REVIEW ARTICLE

CONTENTS

The impact of systemic osteoporosis on the bone structure of the alveolar processes

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ABSTRACT

Aim: Review and analysis of contemporary professional literature on the impact of systemic osteoporosis on the bone structure of the alveolar processes, with a particular focus on the pathogenetic mechanisms of disorders of bone remodelling processes.

Materials and Methods: The bibliosemantic method was used to clarify the state of the problem, to study the analysis of the results of previous scientific research based on the sources of literature and electronic resources.

Conclusions: Thus, the literature shows that the resorptive processes associated with osteoporosis not only alter the bones of the supporting and peripheral skeleton, but also alter the structure of the bone tissue of the jaw. The introduction of a pathogenesis-based approach to treatment will allow significant progress to be made in the dental care of patients with primary osteoporosis. Given the high prevalence of osteoporosis in patients of various profiles, the role of the dentist in the diagnosis and correction of this pathology is becoming increasingly important. It is of particular importance to direct attention to older patients, given the increased risk of developing postmenopausal and senile osteoporosis.

KEY WORDS: osteoporosis, bone tissue, alveolar processes, remodelling processes, mineral density

Wiad Lek. 2025;78(2):410-414. doi: 10.36740/WLek/196443 DOI

INTRODUCTION

Osteoporosis (OP) is a systemic skeletal disease characterised by a decrease in bone mass and impaired bone quality (microarchitecture), which leads to bone fragility and manifests itself in fractures following minor trauma [1]. The most common manifestations of OP are vertebral compression fractures, fractures of the distal forearm, proximal femur, and proximal humerus. In recent years, OP has not only become a significant public health concern, but also one of the most common causes of disability and mortality among patients. The International Osteoporosis Foundation (IOF) has published a report on the prevalence of osteoporosis in the European Union. In the report, 'Improving the Assessment of Fracture Risk', it was noted that after the age of 50, this disease is diagnosed in every third woman and every fifth man. Of these, 24% of women and 33% of men die within the first year after a hip fracture [2].

Given the high prevalence of osteoporosis in patients of various profiles, the role of the dentist in the diagnosis and correction of this pathology is becoming increasingly important. It is of particular importance to direct attention to older patients, given the increased risk of developing postmenopausal and senile osteoporosis [3]. Furthermore, in men with androgen deficiency, bone mineral density loss is more pronounced than in women with hypogonadism [4].

A number of studies have demonstrated a strong correlation between estrogen deficiency and the onset of periodontitis and osteoporosis [5, 6]. In recent years, an increasing number of researchers have proposed that postmenopausal osteoporosis contributes to the development and progression of periodontitis [7]. It has been demonstrated that periodontal bacteria contribute to the loss of alveolar bone tissue in periodontitis by increasing the activity of osteoclasts and/or by releasing toxins and pro-inflammatory cytokines [8]. Nevertheless, the precise mechanisms remain uncertain.

Bone tissue, like all other tissues, responds to a general or local pathological process and has a great adaptive response to variations in functional load [9]. As a consequence of alterations in the orientation and thickness of bone plates, the structure of bone tissue in general and in the jaw system in particular is remodelled. The eruption of milk and permanent teeth, tooth loss, and the use of prosthetics result in alterations to the load on specific areas of the alveolar processes, which in turn lead to the restructuring (remodelling) of the bone structure of the jaws [10].

AIM

A review and analysis of contemporary professional literature on the impact of systemic osteoporosis on the bone structure of the alveolar processes, with a particular focus on the pathogenetic mechanisms of disorders of bone remodelling processes.

MATERIALS AND METHODS

The bibliosemantic method was used to clarify the state of the problem, to study the analysis of the results of previous scientific research based on the sources of literature and electronic resources.

REVIEW AND DISCUSSION

The bone tissue of the jaws is not much different in structure and chemical composition from other bones of the skeleton [11]. However, the alveolar bone is unique in that the processes of internal restructuring are more active than in other bones of the skeleton. The height of the alveolar ridge is maintained by a physiological balance between bone formation and resorption. This is regulated not only by systemic factors but also by local factors [12, 13].

In accordance with the change in functional load on the dentition, remodelling modifies the structural anatomy of bone tissue so that the trabeculae and structures under load are strengthened to the maximum extent possible. Conversely, in the absence of load, bone tissue resorbs (Wolf's law). Systemic and local regulatory mechanisms frequently conflict with one another. Studies have demonstrated that even in instances of calcium deficiency, masticatory load can regulate bone mass [14].

