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Nutrition In Orthodontics: A Review

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Abstract

Nutrition plays a critical role in influencing the biological, mechanical, and clinical aspects of orthodontic treatment. Adequate intake of macro- and micronutrients supports bone remodeling, collagen synthesis, and periodontal health, facilitating efficient orthodontic tooth movement (OTM). Deficiencies in essential nutrients such as calcium, vitamin D, and trace minerals can delay tooth movement, increase root resorption risk, and compromise periodontal stability. Bioactive food components like omega-3 fatty acids and flavonoids exhibit anti-inflammatory and antioxidant effects, enhancing tissue healing and reducing orthodontic-induced inflammation. Dietary modifications, including a soft yet nutrient-dense diet, protect appliances while maintaining nutritional adequacy. Integrating nutritional counseling and digital dietary tracking into orthodontic practice optimizes treatment efficiency, reduces complications, and promotes long-term stability. Overall, nutritioncentered orthodontic care strengthens the biological foundation of tooth movement and enhances treatment outcomes.

Keywords: Orthodontic tooth movement, Nutrition, Bone remodeling, Micronutrients, Dietary counseling

Introduction

Orthodontic treatment involves the application of controlled mechanical forces to teeth, stimulating their movement through the alveolar bone via a complex process of cellular and molecular remodeling primarily mediated by the periodontal ligament (PDL) and surrounding bone structures.[1] The biological basis of orthodontic tooth movement (OTM) relies on the coordinated activity of osteoclasts and osteoblasts in response to pressure and tension zones created within the PDL where bone resorption occurs on the pressure side and bone deposition takes place on the tension side resulting in progressive tooth displacement while preserving periodontal attachment integrity.[2] This remodeling process proceeds through distinct phases: an initial phase of rapid movement, a lag phase with minimal displacement, and a final phase characterized by steady tooth migration. Key signaling pathways, including cytokines (IL-1β, TNF-α), prostaglandins, and the RANK/RANKL/OPG system, regulate osteoclastic and osteoblastic activity, ensuring a balanced bone turnover in response to orthodontic forces.[3] The PDL acts as a mechanotransducer, converting physical stress into biochemical signals that initiate adaptive responses in osteocytes, osteoblasts, and osteoclasts, with controlled inflammation serving as an essential yet finely regulated component of this process. Both systemic and local factors influence OTM systemic parameters such as age, hormonal status, nutritional adequacy, and systemic diseases (e.g., osteoporosis, diabetes) can significantly alter the rate and quality of bone remodeling, while local factors such as the magnitude and duration of force application, bone density, and periodontal health directly determine the biological efficiency of tooth movement.[4] Among these, nutrition plays a pivotal role by supporting bone metabolism, maintaining healthy oral tissues, and enhancing the biological environment necessary for optimal orthodontic outcomes. Adequate intake of calcium, vitamin D, and phosphorus strengthens bones and teeth and supports active bone

remodeling, while protein facilitates tissue repair and collagen synthesis.[5] Vitamins A and C contribute to soft tissue healing and periodontal integrity, whereas fibrous fruits and vegetables like apples, carrots, and celery promote mechanical cleaning and stimulate saliva production to aid in maintaining oral hygiene.[6] For orthodontic patients, a well-balanced diet rich in fruits, vegetables, lean proteins, dairy, and whole grains is essential, while minimizing sticky, hard, or sugary foods helps prevent appliance damage, enamel demineralization, and soft tissue irritation.[7]

