Indication and treatment strategies in antiresorptive risk patients

Summary:
Antiresorptive drug related osteonecrosis of the jaw (ARONJ) develops primarily in patients with bisphosphonate and/or denosumab therapy. The therapeutic indications of these drugs range from patients with osteoporosis to multi-morbid patients with osseous metastases of solid tumors. In addition to reduced bone remodeling, etiology also describes other factors such as changes to the soft tissues, vessels and the immune system. Here, trigger factors such as inflammatory changes in the oral cavity, periodontitis, peri-implantitis or even surgical procedures such as tooth extractions and prosthetic pressure points play a decisive role in the pathological process. If a full dental functional rehabilitation is to be realized, it is crucial to select a treatment regime that considers the least possible risk of developing osteonecrosis. Clearly general dental surgical procedural risks should also be considered. In individual cases functional rehabilitation may also include an implant-supported denture. The possible risk factor for the development of a drug-associated necrosis of the jaw by prosthetic pressure points caused by removable dentures can be reduced by using implant-supported restoration.

Keywords:
bisphosphonate; individual risk; antiresorptive drug related osteonecrosis of the jaw (ARONJ); DGI-evaluation chit; dental implant insertion; current state of the guidelines
Introduction

Bisphosphonates have been successfully used in medicine for more than 25 years for the treatment of osteoporosis as well as for osseous metastases of solid tumors. The first description of bisphosphonate-associated osteonecrosis of the jaw [BP-ONJ] in 2003 [18] presented doctors and dentists with new challenges and new treatment issues. On the one hand bisphosphonates achieve positive bone balance and thus a reduction of bone resorption through effective inhibition of osteoclast activity. On the other hand, however, they lead to reduced rate of bone regeneration and remodeling, which can lead to osteonecrosis of the jaw under certain circumstances. Osteonecrosis of the jaw similar to that of bisphosphonate-associated osteonecrosis of the jaw, has subsequently been described following the use of other medications. The term bisphosphonate-associated osteonecrosis of the jaw was replaced by the term antiresorptive drug related osteonecrosis of the jaw because this old terminology was based on the commonality of the antiresorptive properties in bone metabolism or the osteoprotective properties factors involved. The terminology of medication-associated osteonecrosis of the jaw (MRONJ) describes the same entity and is used in particular to cover new medication groups, e.g. Bevacizumab (Avastin), whereby these are much more rarely associated with osteonecrosis of the jaw.

The occurrence of ARONJ is usually fostered by intraoral wounds, e.g. inflammatory changes to the oral mucous membrane, periodontal disease, surgical intervention or denture pressure points (Figure 1). An interdisciplinary approach with cooperation between dentists and medical doctors is best adopted to ensure a successful outcome in such cases. Implant support for the prevention of or sustained reduction of denture pressure points on the oral mucous membrane can reduce individual risk for the patient and lead to improved retention and stability of the prosthesis. As any surgical procedure on the jaw of an ARONJ patient entails the risk of later osteonecrosis of the jaw the risk must be measured against benefit and an individual risk profile analysis carried out.

This article discusses current recommendations in the literature, the classification of risk profiles, and prevention strategies adopted in ARONJ patients undergoing dental implant regimes [33].

Bisphosphonates and antiresorptive drug related osteonecrosis of the jaw (BPONJ/ARONJ)

Physiological bone metabolism involves a coordinated system of bone resorption and formation processes. The osteoblasts that form the bone substance, the osteoclasts that break it down and the osteocytes that are created, are regulated by different regulatory systems both inside and outside the bone matrix. Stimulation of the osteoblasts leads to bone formation. Stimulation of the osteoclasts, on the other hand, has the opposite effect, leading to continually regulated resorption and formation. “In a steady state the resorption and formation are balanced, which leads to continual renewal of the existing bone tissue (bone remodeling)” [10]. Different pathological situations can substantially disrupt this balance. The most important diseases in this category are osteoporosis, in which generalized negative bone balance occurs, and oncological diseases associated with bone metastases (e.g. mammary and prostate carcinoma) that occur primarily in the bone tissue (plasmocytom, multiple myeloma). The issue that all these diseases in common is the progressive instability of the skeletal system with increasing risk of spontaneous fracture and consequences through to paraplegia. Bisphosphonates strive, as a group of medications, to intervene positively into this derailed regulation mechanism.

