



The Influence of Vitamin D and Calcium Supplements on Tooth Stability in Elderly: Systematic Review

Noha Algallai^{1*}

¹*School of Health Professions, Rutgers University, New Jersey, USA.*

Author's contribution

The sole author designed, analysed, interpreted and prepared the manuscript.

Article Information

Editor(s):

(1) Dr. M. Jaya Nagendra Krishna, Kamineni Institute of Dental Sciences, India.

Reviewers:

(1) Thais de Rezende Bessa Guerra, Instituto de Nutrição do Cérebro e Coração (INCCOR), Brazil.

(2) Rosario Almanzar, Instituto Tecnológico de Santo Domingo (INTEC), Dominican Republic.

Complete Peer review History: <http://www.sdiarticle4.com/review-history/63732>

Review Article

Received 05 October 2020
Accepted 10 December 2020
Published 26 December 2020

ABSTRACT

Background: Vitamin D is a fat-soluble vitamin that is available hardly ever in food, and can be available as a supplement. Furthermore, it is formed endogenously when rays from the sun strike the skin and prompt vitamin D synthesis. Vitamin D motivates the absorption of calcium in the intestine and maintains adequate serum calcium and phosphate concentrations to allow bone mineralization and to prevent hypocalcemia. Periodontitis is an inflammatory disease, described by losing in alveolar bone prompted by the immune response to bacterial invasion. Since vitamin D is associated with some inflammatory disorders and has a significant role in bone homeostasis, its insufficiency could affect the periodontium in a negative way and increase tooth loss that will assume vitamin D has an important role in decreasing the risk of periodontitis. The purpose of this study is to determine the effectiveness results of vitamin D and Calcium supplements in reducing tooth loss and improving the tooth retention.

Methods and Materials: This research is a systematic review that includes varies studies design of randomized controlled trials, cohort studies, cross-sectional studies and case-control studies that conducted in period (2000-2016). Among 25 studies, 8 studies have included in this systematic review

Results: The findings were got by varies statistical methods including logistic regression, and t-tests, and most of them showed the statically significant between Vitamin D supplements and reduce tooth loss.

*Corresponding author: Email: nea42@shp.rutgers.edu;

Conclusion: In conclusion, the studies presented the robust relation between vitamin D insufficiency intake and tooth loss. Intake both of vitamin D and calcium can associate inversely with periodontitis

Keywords: Periodontitis; vitamin D; calcium supplement; tooth loss.

1. INTRODUCTION

Vitamin D is a fat-soluble vitamin that is available rarely in food, and can be available as a supplement. Furthermore, it is formed endogenously when rays from sun strike the skin and prompt vitamin D synthesis. Vitamin D motivates the absorption of calcium in the intestine and maintains adequate serum calcium and phosphate concentrations to allow bone mineralization and to prevent hypocalcaemia. In addition, it is required for bone development and bone remodeling that has done by both of osteoblasts and osteoclasts [1]. If there is insufficient amount of vitamin D, the bone can become tinny, brittle, or distorted. Vitamin D adequacy avoids the occurrence of rickets in children and osteomalacia in grown people with calcium, vitamin D also helps protect older adults from osteoporosis [2].

Periodontal disease is a set of inflammatory diseases with the equal end results; start with gingivitis, destruction of the periodontal ligament, and ends with loss of supported alveolar bone which prompted by immune response to bacterial invasion and eventually lead to tooth loss. Since vitamin D is related to some inflammatory disorders and has a significant role in bone homeostasis, its insufficiency could affect the periodontium in negative way and increase tooth loss. Therefore, it will assume that vitamin D has an important role in decreasing the risk of periodontitis. Vitamin D stimulates calcium absorption; the active form of vitamin D, $1\alpha,25\text{-dihydroxyvitamin}$, play role as an immune-modulator because of its anti-inflammatory and antimicrobial properties that can inhibit the inflammatory response through cytokine production and prompt of monocytes and macrophages for antibacterial action; another role of vitamin D in periodontal health is that polymorphisms of the vitamin D receptor gene are related to periodontitis and its associations. These roles are hypothetically encouraging for the treatment periodontitis [3].

The deficiency of vitamin D is more related to elderly people that will lead to bone loss and muscle failure [4].

