soft tissues should receive a thorough inspection and any potentially irritating factors such as rough restorations or prostheses which impinge on soft tissue should be addressed. Except in acute disease such as hypercalcemia of malignancy, where the systemic disease is of primary concern, if at all possible dental procedures should be completed and oral health established prior to initiation of bisphosphonate therapy. Teeth which have a poor long term prognosis should be extracted and periodontal procedures such as scaling and root planing should be completed in order to improve the chances of maintaining oral health in the long run. Dental procedures involving exposure of bone should ideally be completed 3 to 6 weeks before initiation of bisphosphonate therapy to allow adequate mucosal coverage of surgically exposed bone. Once bisphosphonate therapy is initiated, the patient should maintain a schedule of 3 to 6 month dental visits and should immediately report to their dentist any acute oral symptoms, soft tissue lesions, or areas of exposed bone. Invasive oral procedures which may result in exposure of bone should be avoided.22

What if a patient exposed to bisphosphonates needs dental treatment?

Decisions regarding dental treatment in patients exposed to bisphosphonates primarily depend on the dosage form (oral vs. IV) and duration of therapy. Patients taking or who have taken oral forms: typically these are patients taking bisphosphonates for prevention or treatment of osteoporosis, the most common bone disease of humans. About half of Caucasian women and one fifth of men in the US will have an osteoporotic related fracture at some point in their lifetimes with a resulting cost to the US healthcare system in 2005 of between $14 and $20 billion and an expected cost of $25 billion by 2025.23 FDA approved bisphosphonate drug regimens are an integral part of administration of these drugs with more than 2 to 3 years. For these patients, the prescribing physician should be consulted regarding the possibility of discontinuing therapy for 3 months prior to oral surgery. The risks of dental disease must be weighed against the risks of skeletal complications. If discontinued, the bisphosphonate drug should not be restarted until osseous healing with complete mucosal coverage has occurred. Although it has been suggested that certain biomarker testing, such as serum C-terminal telopeptide (CTX) testing, can predict the risk of developing BONJ, discontinuing drug therapy based on biomarker testing is not a currently accepted practice. When dentoalveolar surgery is performed, a conservative technique performed asatraumatically as possible, with achievement of primary tissue closure, is advised. Antibiotic prophylaxis and chlorhexidine rinses may prevent the development of BONJ. Antibiotic prophylaxis should begin one day before and extend 7 days after surgery.25 Chlorhexidine rinses should be performed twice daily, beginning the day after surgery, and extend until there is complete mucosal healing. Overall, when making treatment decisions about patients who have taken oral bisphosphonates, the clinician should take a judicious approach weighing risks of dental disease & dental procedures versus the small risk of BONJ.4,9

Patients taking or who have taken IV forms as part of cancer therapy: Since these patients are at greater risk of developing BONJ than those who have taken oral forms, maintenance of good oral health is especially important and a much more cautious approach to surgery is advised (avoiding surgery if possible). If nonrestorable teeth must be addressed, they can be decoronated and endodontics performed on the remaining roots or asymptomatic root fragments be left to exfoliate. When surgery is necessary, it would be prudent to refer the patient to a surgeon with experience treating these patients. Conservative, atraumatic surgery, using the same guidelines as suggested above, will decrease the chances of development of BONJ. Depending on the patient’s systemic condition and in consultation with the treating physician, interruption of bisphosphonate therapy may be considered. Ideally, bisphosphonate administration would cease 3 to 6 months prior to the surgical procedure until the surgical site has healed. However, this approach is based on empirical data and not on clinical trials.26

If BONJ does occur, how should it be treated?