Bisphosphonates are synthetically manufactured analogs of pyrophosphates and inhibit an enzyme, mainly in osteoclasts. The suppressed enzyme in the osteoclasts then leads to reduced resorption of the bone. The intervention into this regulatory circuit of bone metabolism means that the physiological bone remodeling no longer occurs and the bone-remodeling rate reduces. However the intervention into the regulatory circuit as described above is considered to be the main cause of antiresorptive drug related osteonecrosis of the jaw, in combination with other factors.

The leading symptom of antiresorptive drug-associated osteonecrosis of the jaw is exposed bone which may be determined by inspection or palpation with a probe. Further classical symptoms are loose teeth, foetor ex ore, jaw ridge fistula with or without exudation, swelling or spontaneous sensitivity disorders of the lower lip (Vincent symptom). A patient’s existing or intermittent pain should not be considered as a principal symptom. This is rather an expression of the (super) infection and frequently characterized by additional pus exudation.

The monoclonal IgG2-Anti-RANKL antibody denosumab (trade name: Prolia or X-Geva) is also associated with the formation of osteonecrosis [6]. Denosumab also intervenes in the bone metabolism by deactivating a protein that normally activates osteoclasts, precipitating osteoclast inhibition. Denosumab and bisphosphonate therapy produce a similar incidence of osteonecrosis in ARONJ, oncological and osteoporosis patients [22, 27].

Treatment of primary and secondary osteoporosis as well as supportive therapy for oncological diseases are the main indications for antiresorptive agents. These include:

- multiple myeloma (or plasmocytom),
- the osseous metastases of solid tumors, whereby mammery carcinoma and prostate carcinoma are the main indication here,
- primary (usually postmenopausal) osteoporosis,
- secondary (usually therapy-induced) osteoporosis,
- Paget’s disease.

Probably the most frequent treatment with antiresorptive agents is for primary osteoporosis with oral bisphosphonate medication or intravenous dose just once a year. Cases of secondary osteoporosis or malign diseases without bone metastases usually indicate intravenous adminis-
vation 2 to 4 times a year [6]. Osteo-
seous metastases and multiple myelo-
ma, however, require increased medi-
cation commonly with one intra-
venous therapy every 4 weeks [1, 30].

Besides the above antiresorptive
agents several other medications are
also now suspected of being able to
trigger osteonecrosis of the jaw. The
only secured data on the subject is on
the prevalence of osteonecrosis of the
jaw with the angiogenesis inhibitor
bevacizumab, which (without accom-
panying bisphosphonate medication)
is 0.3–0.4 % [11]. However the com-
bination of an angiogenesis inhibitor
such as bevacizumab or sunitinib with
bisphosphonates reveals an ONJ risk
elevation of 16 % [3].

Further case reports for triggered
osteonecrosis of the jaw exist for the
medications trastuzumab (trade name: Herceptin) and aflibercept (trade name: Zaltrap) [19, 20, 37]. It is
not currently possible to make a
statement on the prevalence for these
medications.

Therefore, the group of antire-
sorptive agents and the individual
medication Alvastin are important
and must be included in the dentist’s
medical history record.

Definition and prevalence
of the antiresorptive drug
related osteonecrosis of
the jaw

The special aspect of the patient
group with using antiresorptive
agents is not explained wholly on the
basis of the prevalence rates but
rather with the knowledge that there
is a half-life time that can last several
years caused by the complex bond of
the medication to the hydroxyapatite
of the bone that is sometimes ex-
tremely long and individually very
difficult to estimate. This means that
osteonecrosis of the jaw can even de-
velop after years without oral mucous
membrane symptoms.

The currently recognized definiti-
on of antiresorptive drug related os-
tonecrosis of the jaw is a com-
bination of 3 symptoms:

• exposed bone for more than 8
weeks (inspection or probe pal-
pation),

• bisphosphonate, denosumab
medication or intake of another
responding medication and

• a lack of head/neck radiotherapy
in the medical history [18, 24, 25].

Patient risk susceptibility to ONJ is
variable. In order to determine the
individual risk of each person we
must first differentiate the risk ac-

cording to literature-based rates of
osteonecrosis of the jaw for three typi-
cal groups of patients that are de-
scribed in the guideline on bisphos-
phonate-associated osteonecrosis of
the jaw (BP-ONJ) and other medi-
cation-associated osteonecrosis of the
jaw [6]:

• Low risk profile: 0.1 %
  – With primary osteoporosis
  (usually oral alendronate, more
  rarely zoledronate 5 mg i.v.
every 12 months or 60 mg de-
nosumab every 6 months)

• Moderate risk profile: 1 %
  – With therapy-induced osteopo-
rosis (e.g. zoledronate 4 mg
every 6 months or denosumab)
or with prophylactic adminis-
tration without bone metastases

• High risk profile: 4 to 20 %
  – With oncological indications
with bone metastases or with
plasmocytom (e.g. zoledronate
4 mg or denosumab 120 mg
every 4 weeks) [6].