Many studies have presented tooth loss and its relation with low bone density. From this point, the purpose of this study is to determine the effectiveness and influence of vitamin D and Calcium supplements in reducing tooth loss and improve tooth retention in healthy elderly people.

2. SOME LITERATURE REVIEWS

Varies studies design of; randomized controlled trials, cohort studies, cross-sectional studies and case-control conducted in period (2000-2016). Among 25 studies were searched in Pubmed and Google Scholar, 8 studies have included in this systematic review.

These studies established the relation between vitamin D deficiency and tooth loss from these studies; a study was conducted in 2000 to evaluate the effect of withdrawal of calcium and vitamin D supplements on bone mass in elderly men and women. Bess Dawson-Hughes et al. [5] conducted this study to determine whether rises in bone mineral density stimulated by supplementation of calcium and vitamin D remain after removing of supplements. The study involved 295 old men and women who are healthy with ages $>$ or $=$ 68 years old, and ended a randomized clinical trial in 3 years period. Those participants were followed for about additional 2 years without calcium and vitamin D supplements administration. Bone mineral density was measured by absorption of an X-ray which has dual-energy. In addition, variables that related to the metabolism of calcium and bone turnover were also measured. In findings, the authors found out that in 128 males, small benefits in whole-body bone mineral density were remained. However, the stimulation of supplements in spinal and femoral neck were lost in 2 years of calcium and vitamin D supplements discontinuation. On other hand, in the 167 females, there were no benefits lasted in total-body bone mineral density. Therefore, they concluded that discontinuation in calcium and vitamin D supplements has inadequate cumulative effect on bone mass in both men and women their ages $=$ or $>$ 68 years old. However, the findings show that vitamin D and calcium supplements play an important role in reducing tooth loss.

In 2001, Elizabeth A. Krall et al. executed a study that was investigated whether there is a relationship between bone loss which lead to tooth loss and bone loss in sites that are non-oral [6]. Therefore, they examined tooth loss in 145 subjects who have a good health status. Their ages 65 years and older who finished a 3-year, randomized, placebo-controlled trial which achieved to evaluate the effect of both calcium and vitamin D supplementation on bone loss of the hip, as well as a 2-year follow-up study after cessation of study supplements. In this study teeth were calculated at 18 months and 5 years. They used stepwise multivariate logistic regression to estimate tooth loss. They found out that within the study, 11 out of 82 participants in treatment group and 17 out of 63 participants in placebo group lost one or more teeth. These results recommend that consumption levels of calcium and vitamin targeted at inhibiting osteoporosis have a beneficial influence on tooth retention.

Diana E. Moedano et al. [7] also conducted a study in Mexico in 2009 to determine that osteoporosis is the risk of fracture of vertebra, and periodontitis in old people. The purpose of this study is to determine the relationship among osteoporosis, fracture risk and periodontal disease. Study method was done by participation of patients their ages 60 years old and more from the Mexican National Medical Science and Nutrition Institute Salvador Zubira. These participants had been referred by physicians of the clinic of this institute due to a doubt of osteoporosis. To evaluate osteoporosis and vertebral fracture, dual-energy X-ray absorptiometry (DXA) was used. In addition, a modified version of the extent and severity index (ESI) was used to assess periodontitis and whole teeth were inspected. The findings of this study had shown that 166 patients were examined. The Mean age was 69.1 years (variety 60 to 85 years; Standard deviation (SD) 6.7); 147 (88.6%) were women; 47.0% of them had osteoporosis and about 38.6% had a high risk of fracture. 19 (11.4%) were men. Logistic regression models used to determine severity and level of periodontal disease and tooth loss. The model for periodontitis exhibited the relation between oral hygiene and osteoporosis medication. ESI showed the relation among smoking, osteoporosis and osteoporosis medication. The model of losing tooth identified a relationship between risk of fracture and osteoporosis medication. In Conclusion, Periodontal disease

degree was related with osteoporosis, and loss of tooth with risk of fracture.