Nutritional and Cellular Determinants of Tooth Movement in Orthodontics

Orthodontic Tooth Movement (OTM) represents a complex biological process in which controlled mechanical forces applied to teeth are converted into cellular and molecular responses within the periodontal ligament (PDL) and alveolar bone, resulting in progressive tooth displacement.[6] According to the pressure-tension theory, the application of orthodontic forces generates two distinct zones within the PDL: a pressure side where compression activates osteoclast-mediated bone resorption to clear the path for movement, and a tension side where stretching stimulates osteoblast activity, leading to new bone formation that stabilizes the tooth in its new position.[7] This dynamic remodeling process maintains the structural integrity of the attachment apparatus while enabling controlled movement. The biological interplay is primarily regulated by osteoclasts, osteoblasts, and a network of inflammatory mediators such as cytokines (IL-1β, TNF-α), prostaglandins, and the RANK/RANKL/OPG signaling pathway, which collectively coordinate bone resorption and deposition. In this context, inflammation is a controlled, sterile response essential for effective bone remodeling without pathological tissue damage.[8] Nutrition plays a crucial modulatory role in this process, as adequate intake of key nutrients such as calcium and vitamin D supports bone mineralization and osteoblastic activity, while proteins contribute to collagen synthesis in the PDL and bone matrix, ensuring structural resilience. Vitamins A and C further enhance tissue healing and maintenance, promoting a balanced cellular environment conducive to optimal tooth movement.[9] Conversely, nutritional deficiencies can disrupt the equilibrium between osteoclast and osteoblast function, leading to slower remodeling rates, prolonged treatment duration, and higher susceptibility to periodontal complications.[10] Therefore, optimal nutritional status not only accelerates the biological mechanisms underlying OTM but also enhances treatment efficiency, tissue health, and overall orthodontic outcomes, underscoring the integral link between nutrition and the biomechanics of tooth movement.[11]

Nutritional Requirements During Orthodontic Therapy

Nutrition is a vital determinant of successful orthodontic treatment, as it supports the biological mechanisms and tissue responses involved in tooth movement, bone remodeling, and oral health maintenance. Adequate intake of macronutrients and micronutrients ensures efficient collagen synthesis, controlled inflammation, and proper healing of the periodontal ligament (PDL) and surrounding tissues subjected to mechanical stress.[12] Among macronutrients, proteins play a central role in collagen formation and tissue repair, essential for recovery from the microtrauma and inflammation induced by orthodontic forces, while carbohydrates provide the primary energy source for cellular metabolism but must be consumed in moderation to prevent plaque accumulation and enamel demineralization, which are common risks during fixed appliance therapy.[12] Fats, particularly essential fatty acids, aid in the regulation of inflammatory mediators, thereby promoting balanced tissue remodeling and healing responses. Micronutrients are equally crucial calcium and phosphorus are indispensable for bone mineralization and maintaining alveolar bone density, preventing root resorption and ensuring effective tooth movement, while vitamin D enhances calcium absorption and promotes osteoblastic activity critical for bone turnover.[13] Vitamin C supports collagen synthesis, gingival health, and connective tissue repair through its antioxidant and anti-inflammatory properties. Minerals like magnesium and zinc contribute to enzymatic activation, osteoblastic function, and cellular regeneration, all necessary for continuous bone and tissue remodeling.[14] Furthermore, iron facilitates oxygen transport and immune function, while B-complex vitamins support energy metabolism and preserve the integrity of oral mucosa, enhancing the resilience of soft tissues throughout treatment.[15]

Table: Nutritional Requirements During Orthodontic Therapy

Nutrient Type	Key Nutrients	Physiological Role in Orthodontic Therapy	Clinical Importance / Effects	Food Sources
Macronutrients	**Proteins**	Promote collagen synthesis and tissue repair in the PDL and surrounding structures	Aid healing of microtrauma and adaptation of tissues during tooth movement	Eggs, lean meats, dairy, legumes, pulses
	Carbohydrates	Provide primary energy for cellular metabolism	Excess intake increases plaque and risk of enamel demineralization; moderation required	Whole grains, fruits, vegetables
	Fats (Essential Fatty Acids)	Regulate inflammatory response during tissue remodeling	Support controlled inflammation and promote healing	Fish, nuts, flaxseeds, olive oil
Micronutrients	**Calcium & Phosphorus**	Ensure bone mineralization and alveolar bone density	Prevent root resorption and support stable tooth movement	Milk, cheese, yogurt, leafy greens
Nutrient Type	**Key Nutrients**	**Physiological Role in Orthodontic Therapy**	**Clinical Importance / Effects**	**Food Sources**
	Vitamin D	Enhances calcium absorption and promotes osteoblastic activity	Deficiency slows tooth movement and weakens bone quality	Sunlight exposure, fortified milk, fish
	Vitamin C	Supports collagen formation and gingival health	Promotes tissue repair and reduces inflammation in PDL	Citrus fruits, berries, tomatoes, bell peppers
	Magnesium & Zinc	Participate in enzymatic reactions and bone metabolism	Enhance osteoblastic function and cellular turnover	Nuts, seeds, whole grains, spinach