This categorization of patients into a
low, moderate or high-risk profile is
very helpful but only represents an
initial approach to the evaluation of
the individual’s risk profile. This
comprises [23, 31, 32]:

• The selected bisphosphonate prep-
paration (non-amino versus amino-
BP),

• The method of application (i.v.
versus oral intake),

• The dose and number of individ-
ual doses,

• The therapy duration,

• The underlying disease (oncologi-
cal versus non-oncological),

• Further medication and therapies
(e.g. chemo, cortisone, anti-angio-
genetic or radiation therapy),

• Other risk factors (e.g. diabetes
mellitus, nicotine abuse, other
underlying diseases etc.),

• Local infection entry sites (peri-
odontitis, oral hygiene with any
injury to the oral mucous mem-
brane, surgical intervention, den-
ture pressure points).

A so-called ‘routing slip’ has been de-
veloped in ordeerto simplify this very
complex evaluation of the individ-
ual’s risk profile for the dentist and to
improve the necessary, interdisciplin-
ary communication between the doc-
tors prescribing the antiresorptive
agents. Use of this slip is also recom-

mended in the S3 guideline [8]. It in-
cludes the patient’s underlying dis-
eease, the type of medication and any
other oncological therapies (chemo-
therapy, radiation therapy, immune
or antibody therapy or cortisone
therapy) and can be implemented in-
dividually.

Etiology and pathogenesis
of antiresorptive drug-
related osteonecrosis

Multiple factors are assumed in the
development of ARONJ [12, 35]. Be-
sides the reduced bone remodeling
rate described above the medication
that is used has a differing level of in-
fluence on the gingiva. This involves
fibroblast, keratinocyte and vessel
cell functions.

It has become apparent that in-
fecions in the jaw area are possible
tigger factors. These include gingivi-
tis, periodontitis and dentito difficili-
s. The literature also reveals that
tooth extraction, injury to the oral
mucous membrane from denture
pressure points, sharp bone edges,
defective cleaning or biting inter alia,
have a strong influence on oral bac-
terial populations.

Several studies support the as-
sumption that there is a direct cor-
relation between having untreated or
exacerbated periodontitis and the development of osteonecrosis of the jaw [21, 26, 28, 29]. Thus patients with bisphosphonate-associated osteonecrosis of the jaw usually have fewer teeth than corresponding control groups and greater quantitative (more teeth) and qualitative attachment loss (more severe affliction) [28, 36]. The same evidence exists for important triggers ‘denture pressure point’ and ‘tooth extraction without safety provisos’. It is important that the infection is manifest in the soft tissue (including the parodontium) or that the bacterial population is in the bony embedding tissue at the ‘integumental perforation’ (pressure point) or open soft tissue bone wound (extraction alveolus). This does not then cause passing osteitis or osteomyelitis, in contrast to infected osteoradionecrosis or more rarely sequestration in chronic osteomyelitis, but rather to the bone directly entering necrosis (Figures 2–5).

Primary importance is placed on all measures to avoid an ONJ before beginning antiresorptive therapy (ONJ prophylaxis) or during or after AR therapy (ONJ prevention). The cooperation of dentist, doctor and patient are required for a successful outcome.

A 2016 study involving 192 internists, orthopedists and pediatricians in Seoul were interviewed on ARONJ, the prophylaxis, prevention and therapy. 22 % of those questioned were not aware of osteonecrosis as a disease. Only less than 30 % refer for oral prophylaxis/prevention measures [14]. The central point is that 78 % of those questioned were aware of the ONJ problem but still only approximately 30 % initiated an ONJ prophylaxis! The aim was to alert this almost 50 % of those questioned so that they refer the patient to the relevant dentist before AR therapy. This study reveals the major issue that osteonecrosis cannot be prevented if the dentist is aware of the disease but the patient is still not provided with information by the doctor treating him or her.