Another study conducted by Paulo Sergio et al to evaluate the association between tooth loss and bone mineral density in Brazilian postmenopausal women according to dental index of decayed, missing, filled teeth (DMFT) and density of bone mineral (BMD) in 2011 [8]. They used a cross-sectional study on 100 women in post-menopause stage at Center of Integral Attention to Women's Health facility (CAISM) to assess DMFT and its correlations with both lumbar and femoral BMD. These women experienced densitometry test in 3 years prior the assessment and were amenorrhea for as a minimum 12 months. They analyzed the covariance and multiple logistic regressions in addition to the mean and standard deviation. They found out that the analysis of covariance shown significant correlation between the DMFT index and bone mass, in comparison to the young people ($P = 0.0252$) and also in bone mass (below average) and in the index of DMFT ($P = 0.0332$), and for women who have bone mass below the average index DMFT was more. The results of the study shown that postmenopausal females with poor and not good oral hygiene may suffer reduced bone mass. In addition, there was statistically significant correlation between bone mineral density and DMFT. These females had better to be educated regarding their oral hygiene, bone mass should also be considered in their concerns.

E.N. Alshouibi et al. conducted a study in 2013 to determine vitamin D and periodontal health in old males [9]. They used cross sectional study to estimate the relationship between intake of vitamin D and the health of periodontal tissue in old males. 562 subjects who are members of the department of Veterans Affairs Dental Longitudinal Study, age mean 62.9 years old were inspected from 1 to 4 times between years 1986 and 1998. The inspector measured pocket depth by probe on each tooth. Bone loss surround tooth was evaluated from x rays. Severe bone loss was distinct as ≥ 5 mm at more than 1 site and moderate-to-severe alveolar bone loss as at ≥ 3 sites. Generalized estimating equations were used in this study to estimate the odds ratios and 95% confidence intervals. Vitamin D intake ≥ 800 IU was correlated with decrease odds of severe bone loss. Intake of vitamin D may reduce severity of bone loss.

Additional study was performed in Boston by Monik Jimenez et al. to predict vitamin D status and incidence of tooth loss and periodontitis in 2014 [10]. They concentrated in this study on insufficiency of vitamin D which is highly dominant, with certain subcategories at more risk such as the elderly and people with darker skin, so they evaluated the correlation between a score of plasma 25-hydroxyvitamin D (25(OH)D) and occurrence of tooth loss. They performed biennial questionnaires which were gathered on medical history, lifestyle and tooth loss. The score was derivative from some variables have effect on concentrations of plasma 25(OH) D and endorsed against concentration of plasma among a sub-group. Multivariable Cox proportional-hazards models assessed the correlation between the vitamin D score and period until loss first tooth. 42730 participants aged 40-75 years old followed from 1986-2006. The researchers observed 13 581 tooth loss incidence from about 539335 individuals. There was a dependent dose significant opposite correlation of the 25(OH) D score and incidence of tooth loss. In conclusions, the findings of this study were indicated of correlation between score of vitamin D and decrease incidence of tooth loss.

Another study in Buffalo was conducted by Amanda RA Adegboye et al. [11] to evaluate of

the association of calcium, vitamin D, casein and whey protein intakes and periodontitis among Danish people. The purpose of this study is to evaluate whether Calcium and vitamin D, casein and whey intake are related to periodontitis and to evaluate the probability of interactions between them. This study was a cross-sectional study, and it is an Internet-based, 267-item of food frequency questionnaire was used to estimate intake of diet which included intakes of casein (32.0g/d), whey proteins (9.6g/d) and vitamin D (5.8µg/d). Severe bone loss surround the tooth was defined as ≥ 2 inter-proximal sites with clinical attachment loss ≥ 6 mm and ≥ 1 inter-proximal site with depth of pocket ≥ 5 mm. because vitamin D affects Ca absorption, the models were divided by lower and higher (< 5.8 v. ≥ 5.8 µg/d) vit D intake. The subjects (n 3287) were involved in 2007–2008. The authors found out that intakes of Calcium, whey ≥ 9.6 g/d and casein ≥ 32 g/d were related with lower risk of tooth loss after adjustment for gender, age, education, smoking, sugar intake, consumption of alcohol, number of teeth, brushing, regular visits to the dentist and chronic diseases. Vitamin D alone intake was not related to reduce the risk of tooth loss. Therefore, the authors concluded that vitamin D along with calcium intake, casein and whey protein were in reverse related to periodontitis.