	Iron & Vitamin B Complex	Iron aids oxygen transport; B vitamins support energy metabolism and mucosal integrity	Promote tissue health, immune support, and healing	Red meat, eggs, legumes, leafy vegetables

Impact of Nutritional Deficiencies on Orthodontic Treatment

Nutritional deficiencies during orthodontic therapy can profoundly affect both the biological mechanisms governing tooth movement and overall oral health, leading to delayed treatment progress and compromised outcomes. Adequate bone metabolism is essential for efficient orthodontic tooth movement (OTM), and deficiencies in key nutrients such as calcium, phosphorus, vitamin D, magnesium, copper, and manganese can disrupt bone remodeling, resulting in slower tooth displacement and impaired alveolar adaptation.[16] In particular, vitamin D deficiency hampers calcium absorption, causing poor bone mineralization, rickets, and maxillary dysplasia, which can interfere with facial suture closure and contribute to malocclusions like open bites and narrow maxillae.[17] Similarly, copper and manganese play vital roles in enzymatic reactions that regulate bone turnover, and their inadequacy diminishes remodeling efficiency, prolonging orthodontic treatment. Deficiencies in vitamin C and Bcomplex vitamins impair collagen synthesis, vascular integrity, and immune response, increasing the risk of gingival inflammation, mucosal ulcerations, and delayed soft tissue healing, all of which compromise periodontal health and orthodontic stability.[18] Excessive intake of fermentable carbohydrates and inadequate mineral balance can further lead to enamel demineralization and the development of white spot lesions around brackets due to heightened plaque accumulation and acid production, especially when oral hygiene is insufficient.[19] Reduced bone density resulting from inadequate calcium and vitamin D levels weakens anchorage control, making tooth movement less predictable and increasing the likelihood of relapse or undesired shifts. Beyond localized effects, systemic nutritional deficiencies have broader implications on craniofacial growth and dentofacial development; for instance, vitamin D insufficiency is linked to altered skeletal morphology and increased treatment complexity. Therefore, identifying and correcting nutritional inadequacies is crucial for maintaining optimal bone health, ensuring biological efficiency in tooth movement, minimizing complications, and achieving stable, long-term orthodontic results.[20]

Diet Modifications During Orthodontic Treatment

Orthodontic treatment necessitates specific dietary modifications to protect appliances from mechanical damage while ensuring sufficient nutritional intake to support tissue health, bone remodeling, and overall treatment efficiency. Following appliance placement or activation, patients often experience tenderness or discomfort, making a soft diet essential to minimize pressure on brackets and wires.[20] Foods such as mashed potatoes, yogurt, soups, smoothies, cooked vegetables, scrambled eggs, and soft fruits like bananas and grapes provide nourishment without causing strain or irritation. Hard foods such as nuts, raw carrots, apples, ice, and candies, as well as sticky items like caramel, toffee, and chewing gum, should be strictly avoided since they can bend wires, debond brackets, or break appliance components, leading to treatment delays.[21] Practical modifications like cutting fruits into small pieces or cooking vegetables until soft allow for diet variety without risking appliance integrity. Despite the need for soft-textured foods, maintaining a balanced intake of essential nutrients remains crucial; incorporating protein-rich items such as eggs, dairy, and legumes, along with vitamin- and mineral-dense options like soups and fortified smoothies, helps sustain the biological demands of tooth movement.[22] Smoothies and soups are particularly beneficial for patients experiencing difficulty chewing, as they can be enriched with protein powders, fruits, vegetables, and supplements to ensure comprehensive nutrient coverage. In cases of clinically identified deficiencies, targeted supplementation under professional guidance may be necessary. Ultimately, adopting a soft, non-damaging, and nutritionally balanced diet during orthodontic treatment not only enhances comfort and

prevents appliance complications but also ensures the optimal biological environment for efficient tooth movement and favorable treatment outcomes.[23]