**ONJ Prophylaxis**

This is why prophylaxis for osteonecrosis of the jaw is carried out prior to therapy with antiresorptive agents. It should be noted that the measures listed correspond to standard dental prophylaxis and are not a special therapy for bisphosphonate patients [6]:

- Extraction of teeth and implants that cannot be saved or are not worth maintaining,
- Rehabilitation of infections in recesses by beginning systematic periodontal therapy on teeth with periodontal disease that are worth maintaining (this can also be continued in parallel to the beginning of the BP therapy),
- Beginning a systematic peri-implantitis therapy on implants that are worth maintaining (this can also be continued in parallel to the beginning of the BP therapy),
- Removal of partially retained teeth with chronic pericoronitis,
- Removal of cysts, foreign bodies and other enosseal chronic sources of infection,
- Root tip re-sectioning only with clinically symptomatic apical periodontitis (caution: a radiological finding alone for apical osteolysis is not an indication of WSR because of the reduced rate of bone remodeling in these patients!),
- Root canal treatment on non-vital teeth without root treatment,
- Rehabilitation of existing and avoidance of future entry points for pathogens by treating existing pressure points (modification of dentures),
- Reduction of the risk of pressure points by adapting the prosthetic base, smoothing sharp bone edges, exostoses and tori with relevant risk for future mucous membrane perforation,
- Motivation and instruction relating to above average oral hygiene,
- Classification of the patient in a risk-adapted recall program.

Achievable oral hygiene should be taken into account for all the recommendations to the patient. Of course optimum results in domestic oral hygiene should be exhausted and the patient re-motivated in the course of the treatment or at check up appointments. However, limitations of oral hygiene because of possible general disorders (e.g. rheumatoid arthritis, Parkinson’s disease or a condition following a stroke) must also be considered in the approach to and assessment of the value of maintaining teeth with existing periodontal disease. If the patient is not capable of appropriate oral hygiene even after implementing all possibilities then he or she should be classified as a high-risk patient for the formation of osteonecrosis of the jaw.

Following the confirmation of any necessary surgical intervention in this group of patients, subsequent ONJ risk factors should be considered and balanced against the consequences of non-action. For example, degree of dental/periodontal pathology and their likely consequences versus risk of ARONJ.

Tegumental denture pressure points represent a further risk factor that could also trigger the occurrence of osteonecrosis [34]. The insertion of implants is a good way to reduce the risk of a denture pressure point by avoiding tegumental dentures. However, implants per se do represent a
risk for the development of osteonecrosis of the jaw [34] from possible periimplantitis or intervention following antiresorptive agent therapy.

Precautionary measures for tooth removal
As with other patients, a necessary tooth extraction should not be long delayed in risk patients. A number of defined safety measures exist in order for the intervention to take place with as few problems as possible:

• A prolonged, peri-operative, systemic antibiotic prophylaxis at least from the day before the operation and until the clinical signs of bacterial load abate. Here the antibiotic Amoxicillin, 1 g is recommended 3× daily, or (in the case of a penicillin allergy) Clindamycin 600 mg 3× daily.

• Minimally invasive operations and atraumatic procedures (avoiding thermal or mechanical lesions in the bony tissue),

• Careful removal of the sharp bone edges (modeling osteotomy), particularly in order to prevent secondary perforation of the mucosa. It should be noted here that a flap opening or formation of a flap is still necessary for ‘simple’ tooth extraction. Minimally invasive piezosurgery has established itself for the additional, atraumatic smoothing of the sharp bone edges.

• Primary, plastic cover of the defect with tension-free wound closure.

Antiresorptive agents and implants
A new guideline was published in 2016 entitled ‘Tooth implants during medical treatment with bone antiresorptive agents (including bisphosphonate) [33] in order to help both the patient and his or her doctor/dentist with this issue.

Risk evaluation is the primary factor to be considered in functional rehabilitation involving antiresorptive agent therapy as described above. A risk evaluation sheet with traffic light classification has been developed and commissioned by the German Association for Implantology, in order to simplify risk assessment for surgeons. The risk assessment consider underlying disease, antiresorptive medication

Figure 3 The corresponding enoral clinical picture. Exposed bone at the alveoli with a putrid superinfection show the enoral status.

Figure 4 Resectate of the lower jaw with partial greyish-green bone necrosis.

Figure 5 Condition after resection and smoothing of the sharp bone edges in the lower jaw with plastic covering.
dosage dynamics, oncological considerations bone remodeling dynamics. The relevant ONJ risk is classified as ‘low = green’, ‘moderate = yellow’ or ‘high = red’ [5].

Particular significance is given to the radiological diagnosis of a ‘persistent alveolus’. Radiological changes in the panoramic tomography that are induced by the antiresorptive agent therapy can mean that an unhealed alveolus in the x-ray can be taken as a very low level of bone regeneration [4]. The clinical and radiological healing process of alveolus should therefore be included in the evaluation of a possible implant procedure [33].