In recent years, there has been a great deal of interest in elucidating the relationship between metabolic bone diseases and alterations in the jawbone tissue. It appears that systemic processes occurring within the body inevitably impact the condition of the dentition. Nevertheless, the relationship between osteoporosis and oral health remains a matter of contention [15].

The precise role of osteoporosis in the reduction of jaw bone mass, the pathogenesis of periodontal disease, tooth loss, and other changes remains unclear. According to [16], there may be three possible relationships: 1) systemic osteoporosis may act as a risk factor for periodontitis; 2) systemic osteoporosis may act as a risk factor for jaw osteopenia, regardless of the presence of periodontitis; 3) periodontitis may act as a primary (exclusive) risk factor for jaw osteopenia. Despite the numerous scientific studies conducted over the past two decades, certain issues remain controversial and insufficiently studied. For instance, [17] discovered a correlation between systemic osteoporosis, diminished jaw bone mass, and tooth loss. Furthermore, there is evidence that treatments aimed at increasing bone mineral density, such as hormone replacement therapy or bisphosphonate administration, help to preserve teeth and slow down alveolar bone loss.

A number of authors have conducted analyses of the relationship between systemic osteoporosis and alveolar bone volume, as well as the effect of estrogen on the condition of alveolar bone and teeth [18, 19]. The authors observed a positive correlation between systemic bone loss and the degree of alveolar bone resorption. The administration of estrogen has a similar effect on the jawbone as it does on other parts of the skeleton.

In a study conducted by M. Tezal and J. Wactawski-Wendè (2010), a correlation was established between the mineral density of bone tissue, different parts of the skeleton and the height of the alveolar ridge in the interproximal parts. The study involved 70 women aged 51 to 78 years. A reduction in skeletal bone mass was found to be correlated with a reduction in the height of interdental bone septa and gingival recession. The findings permit the authors to conclude that postmenopausal osteoporosis represents a risk factor for periodontal disease [20].

Balshi TJ and Wolfinger GJ (2007) conducted a comprehensive literature review to investigate the interrelationship between osteoporosis and periodontitis. A number of studies have indicated that osteoporosis results in both a loss of bone mass in the supporting skeleton and a decrease in jawbone density. Although the aetiologies of these diseases are distinct, some studies have demonstrated that the treatment of osteoporosis can improve the condition of periodontal tissues [21].

J. Wactawski-Wende et al. posit that the loss of alveolar height and the number of lost teeth in postmenopausal women is contingent upon the severity of osteopenia [22]. As stated by E.A. Krall (2011) and M.S. Reddy (2012), a reduction in bone mineral density in patients with osteoporosis, both in men and women, represents a risk factor for the development of periodontitis. Conversely, drugs used to treat osteoporosis have a favourable effect on the state of the oral cavity [23, 24].

In a study published in 2018, J.S. Mattson and colleagues investigated the relationship between systemic osteoporosis and periodontal status. Their findings indicated that the correlation between mandibular bone loss and tooth loss is observed in only a subset of patients. Furthermore, it is acknowledged that a multitude of potential factors contribute to the development of osteoporosis and periodontal disease, rendering it challenging to establish a direct correlation between the reduction in bone mineral density observed in osteoporosis, tooth loss, alveolar bone loss, and periodontitis. This highlights the necessity for further research in this area [25].

M. Jeffcoat et al. (2015) presented a synthesis of the findings from 15 clinical trials with the objective of elucidating the relationship between jaw bone loss and systemic osteoporosis. Indeed, 13 of the 15 studies demonstrated a positive correlation between systemic and local bone loss, specifically in the bones of the facial skeleton. The author considers that the interpretation of the literature is complicated by the variety of methods used to assess the severity of osteopenia, alveolar bone mass, and periodontitis [26].

The objective of Dervis E. (2019) was to analyse the described research methods, which were dedicated to the following areas: The following research methods were employed in the study:1) assessment of bone mineral density (BMD); 2) assessment of osteoporosis-induced changes in the oral cavity; 3) identification of the relationship between mandibular BMD and skeletal BMD; 4) identification of changes in the jaws and periodontal tissues in osteoporosis; 5) diagnosis of changes in oral tissues in conditions of estrogen deficiency; 6) study of the effect of hormone replacement therapy, calcium and vitamin D preparations on the state of the oral cavity. A meta-analysis of 97 studies conducted globally revealed that systemic osteoporosis is associated with a heightened risk of reduced jawbone density. However, this association has not been definitively established [27].