Influence of Nutrition on Orthodontic Treatment Outcomes

Nutrition plays a pivotal role in determining the success and biological efficiency of orthodontic treatment by directly influencing the rate of tooth movement, periodontal health, and the risk of root resorption. Adequate intake of essential nutrients such as calcium, vitamin D, copper, and manganese is fundamental for effective bone remodeling, mineralization, and cellular metabolism that drive orthodontic tooth movement.[23] Deficiencies in these nutrients can impair osteoblastic and osteoclastic balance, leading to delayed tooth movement, weakened alveolar bone structure, and an increased likelihood of root resorption or periodontal complications.[19] Clinical studies have indicated that dietary changes during orthodontic therapy may reduce levels of trace minerals like copper and manganese, potentially diminishing bone turnover and slowing treatment progress. Additionally, antioxidants and anti-inflammatory nutrients such as vitamin C and polyphenols play an important role in mitigating orthodontic-induced inflammation, facilitating tissue repair, and reducing discomfort caused by mechanical forces.[21] A well-balanced diet also strengthens immune function and supports gingival health, thereby minimizing the risk of gingivitis, mucosal ulcerations, and other inflammatory conditions commonly encountered during treatment.[24] To optimize outcomes, incorporating nutritional counseling into orthodontic practice through an interdisciplinary approach involving dietitians is highly beneficial. Nutritional screening at the initial assessment can help identify existing deficiencies and guide tailored dietary interventions. Educating patients on maintaining a nutrient-rich diet while avoiding foods that damage appliances or promote caries formation enhances compliance and oral health. [25]

Conclusion

Bioactive food components such as omega-3 fatty acids and flavonoids play a supportive role in orthodontic tooth movement by modulating inflammation, enhancing bone remodeling, and promoting tissue healing. Nutritional optimization serves as both a preventive and supportive measure, reducing complications and improving overall treatment efficiency. Integrating dietary counseling into routine orthodontic care ensures that patients maintain the biological conditions necessary for effective tooth movement. The use of digital dietary tracking and feedback tools further enhances compliance and engagement. Ultimately, a holistic, nutrition-centered approach contributes to healthier tissues, faster treatment, and more stable orthodontic outcomes.

References

1. Ubuzima P, Nshimiyimana E, Mukeshimana C, Mazimpaka P, Mugabo E, Mbyayingabo D, Mohamed AS, Habumugisha J. Exploring biological mechanisms in orthodontic tooth movement: Bridging the gap between basic research experiments and clinical applications - A comprehensive review. Ann Anat. 2024 Aug;255:152286. doi: 10.1016/j.aanat.2024.152286. Epub 2024 May 27. PMID: 38810763.
2. Hu Y, Li H. Biological mechanism of surgery-mediated acceleration of orthodontic tooth movement: A narrative review. J Int Med Res. 2022 Sep;50(9):3000605221123904. doi: 10.1177/03000605221123904. PMID: 36124927; PMCID: PMC9511313.
3. Krishnan V, Davidovitch Z. Cellular, molecular, and tissue-level reactions to orthodontic force. Am J Orthod Dentofacial Orthop. 2006 Apr;129(4):469.e1-469.e32.
4. Krishnan V, Kuijpers-Jagtman AM, Davidovitch Z, editors. Biological Mechanisms of Tooth Movement. Hoboken, NJ: John Wiley & Sons Ltd; 2021.
5. Khatri JM, Kolhe VD. Nutrition and orthodontics. Int J Orthod Rehabil 2018;9:163-7.
6. Li, Y., Zhan, Q., Bao, M. *et al.* Biomechanical and biological responses of periodontium in orthodontic tooth movement: up-date in a new decade. *Int J Oral Sci* **13**, 20 (2021). https://doi.org/10.1038/s41368-021-00125-5