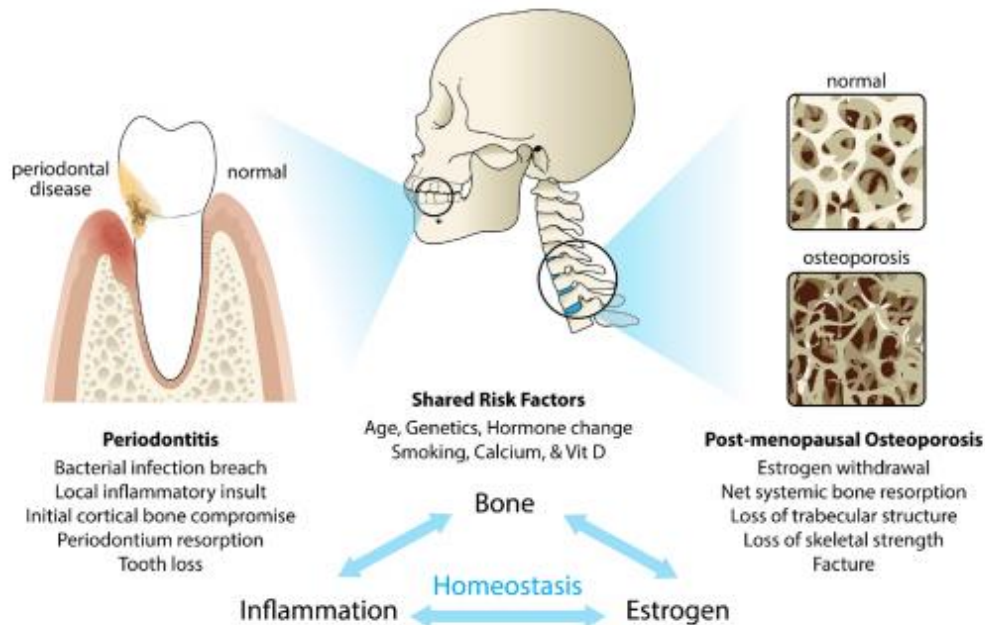


Fig. 1. Association between periodontitis and osteoporosis

Furthermore studies were done regarding Osteoporosis and Periodontitis. This report was conducted in 2016 in New York by Chin-Wei (Jeff) Wang & Laurie K. McCauley. In this report, the authors investigated from various studies that described both osteoporosis and periodontitis as an inflammation condition which characterized by destruction of the bone. They mentioned some cross-sectional studies that have confirmed the relationship between osteoporosis and periodontitis by both radiographic and clinical measurements, and some risk factors that can have effect on them such as age, genetic, and hormonal factors. Prevention and treatment of both diseases required comprehensive approaches and controlling for clinical guidelines (Fig. 1) [12].

3. DISCUSSION

According to Dawson-Hughes B et al., this study indicated that the enhancements in bone mineral density (BMD) detected in participants who were supplemented with calcium and vitamin D were lost when this supplementation was stopped. A simple benefit to BMD remained after 2 years in men, but there was no residual benefit at the lumbar vertebrae and the femoral neck in men or women. For both the men and women, the decrease in the rate of bone remodeling that occurred with the treatment was also lost in both genders. Calcium and vitamin D supplement use through the follow-up period had no effect on the results, may be due to the amounts that taken were less than those taken during the intervention study and possibly because of irregular use. It is possible the concentration of estrogen, known to be greater in men than in women at this age, may have improved dietary calcium use [13,14] in the men. This study had some limitations such as; the sample size is not large, so that will affect the external validity of the study. In addition, this study does not have enough information about the drop off of the participants.

Elizabeth A. Krall et al. performed a study to investigate whether there is a relationship between bone loss which lead to tooth loss and bone loss in sites that are non-oral. In this study, they used stepwise multivariate logistic regression to estimate tooth loss. The findings recommend that consumption levels of calcium and vitamin targeted at inhibiting osteoporosis have a beneficial influence on tooth retention.

According to Diana E. Moedano et al's study, there is a probability of selection bias assumed in

patients approached from a hospital's site. [15] In the periodontal assessment, not all sites of the tooth were measured in order to avoid the discouraging of subjects to participate in the study due to a prolonged oral examination. That could underestimate periodontal destruction. According the reports in Mexico, 42% of the inhabitants is poor, [16] and the most of subjects in this study had a low socio-economic level, so that was not allowed the identification of their periodontal issues.

Side effect of bisphosphonate' treatment is osteonecrosis of the jaw. On other hand, there were cases had some osteonecrosis related to bisphosphonates by oral administration. [17] for the patient's safety, it is recommended to do dental exam and provide dental treatment prior the initiation of bisphosphonate regimen.