Recent literature suggests that a conservative protocol should be attempted prior to surgical intervention. One proposed protocol included use of twice daily 0.12% chlorhexidine gluconate (Peridex®) rinses alternating every 2 weeks with essential oils mouthrinse (Listerine®) to prevent bacterial resistance. Patients were monitored at least every 3 months
and any mobile necrotic bone fragments were removed with tissue forceps and rough bone surfaces were smoothed using piezosurgery tips. Patients in pain or showing purulent drainage received antibiotics consisting of amoxicillin/clavulanate potassium and metronidazole (substituting ciprofloxacin for penicillin allergic patients). Following this protocol resulted in controlling pain and decreasing the size of exposed bone. However, none of the patients had complete healing of lesions. A recent review of 671 publications stated that conservative vs. surgical treatment protocols have equivalent success rates (approximately 60%) if success is defined as healing of lesions. The authors suggested that total healing of lesions when a conservative approach is followed occurs primarily in lower (less severe) stages of BONJ. They did, however, recommend a conservative approach in all cases as the initial treatment of pain and resolution of acute inflammation prior to any surgical treatment.

Those with BONJ not responding to conservative management should be referred to a surgeon who is experienced in the treatment of this condition. Although various modalities such as hyperbaric oxygen, teriparatide (Forteo®) drug therapy, a synthetic hormone which stimulates bone formation, laser-assisted surgery, and platelet-rich plasma to enhance healing have been proposed for non-responding cases, these methods are conjectural at this point in time. It appears that many of these cases will respond to surgical debridement if the surgeon follows a meticulous surgical technique including pre and perioperative antibiotics. The technique involves removal of all necrotic bone, smoothing of rough edges, and reduction of socket margins, so that soft tissue covers the wound in a totally passive manner while achieving primary closure with long-term synthetic resorbable suture materials. Various patient related factors may affect surgical outcomes. A recent study examined various factors related to surgical success. Cessation of bisphosphonate therapy for 6 months following surgery for treatment of BONJ had a positive outcome on results. Surgery was more successful in patients with osteoporosis as opposed to those with cancer, whose bone metabolism may have been affected by steroids or chemotherapy. Surgery was less successful in patients who developed BONJ as a result of implant failure. Based on this last factor the authors suggested that implant placement is contraindicated in patients who have been exposed to IV bisphosphonate therapy. However, regarding implant placement, a distinction must be made between patients exposed to oral vs. intravenous forms of bisphosphonates. A review of 115 cases of 468 dental implants placed in patients taking oral bisphosphonates concluded that implant success rates were comparable to success rates in patients not receiving oral bisphosphonates. The authors did suggest that alternative treatment options may be prudent in patients with more than a 3 year history of oral bisphosphonate usage, or with concomitant treatment with prednisone.

**Summary**

Although the consequences of BONJ can be significant to the overall quality of life for patients who experience it, appropriate preventive measures and maintenance of good oral health prior to initiation of therapy and throughout the life of the patient can minimize its occurrence and limit its severity. Particular attention must be paid to any oral condition which may potentially traumatize soft tissue or involve alveolar bone. Dental treatment decisions in these patients must take into account the route and duration of drug administration and the current systemic condition of the patient. When BONJ does occur, conservative management primarily involving use of oral antibacterial rinses and minimal debridement can often result in healing. Cases which require surgical intervention generally respond to a meticulous technique and concomitant antibiotic therapy. With ever increasing numbers of patients taking these drugs we might expect to see an increase in the number of cases of BONJ. Dentists must therefore be vigilant when reviewing medical histories, do careful intraoral exams, and respond immediately to any soft tissue lesions or bone exposure in these patients. Because the science related to this topic is continually developing, evolving and undergoing refinement, all health care professionals must ensure that they continually have an up to date knowledge of this topic.

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- Forteo® (Eli Lilly, Indianapolis, IN)

**References**


Author Profile
David A. Lazarchik, DMD
Associate Professor / Assistant Dean for Patient Care and Clinical Education, College of Dental Medicine, Western University of Health Sciences.

Dr. Lazarchik received his dental degree at University of Florida and a GPR certificate at University of Alabama at Birmingham. His primary practice focus has been hospital dentistry, academics, and private practice. Currently he is responsible for the clinical education program and the operations of The Dental Center at Western University of Health Sciences. His research/clinical interests include medically complex patients, dental erosion & GERD, and the plaque control potential of carbamide peroxide.