A difficult but necessary factor involving all patients with underlying oncological diseases is the prognosis quoad vitam. The participation of the patients oncologist should be sought in this respect [33].

The implant indication should also be checked with regard to whether the risk of osteonecrosis can be lowered through the insertion of implants by avoiding denture pressure points and therefore reducing the stress on the mucous membrane [33]. The degree to which the peri-implant embedding tissue needs to be improved with bone augmentation procedures will determine the risk of a wound healing disorder, of osteonecrosis and the possible failure of implants.

A table from the guidelines: ‘Dental implants during medication with bone resorptive agents (including bisphosphonates)’ [33] provides a good summary of implant indication (Table 1). The attending dentist or physician can also go through the algorithm to reach a decision for or against an implant together with the patient.

If the above aspects are observed and the patient is classified in the correct risk group then implantation in antiresorptive agent patients is promising. Past studies and meta-analyses and evaluation of the literature show implant survival rates of 95–100 % [7, 16] or 86 % [13]. While most studies were carried out with patients with primary and secondary osteoporosis and involved concurrent oral bisphosphonate medication, it should be noted that subjects involved had a rather lower risk to develop osteonecrosis. Two systematic reviews from 2013 show no absolute contraindication for implant therapy in oral or intravenous bisphosphonate therapy [2, 9].

Patients must be informed at the end of the pre-operative phase. The patient should be informed of the individual risk of osteonecrosis prior to the planned implant insertion. This information should also include alternatives to the therapy, the advantages and disadvantage and the necessary structured aftercare, along with a note of these subsequent costs. Two central points should be discussed with patients: the risk of osteonecrosis from a dental operation, i.e. the implantation itself, and the possible future risk of periimplantitis. Studies currently show that the risk of periimplantitis, i.e. of bacterial population of the gingiva and the embedding tissue around the implant, is seen as a significant factor in causing osteonecrosis of the jaw compared to the risk of the implantation itself. As several implants need to be inserted in order to avoid a removable denture the consequent prophylaxis and aftercare for the implants is one of the central points for the patient and the dentist [15, 17, 28, 34]. Regular aftercare is essential for dentures mounted on implants. The focus here is on correct fit, particularly of small denture saddles in the distal area. This could also lead to pressure point-associated necrosis with an imprecise fit.

### surgical procedure
Surgical intervention on antiresorptive agent patients requires an exact planning phase. There is no resilient data in current literature for a so-called ‘drug holiday’ around the time of the operation and this cannot be recommended [33].

Implant placement can take place safely if certain safety precautions are observed (including prolonged peri-
operative treatment with antibiotics, a strict diet of liquid or soft food, a minimally invasive operation). The perioperative, systemic antibiotics prophylaxis should be carried out with all antiresorptive agent patients. However, no uniform regime of antibiotics can be recommended. Antibiotic indications must be assessed individually. Analogously to the endocarditis prophylaxis a single dose 30–60 min before the intervention could be sufficient, whereby antibiotic regimes are sometimes started earlier in the literature and given over a period of several days [33]. A prolonged, perioperative, systemic antibiotic screen has proven effective in clinical practice until clinical signs of germ population have abated after the operation.

Overall conservative treatment regimes dominated with these patients, following assessment of a positive indication for implantation:
- No immediate implantation (together with tooth extractions!),
- No immediate restoration,
- No immediate loading,
- Preference for medium strength primary stability (e.g. thread tapping, avoidance of concity),
- Preference for regimes to avoid perimplantitis (e.g. angulation, vertical biological width etc.).

There is no reliable data available concerning implant healing. Transgingival heating with initial, possibly lesser contamination of the bone via the larger wound is contrasted with a second intervention when exposing subgingival healing. Healing time following implantation is also based on conjecture. A longer healing time can be assumed, based on the reduced bone-remodeling rate, until the implant is integrated into the bone.

**Conclusion**

The new guideline ‘Dental implants in the medical treatment with bone antiresorptive agents (including bisphosphonate)’ provides the caregiver with a valuable decision reaching aid. The indication for implant care can be reviewed precisely in combination with a further risk evaluation using the ASORS routing slip and the DGI evaluation sheet. The insertion of implants in antiresorptive agent patients may include functional rehabilitation in certain circumstances and thus probably reduce the risk of the development of osteonecrosis by avoiding denture pressure points. However, further long-term studies are necessary in order to evaluate the probability of success of the implant/denture solution for the patient.

**Conflicts of Interest:**

The authors declare that there is no conflict of interest as defined by the guidelines of the International Committee of Medical Journal Editors.

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