In Paulo Sergio's study, the main result of this study pointed to "the associations between the dental index of decayed, missing, filled teeth (DMFT index) and bone mass change (T-score) when measured in L2-L4, between DMFT index and extracted component and the bone mass below-average (g/cm^2)"⁸. The matrixes analysis which was achieved in this study showed that women with changed bone mass in lumbar spine had greater Decayed, Missing, and Filled Teeth (DMFT) index. In addition, there was an increase in the density of bone mineral and decrease in risk of tooth loss [18,19].

Alshouibi et al 's study also was done to examine the relations between vitamin D intake and severe periodontitis as well as moderate-to-severe alveolar bone loss. They found proof of a relationship of vitamin D intake on the measures of periodontitis. The strengths of this study were in the use of a cohort study to outcomes of both medical and dental as well as risk factors, and multivariate generalized estimating equation (GEE) models, but the limitations were in the design of the study and analysis exist. The nonexistence of women and the lack of racial and ethnic diversity limit the generalization of the findings. Also, vitamin D intake was assessed from questionnaires of food frequency, which rank participants according to intake level, but that not provide precise estimations of the intakes. The results of this study recommend that up keeping of vitamin D intake in the recommendation levels, whether by diet or supplementation, could be a harmless and effective way of decreasing the prevalence of periodontal disease.

Monik Jimenez et al did the longest study to evaluate the association between predictors of 25(OH) D and occurrence of tooth loss and periodontal disease. Significant strengths of this study comprise a prediction score use that did not substitute plasma measurements, but has been displayed to predict about a 10 ng/ml difference in true 25(OH) D at extravagances, representing a physiologically increment [20]. Moreover, the power of study was increased by biomarker samples use. Also, the confounding by socioeconomic status and health manners were reduced due to the longitudinal design with 20 years of follow-up.

Amanda RA Adegboye et al showed in their study that greater intakes of calcium, whey protein and casein were separately related to decrease the occurrence of severe periodontitis, after amendments for age, education, gender, smoking, sucrose intake, teeth number, routine brushing, regular visits to the dentist. Deficiency of vitamin D is a risk factor for many illnesses with inflammatory constituents. A randomized clinical trial presented decreases in inflammatory markers with greater vitamin D at baseline and after taking the supplementation [21].

Chin-Wei & Laurie K. McCauley examined the association between osteoporosis and periodontitis. Osteoporosis and periodontitis are both diseases with extreme bone destruction. Many shared risk factors were present, and their effect was developed. Clinical studies are required to establish the evidence for efficient managing of both diseases. Handling both diseases concurrently may have a positive effect for enhanced consequences for interdisciplinary care. Clinicians should be aware of both diseases to make the appropriate transfers for co-management of the diseases.

4. CONCLUSION

Tooth loss has a significant impact on old people. Beside the psychological effect on them, it requires them more expensive techniques to replace their missing teeth such as implant, bridges, and dentures.

The studies presented the robust relation between vitamin D insufficiency intake and tooth loss. Intake both of vitamin D and calcium can associate inversely with periodontitis. Dentists should aware their patients about recommended level of vitamin D.

Given that periodontitis is a chronic disease that progresses over time, further longitudinal studies needed to confirm this association.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Author has declared that no competing interests exist.

REFERENCES

1. Ann Cranney, Tanya Horsley, Siobhan O'Donnell, Hope Weiler, Lorri Puil, Daylily Ooi et al. Effectiveness and safety of vitamin D in relation to bone health. *Evid Rep Technol Assess.* 2007;158:1-235.
2. Institute of Medicine, Food and Nutrition Board. *Dietary Reference Intakes for Calcium and Vitamin D.* Washington, DC: National Academy Press, 2010. Available: [Vitamin-D-and-Calcium-2010-Report-Brief.pdf \(nap.edu\)](#).
3. Garcia N, Miley D, Dixon DA. Vitamin D and periodontal disease. *Handbook of vitamin D in human health.* 2013;242-253.
4. Leif Mosekilde. Vitamin D and the Elderly. *Clin Endocrinol.* 2005;62(3):265-281. Available: [Medscape](#) http://www.medscape.com/viewarticle/500874_4.
5. Dawson-Hughes B, Harris SS, Krall EA, Dallal GE, et al. Effect of withdrawal of calcium and vitamin D supplements on bone mass in elderly men and women. *Am J Clin Nutr.* 2000;72:745-750.
6. Elizabeth A. Krall PhD, Carolyn Wehler RDH, BS, et al. Calcium and Vitamin D Supplements Reduce Tooth Loss in the Elderly. *The American Journal of Medicine.* 2001;111(6):452-456.
7. Diana E Moedano, Maria E Irigoyen, Aida Borges-Yañez, Ismael Flores-Sánchez, Ricardo C. Rotter. Osteoporosis, the risk of vertebral fracture, and periodontal disease in an elderly group in Mexico City. *Gerodontology.* 2011;28:19-27.