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1. Bisphosphonate drugs affect bone metabolism by:
   a. binding to osteoclasts and inducing a decrease in bone mass
   b. being phagocytized by osteoclasts and disrupting the normal balance of the bone remodeling process
   c. binding to oxygen atoms in bone
   d. increasing the activity of osteoblasts

2. A primary use of oral forms of bisphosphonates is for treatment of:
   a. renal cell carcinoma
   b. osteolytic bone lesions related to breast cancer
   c. osteoporosis in women after menopause or osteoradionecrosis related to corticosteroid medications
   d. osteosarcoma

3. A primary use of IV forms of bisphosphonates is for treatment of:
   a. renal cell carcinoma
   b. osteolytic bone lesions related to breast cancer
   c. osteoporosis in women after menopause or osteoradionecrosis related to corticosteroid medications
   d. osteosarcoma

4. Which of the following drugs has not been implicated in causing BONJ?
   a. sunitinib
   b. bevacizumab
   c. denosumab
   d. sorafenib

5. According to the AAOMS, all of the following are correct in defining BONJ except:
   a. preceded by a mucosal lesion of at least 3 weeks duration
   b. current or previous treatment with bisphosphonates
   c. exposed bone in the maxillofacial region that has persisted for more than 8 weeks
   d. no history of radiation therapy to the jaws

6. Which of the following is not true?
   a. the cumulative incidence of BONJ related to IV forms of bisphosphonates is 0.8% to 12%
   b. the risk of BONJ increases in patients over 65 years old
   c. the risk of BONJ is equivalent regardless of duration of administration
   d. the cumulative incidence of BONJ related to oral forms of bisphosphonates is 0.01% to 0.06%

7. BONJ may be caused by all of the following except:
   a. periodontal surgery
   b. implant placement
   c. ill-fitting dentures
   d. endodontic instrumentation beyond the apex

8. Which of the following is true?
   a. BONJ does not occur spontaneously
   b. BONJ frequently begins in areas of thicker oral mucosa
   c. BONJ affects the mandible more frequently than the maxilla
   d. the most common initial symptom of BONJ is sharp, shooting pain

9. Signs of BONJ include all of the following except:
   a. sinus tracts
   b. swelling
   c. purulence
   d. hemorrhage

10. The most common radiographic appearance of BONJ is:
    a. well-defined radiopaque appearance
    b. diffuse radiolucent area related to tooth roots
    c. soap bubble appearance
    d. mixed radiolucent and radiopaque mottled appearance

11. The following theories have been proposed to explain BONJ except:
    a. remodeling suppression
    b. anti-angiogenesis
    c. mucosal toxicity
    d. bacterial signaling

12. Which microorganism has been implicated in causing BONJ?
    a. Streptococcus
    b. Actinomyces
    c. Lactobacillus
    d. Candida

13. Possible reasons that BONJ is restricted to the jaws include all of the following except:
    a. uptake of bisphosphonates into bone because of rapid alveolar bone turnover
    b. repeated trauma to alveolar bone by hygiene and dental procedures
    c. occlusion causes lateral forces on the dentition initiating breakdown of tooth sockets
    d. trauma from dental prostheses may impact soft tissue coverage of bone

14. Which of the following is true?
    a. oral forms of bisphosphonates concentrate in bone to a greater degree than IV forms
    b. oral forms of bisphosphonates concentrate in bone to a lesser degree than IV forms
    c. for oral forms of bisphosphonates, duration of administration does not affect concentration in bone
    d. oral forms of bisphosphonates do not concentrate in bone

15. In patients taking oral forms of bisphosphonates BONJ is typically seen after what duration of administration?
    a. 14 days
    b. 6 months
    c. 1 year
    d. 3 to 5 years

16. The guidelines for preventing BONJ are similar to those for preventing:
    a. osteoradionecrosis
    b. osteosarcoma
    c. osteoporosis
    d. osteolytic bone lesions

