

White Papers

ORAL INFLAMMATION

Scientific Advisory Panel

Ray Williams, DMD
Chair, Department of Periodontology
University of North Carolina
School of Dentistry
Chapel Hill, North Carolina

Maria Emanuel Ryan, DDS, PhD
Professor and Director of
Clinical Research
Department of Oral Biology
and Pathology
SUNY at Stony Brook
School of Dental Medicine
Stony Brook, New York

Sara G. Grossi, DDS, MS,
Clinical Assistant Professor of
Oral Biology
SUNY at Buffalo
School of Dentistry
Buffalo, New York

Frank Scannapieco, DMD, PhD
Professor and Chair, Department
of Oral Biology
SUNY at Buffalo
School of Dentistry
Buffalo, New York

Michael Reddy, DMD
Professor and Chair, Department of
Periodontology
University of Alabama at Birmingham
School of Dentistry
Birmingham, Alabama

Rebecca Wilder, RDH, MS
Director, Graduate Dental Hygiene
Education Program
University of North Carolina
School of Dentistry
Chapel Hill, North Carolina

This article was prepared with the assistance of
BioMedCom Consultants, inc., Montreal, Canada.

Oral Inflammation and Osteoporosis

Elizabeth A. Krall, MPH, PhD, Professor, Director of Epidemiology Division
Boston University School of Dental Medicine

Bone loss is a central, common feature of both periodontal disease and osteoporosis. *Osteopenia*, or low bone mineral density (BMD), results when bone metabolism becomes unbalanced, with bone resorption by osteoclast cells occurring at a faster rate than bone production by osteoblast cells.¹ A woman with a BMD 2.5 standard deviations below the mean peak density for young women has osteoporosis, according to the definition of the World Health Organization.² Prevalence is higher in women than men and increases with age. About 35% of post-menopausal white women have osteoporosis of the hip, spine, or distal forearm; prevalence in Asian women is similar.³

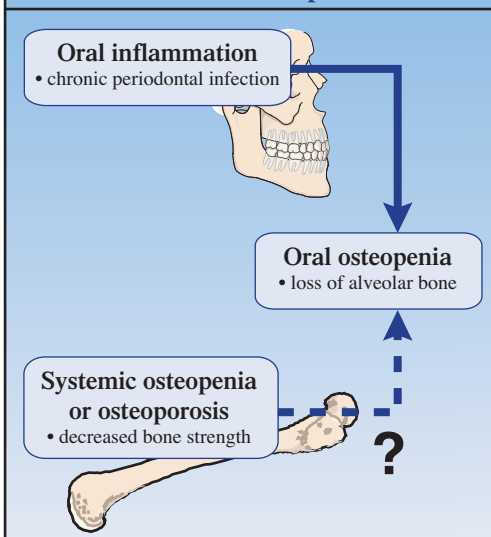
Increased risk of fracture associated with osteoporosis is a serious concern. After age 50, 50% of women and 25% of men will have an osteoporosis-related fracture, and the financial implications are significant. In 2002, for example, the direct cost of treating hip fractures was \$18 billion in the US alone.⁴

In periodontal disease, oral inflammation due to chronic infection of the tissue around the teeth results in destruction of oral bone and periodontal ligament (Figure 1), ultimately leading to tooth loss. Oral inflammation increases production of cytokines, such as interleukin-6, that stimulate osteoclast activity and promote bone resorption.⁵ A similar mechanism may contribute to osteoporosis, raising the question of whether people with low skeletal BMD are at increased risk of oral osteopenia (Figure 1). Several lines of evidence indicate that there is an association between osteoporosis and periodontal disease.