8. Paulo Sergio, Gomes Henriques, Aarao Mendes, Pinto Netob. Association Between Tooth Loss and Bone Mineral Density in Brazilian Postmenopausal Women. *J Clin Med Res.* 2011;3(3):118-123
9. Alshouibi EN, Kaye EK, Cabral HJ, Leone CW, Garcia RI. Vitamin D and Periodontal Health in Older Men. *J Dent Res.* 2013; 92(8):689-693.
10. Monik Jimenez, Edward Giovannucci, Elizabeth Krall Kaye, Kaumudi J Joshipura, Thomas Dietrich. Predicted vitamin D status and incidence of tooth loss and periodontitis. *Public Health Nutr.* 2014;17(4):844-52.
11. Amanda Ra Adegboye, Barbara J Boucher, Johanne Kongstad, Nils-Erik Fiehn, Lisa B Christensen, Berit L Heitmann. Calcium, vitamin D, casein and whey protein intakes and periodontitis among Danish adults. *Public Health Nutr.* 2016;19(3):503-10.
12. Chin-Wei (Jeff) Wang, Laurie K McCauley. Osteoporosis and Periodontitis. *Curr Osteoporos Rep.* 2016;14:284–291.
13. R Civitelli, Agnusdei D, Nardi P, Zacchei F, Avioli LV, Gennari C. Effects of one-year treatment with estrogens on bone mass, intestinal calcium absorption, and 25-hydroxyvitamin D-1 alpha-hydroxylase reserve in postmenopausal osteoporosis. *Calcif Tissue Int.* 1988; 42(2):77-86.
14. Gennari C, Agnusdei D, Nardi P, Civitelli R. Estrogen preserves a normal intestinal responsiveness to 1,25-dihydroxyvitamin D3 in oophorectomized women. *J Clin Endocrinol Metab.* 1990;71(5):1288-93.
15. Woodward M. *Epidemiology: Study Design and Data Analysis*, 2nd edn. Boca Raton, US: Chapman and Hall/CRC text in statistical science series; 2005.
16. World Bank. Poverty in Mexico. Available: Fact Sheet. <http://web.worldbank.org/WBSITE/EXTERNAL>, [accessed on June 28, 2009].
17. Yarom N, Yahalom R, Shoshani Y, et al. Osteonecrosis of the jaw induced by orally administered bisphosphonates: incidence, clinical features, predisposing factors and treatment outcome. *Osteoporos Int.* 2007; 18:1363–1370.
18. Dietrich T, Joshipura KJ, Dawson-Hughes B, BischoffFerrari HA. Association between serum concentrations of 25-hydroxyvitamin D3 and periodontal disease in the US population. *Am J Clin Nutr.* 2004;80(1): 108-113.
19. Drozdowska B, Pluskiewicz W, Michno M. Tooth count in elderly women in relation to their skeletal status. *Maturitas.* 2006;55(2): 126-131.
20. Bertrand KA, Giovannucci E, Liu Y, et al. Determinants of plasma 25-hydroxyvitamin D and development of prediction models in three US cohorts. *Br J Nutr.* 2012;108: 1889–1896. [PubMed: 22264926]
21. Timms PM, Mannan N, Hitman GA et al. Circulating MMP9, vitamin D and variation in the TIMP-1 response with VDR genotype: Mechanisms for inflammatory damage in chronic disorders? *QJM.* 2002;95:787–796.

© 2020 Algallai; This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Peer-review history:
The peer review history for this paper can be accessed here:
<http://www.sdiarticle4.com/review-history/63732>