17. A dental program designed to prevent BONJ would include all of the following except:
    a. dental exam prior to initiating bisphosphonate administration
    b. patient education about the potential risk of BONJ
    c. removal of any factors which may contribute to soft tissue trauma
    d. elimination of all periodontal pockets greater than 4 mm in depth

18. In preparing a patient for IV administration of bisphosphonates, any surgery exposing bone should be completed:
    a. 3 to 6 months prior to bisphosphonate administration
    b. immediately after the first dose of bisphosphonate
    c. 3 to 6 weeks prior to bisphosphonate administration
    d. surgery exposing bone should not be performed on this patient

19. Once bisphosphonate therapy is initiated, what interval of regular dental visits should be maintained?
    a. every 2 weeks
    b. once per month
    c. once per year
    d. every 3 to 6 months

20. In a patient taking bisphosphonate drugs, which of the following dental conditions should immediately be reported to a dentist?
    a. any soft tissue lesion
    b. soft tissue lesions only if larger than 1 cm
    c. calculus build up on mandibular anterior teeth
    d. slight bleeding when brushing

21. The risk of developing BONJ in patients who have taken oral forms of bisphosphonates is:
    a. very small
    b. moderate
    c. high
    d. very high

22. Which of the following is true regarding biomarker testing to predict risk of BONJ?
    a. CTX testing predicts risk of BONJ
    b. it is accepted practice to use biomarker testing to time dental surgery
    c. discontinuing drug therapy based on biomarker testing is not currently accepted practice
    d. CTX testing predicts the time at which drug therapy can be resumed after surgery

23. Which of the following is true regarding dental surgery in patients exposed to bisphosphonate drugs?
    a. antibiotic prophylaxis may prevent development of BONJ
    b. chlorhexidine rinses may prevent development of BONJ
    c. surgery should be performed aggressively, exposing bleeding bone at all margins of the surgical site
    d. surgery should be performed asatraumatically as possible
24. In patients taking or who have taken bisphosphonates as part of cancer therapy, which one is correct?
   a. bisphosphonate treatment should never be discontinued for dental surgery
   b. if dental surgery is necessary, it should be aggressive, with exposure of bleeding bone at the margins of the surgical site
   c. all nonrestorable teeth should be extracted
   d. nonrestorable teeth can be decoronated and endodontics performed on remaining roots

25. If BONJ occurs, which step is not part of a conservative protocol that should be attempted prior to surgical intervention?
   a. Pen VK for patients in pain or with purulent discharge
   b. twice daily chlorhexidine rinses alternating every 2 weeks with essential oils mouthrinse
   c. removal of mobile necrotic bone fragments using tissue forceps
   d. smooth rough bone surfaces using piezosurgery tips

26. A recent review article concluded that conservative (nonsurgical) protocols for treatment of BONJ:
   a. are more successful than surgical protocols
   b. cause greater areas of bone to be exposed over time
   c. have a success rate equivalent to surgical treatment
   d. almost always result in total healing of lesions

27. Which is not cited in the article as an alternative treatment for non-responding cases of BONJ:
   a. piezoelectric surgery
   b. teriparatide drug therapy
   c. hyperbaric oxygen therapy
   d. laser assisted surgery

28. Many cases of BONJ that do not respond to conservative surgical treatment:
   a. will never heal completely
   b. will heal if a meticulous surgical technique is followed, including passive, primary closure of all surgical areas
   c. will respond to extreme aggressive surgery
   d. will heal if the appropriate antibiotic is administered

29. Which factor has a positive effect on surgical treatment of BONJ?
   a. patient was treated with bisphosphonates for cancer
   b. bisphosphonate therapy was discontinued for 6 months following surgery
   c. patient developed BONJ as a result of implant failure
   d. patient was treated with bisphosphonates for multiple myeloma

30. A review of dental implants placed in patients taking oral bisphosphonates concluded that implant success rates:
   a. were somewhat lower than in patients not receiving oral bisphosphonates
   b. were higher than in patients not receiving oral bisphosphonates
   c. were much lower than in patients not receiving oral bisphosphonates
   d. were comparable to patients not receiving oral bisphosphonates
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PLEASE PHOTOCOPY ANSWER SHEET FOR ADDITIONAL PARTICIPANTS.