Common Risk Factors

First, there are risk factors common to both conditions. Both osteoporosis and periodontal disease become more prevalent with advancing age, and individuals with a family history are at higher risk.⁵ In women, estrogen deficiency increases the risk of both oral and systemic

Figure 1. Relationship between Oral Inflammation, Systemic Osteoporosis, and Oral Osteopenia



Adapted from Chesnut, 2001⁶

osteopenia.⁶ Smoking is a risk factor for, and hastens progression of, both conditions.^{5,6}

Cross-Sectional and Longitudinal Studies

Second, many studies have reported an association between systemic BMD and periodontal disease, regardless of whether the measure of periodontal status is clinical (*e.g.*, attachment loss, probing pocket depth), or radiographic (alveolar crestal height loss).⁵ Although studies of osteoporosis and clinical attachment level have produced mixed results, larger cross-sectional studies and at least two prospective studies support an association.⁵ For example, in a three-year longitudinal study, 70-year-old subjects were divided into osteopenia and non-osteopenia groups based on BMD of the heel at baseline.⁷ The number of sites with at least 3 mm of additional attachment loss after three years was significantly higher in the osteopenia group ($p =$

0.043).⁷ This study indicates that, in this older population, systemic BMD may be one factor in predicting periodontal disease progression.⁷ A positive association between low BMD and tooth loss has also been reported in many studies, and studies that found no association have generally been in younger populations.⁵

The relationship is not firmly established, however, because some studies report no association, and of those that do, most are cross-sectional, many have small sample sizes, and most do not control adequately for possible confounding factors, such as smoking status, postmenopausal hormone use, or treatment for periodontal disease.⁵ More prospective studies are needed.

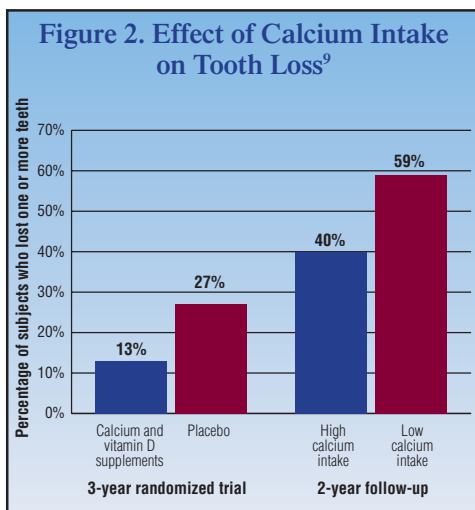
Therapies Affecting Both Osteoporosis and Periodontal Disease

Third, some interventions that improve systemic BMD also improve measures of periodontal disease.⁸ Improvement of the two conditions by the same therapies suggests an underlying connection. The three classes of therapy that have been implicated in this regard are 1) hormone replacement therapy (HRT), 2) diet supplementation with calcium and vitamin D, and 3) bisphosphonates.

HRT appears to improve oral bone density, and also leads to less bleeding on probing, less frequent clinical attachment loss, and less tooth loss.⁸ These effects are consistent with the benefit of HRT for systemic BMD.

Sufficient dietary calcium is essential for maintaining BMD, and low calcium intake may increase the risk of periodontal disease or hasten disease progression.⁸ Vitamin D aids calcium absorption from the intestine and regulates calcium metabolism. A three-year prospective, placebo-controlled trial of calcium and vitamin D supplementation in men and women over age 65 found that fewer subjects who received supplements lost at least one tooth (Figure 2, odds ratio for tooth loss = 0.4, $p < 0.05$).⁹ In a two-year follow-up period, fewer subjects consuming at least 1000 mg of calcium per day lost one or more teeth than those who consumed less calcium (Figure 2, odds ratio for tooth loss = 0.4, $p < 0.03$).⁹ These results support a potential benefit of calcium and vitamin D for improving periodontal disease.

Few studies have examined the impact of bisphosphonate therapy on periodontal outcomes. One prospective, double-blind trial in women aged 55–65 years who were not receiving HRT found greater improvement in probing depth and gingival bleeding in subjects receiving bisphosphonate alendronate than in those receiving placebo.¹⁰ Systemic BMD and alveolar crestal height increased in



the alendronate group but worsened in the placebo group.¹⁰ More studies of bisphosphonates are needed to confirm their impact on periodontal disease.