In a study published in 2016, M.A. Amorim and colleagues found no correlation between systemic osteoporosis and densitometric parameters of mandibular bone quality. A study by W. Becker et al. (2020) demonstrated that a simple visual assessment of bone quality at the implant site may be a more informative predictor of implant osseointegration than mineral density values obtained from peripheral skeletal bone examination [28].

Yu B & Wang CY (2022) postulates that osteoporosis and periodontal disease share several common risk factors, including advanced age, tobacco consumption, and deficiencies in calcium and vitamin D within the body. The author concurs with the assertion that osteoporosis, irrespective of periodontitis, results in a reduction in alveolar bone height. Furthermore, it is posited that pharmacological intervention for osteoporosis serves to maintain alveolar bone volume [29].

A number of studies have been conducted in recent years with the objective of assessing mandibular bone structure in the context of osteoporosis. For instance, investigated the correlation between skeletal bone mineral density, mandibular alveolar bone mass, structure, and thickness. The authors posit that a reduction in the trabecular pattern of the alveolar bone on intraoral radiographs represents a significant clinical indicator of skeletal BMD. This is superior to densitometric parameters of the alveolar bone in predicting the value of bone mineral density. A dense trabecular pattern is indicative of high BMD, whereas a sparse pattern is indicative of low bone mass [30].

The correlation between skeletal bone mineral density and alveolar bone mass was relatively weak, likely due to the significant influence of local functional factors on jaw bone. Subsequent studies have demonstrated that, although alveolar bone mass and thickness are primarily influenced by masticatory load, in women with postmenopausal osteoporosis, measurement of alveolar bone thickness in the premolar region can be employed to estimate the probable level of bone mineral density. The reduction in alveolar bone size with age and in women with postmenopausal osteoporosis is likely to be due to periosteal resorption, which is associated with skeletal bone loss. The authors posit that alveolar bone thickness can be utilized as one of several parameters to predict skeletal bone density [31].

S. Sidiropoulou-Chatzigiannis et al. (2017) highlight that osteoporosis results in a reduction in alveolar bone density and loss of jaw bone mass due to a disruption in the coordination of bone resorption and remodelling. Both bone resorption and bone formation are accelerated, and excessive bone resorption typically results in bone loss [32].

The bone tissue of the jaw, as an integral part of the skeletal system, responds to exogenous and endogenous factors affecting the human body. D. Knezovic Zlataric et al. (2007) analysed the systemic and local factors associated with alveolar bone loss. The study showed that osteoporosis, kidney disease and hormonal disorders were closely correlated with bone loss among systemic factors, and chronic periodontitis, early tooth loss and inadequate prosthetics among local factors [33, 34, 35].

The bone tissue of the alveolar ridge, as well as the skeleton, has been shown to be highly sensitive to hormonal disturbances in the body. Studies by dentists and osteologists have identified the role of hypoestrogenism in postmenopausal women in the development of systemic osteoporosis and pathological processes in the periodontium. Data from F. Sanfilippo, A.E. Bianchi (2013) confirm that ageing and oestrogen deficiency have a negative impact on tooth stability and residual alveolar ridge resorption. However, the authors emphasise that the change in the morphological structure of the edentulous maxilla is mainly due to mechanical factors as a result of changes in its function [36, 37].

Choël L. et al. (2016) assessed bone mineral density before implant placement. According to the authors, the cortical and trabecular bone of the mandible is more sensitive to systemic effects in women, whereas it is more sensitive to local effects in men. This is consistent with studies that have shown an association between osteoporosis and jaw bone loss [38, 39].

CONCLUSIONS

Thus, the literature shows that the resorptive processes associated with osteoporosis not only alter the bones of the supporting and peripheral skeleton, but also alter the structure of the bone tissue of the jaw. The introduction of a pathogenesis-based approach to treatment will allow significant progress to be made in the dental care of patients with primary osteoporosis.

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CONFLICT OF INTEREST

The Authors declare no conflict of interest

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RECEIVED: 20.05.2024
ACCEPTED: 25.11.2024