ANSWER SHEET
Update on Bisphosphonate Osteonecrosis of the Jaws

Name: ______________________ Title: ______________________ Specialty: ______________________

Address: ______________________ E-mail: ______________________

City: ______________________ State: ______________________ ZIP: ______________________ Country: ______________________

Lic. Renewal Date: ______________________ AGD Member ID: ______________________

Requirements for successful completion of the course and to obtain dental continuing education credits: 1) Read the entire course. 2) Complete all information above. 3) Complete answer sheets in either pen or pencil. 4) Mark only one answer for each question. 5) A score of 70% on this test will earn you 2 CE credits. 6) Complete the Course Evaluation below. 7) Make check payable to PennWell Corp. For Questions Call 216.398.7822

Educational Objectives
1. List several bone modifying drugs, how they work, and what medical conditions they are used for.
2. Describe what bisphosphonate osteonecrosis of the jaws (BONJ) is and what causes it.
3. List common signs and symptoms of BONJ.
4. Describe a protocol for preventing BONJ.
5. Describe a protocol for treatment of existing BONJ.

Course Evaluation

1. Were the individual course objectives met? 1) Yes 2) No
   Objective #1: ______________________ Objective #3: ______________________
   Objective #2: ______________________ Objective #4: ______________________
   Objective #5: ______________________

Please evaluate this course by responding to the following statements, using a scale of Excellent = 5 to Poor = 0.

2. To what extent were the course objectives accomplished overall? 1) 2) 3) 4) 5)
3. Please rate your personal mastery of the course objectives. 1) 2) 3) 4) 5)
4. How would you rate the objectives and educational methods? 1) 2) 3) 4) 5)
5. How do you rate the author’s grasp of the topic? 1) 2) 3) 4) 5)
6. Please rate the instructor’s effectiveness. 1) 2) 3) 4) 5)
7. Was the overall administration of the course effective? 1) 2) 3) 4) 5)
8. Please rate the usefulness and clinical applicability of this course. 1) 2) 3) 4) 5)
9. Please rate the usefulness of the supplemental webiography. 1) 2) 3) 4) 5)
10. Do you feel that the references were adequate? 1) Yes 2) No
11. Would you participate in a similar program on a different topic? 1) Yes 2) No
12. If any of the continuing education questions were worded or ambiguous, please list them.
13. Was there any subject matter you found confusing? Please describe.
14. How long did it take you to complete this course?
15. What additional continuing dental education topics would you like to see?

Payment of $49.00 is enclosed.
(Checks and credit cards are accepted.)

Acct. Number: ______________________
Exp. Date: ______________________

Charges on your statement will show up as PennWell

1. ______________________ 2. ______________________ 3. ______________________ 4. ______________________ 5. ______________________

AGD Code 739

The PennWell Corporation has been approved as a distinguish provider of continuing dental education. The formal continuing dental education programs of this program provider are accepted by the ADA for Fellowship/ Masterhip credit. Please contact PennWell for current list of acceptance. Participants are urged to contact their state dental boards for continuing education requirements. PennWell is a California provider. The California Provider number is 4527.

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For immediate results, go to www.ineedce.com to take tests online.
Answer sheets can be faxed with credit card payment to (440) 845-3447, (216) 398-7922, or (216) 255-6619.

FOR Questions Call 216.398.7822

PennWell maintains records of your successful completion of any course for a minimum of six years. Please contact our offices for a copy of your continuing education credits report. This report, which will list all credits earned to date, will be师范大学ed and mailed to you within five business days of receipt.

Please photocopy this answer sheet for additional participants.

Please rate the usefulness of the supplemental webiography. 1) 2) 3) 4) 5)

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