Possible Mechanisms

The above evidence supports an association between systemic BMD and periodontal disease. The mechanisms underlying this association, however, are unknown. Patients with low systemic BMD may also have low oral BMD, allowing periodontal disease to progress more rapidly because there is simply less oral bone present.⁵ A second possibility is that osteoporosis and bone loss due to periodontal disease both proceed by the same cellular mechanism, namely increased production of cytokines, such as interleukin-6, that stimulate osteoclast activity.¹ Genetics may also play a role, in that patients predisposed to BMD loss may also be more likely to suffer periodontal damage.⁵ Finally, certain lifestyle factors may increase a patient's risk of bone loss and periodontal disease.⁵

Regardless of the mechanism, patients with low systemic BMD appear to be at higher risk for progression of periodontal disease. Therefore, it is especially important for patients who have osteoporosis or who are at high risk for systemic bone loss to prevent oral inflammation through good oral hygiene, including daily brushing with an antibacterial dentifrice, such as Colgate® Total® Toothpaste. Colgate® Total® uses a copolymer to improve retention of the antibacterial agent triclosan on oral surfaces, resulting in antibacterial and antiplaque activity for as long as 12 hours after brushing.¹¹ Colgate® Total® also directly inhibits potent inflammatory mediators,¹² helping to keep oral inflammation under control.¹³

Conclusion

Although mechanisms explaining the association between periodontal disease and

osteoporosis have been suggested, it is unknown if one of these conditions helps cause the other, if they are independently caused by the same factors, or if the association is coincidental. More prospective longitudinal studies, ideally intervention trials, are needed to understand this relationship. Given the increasing worldwide prevalence of osteopenia and osteoporosis, a full understanding of the precise relationship between these two diseases is necessary. Measures commonly used to prevent and treat systemic bone loss may have a beneficial impact on the oral health of the population as well.

References

- Mundy GR. Cellular and molecular regulation of bone turnover. *Bone* 1999;24(5 Suppl):35S-38S.
- Assessment of fracture risk and its application to screening for postmenopausal osteoporosis. Geneva: World Health Organization; 1994. Report No. WHO Technical Report Series No. 843.
- Melton LJ, III. Epidemiology worldwide. *Endocrinol Metab Clin North Am* 2003;32(1):1-13, v.
- Fast facts on osteoporosis. National Osteoporosis Foundation website (updated 2005; cited 2005 Jul 22). Available from: <http://www.nof.org/osteoporosis/diseasefacts.htm>.
- Wactawski-Wende J. Periodontal diseases and osteoporosis: Association and mechanisms. *Ann Periodontol* 2001;6(1):197-208.
- Chesnut CH, III. The relationship between skeletal and oral bone mineral density: An overview. *Ann Periodontol* 2001;6(1):193-196.
- Yoshihara A, Seida Y, Hanada N, Miyazaki H. A longitudinal study of the relationship between periodontal disease and bone mineral density in community-dwelling older adults. *J Clin Periodontol* 2004;31(8):680-684.
- Krall EA. The periodontal-systemic connection: Implications for treatment of patients with osteoporosis and periodontal disease. *Ann Periodontol* 2001;6(1):209-213.
- Krall EA, Wehler C, Garcia RI, Harris SS, Dawson-Hughes B. Calcium and vitamin D supplements reduce tooth loss in the elderly. *Am J Med* 2001;111(6):452-456.
- Rocha ML, Malacara JM, Sanchez-Marin FJ, Vazquez de la Torre CJ, Fajardo ME. Effect of alendronate on periodontal disease in postmenopausal women: A randomized placebo-controlled trial. *J Periodontol* 2004;75(12):1579-1585.
- Gaffar A, Afflitto J, Nabi N, Herles S, Kruger I, Olsen S. Recent advances in plaque, gingivitis, tartar and caries prevention technology. *Int Dent J* 1994;44(Suppl 1):63-70.
- Gaffar A, Scherl D, Afflitto J, Coleman EJ. The effect of triclosan on mediators of gingival inflammation. *J Clin Periodontol* 1995;22(6):480-484.
- Davies RM, Ellwood RP, Davies GM. The effectiveness of a toothpaste containing triclosan and polyvinyl-methyl ether maleic acid copolymer in improving plaque control and gingival health: A systematic review. *J Clin Periodontol* 2004;31(12):1029-1033.



This series is brought to you by
Colgate® Total® -
12-Hour Antibacterial plus
Anti-inflammatory Protection.