7. Asiry MA. Biological aspects of orthodontic tooth movement: A review of literature. Saudi J Biol Sci. 2018 Sep;25(6):1027-1032. doi: 10.1016/j.sjbs.2018.03.008. Epub 2018 Mar 14. PMID: 30174498; PMCID: PMC6117289.
8. Alam MK, Abutayyem H, Alswairki HJ, Hajeer MY, Alogaibi YA. A systematic review and meta-analysis of the role of nutrition and its impact on orthodontic treatment/management. J Orthod Sci. 2023 Sep 4;12:41. doi: 10.4103/jos.jos_85_23. PMID: 37881655; PMCID: PMC10597360.
9. Vinay VB, et al. Nutrition in Orthodontic Practice: An Indian Perspective. Indian J Nutr. 2025;12(2).
10. Ajmera, A. J., Tarvade, S. S., & Patni, V. R. (2015). *A systematic nutritional and dietary guideline for orthodontic patients*. *3*(2), 88. https://doi.org/10.4103/23213825.150875
11. Tassabehji, N. M., & Kaye, J. J. (2023). *Nutrition in Orthodontic Practice*. 111–127. https://doi.org/10.1002/9781119870081.ch6
12. Maheshwari, S., Tariq, M., Gaur, A., & M, J. (2021). *A systematic nutritional and dietary guideline for orthodontic and orthognathic surgery patients*. *3*(3), 136–140. https://www.ijodr.com/article-details/4943
13. Singh, N. (2017). Nutrition and Orthodontics-Interdependence and Interrelationship. *Research & Reviews: Journal of Dental Sciences*, *5*(3). https://www.rroij.com/openaccess/nutrition-and-orthodonticsinterdependence-and-interrelationship-.pdf
14. Kaur, P., Ahluwalia, R., Verma, D., Garg, H., & Sharma, K. (2020). *Dietary considerations for patients undergoing orthodontic treatment: A review*. *4*(2), 63–65. https://doi.org/10.18231/2455-1732.2018.0015
15. Mehta, V., Bagga, M. K., & Bhatti, B. K. (2018). How Diet Affects an Orthodontic Treatment Outcome- A Review. *International Journal of Research*, *5*(5), 46–51. https://www.ijrrjournal.com/IJRR_Vol.5_Issue.5_May2018/IJRR009.pdf
16. İşler, A. A. A., & Altun, S. K. (2024). Fermented dairy products and orthodontics. *Middle East Journal of Science*. https://doi.org/10.51477/mejs.1404760
17. Miresmaili, A. (2016). Orthodontic Appliance Effect on Nutrition. *Nutrition Bytes*, *20*(1). https://escholarship.org/uc/item/7g89m79k
18. Hickory W, Nanda R. Nutritional considerations in orthodontics. Dent Clin North Am. 1981 Jan;25(1):195-201. PMID: 6937397.
19. Parekh U. Dietary regimen in Orthodontics. Int J Dent Med Sci Res. 2022 MayJun;4(3):304–311. doi:10.35629/5252-0403304311.
20. Trehan M, Malviya U, Tiwari A, Kumar A, Anamika, Bamal R. Influence of Vitamin D and Calcium on the Development of Malocclusion: A Cross-sectional Study. *Journal of Indian Orthodontic Society*. 2025;59(3):231-236.
21. Bora N, Roy BK, Baruah N, Gogoi R. Role of Nutrition in Orthodontics: A Review. IJHRMLP. 2016 Jan;2(1):15–19.
22. Mehta V, et al. How Diet Affects an Orthodontic Treatment Outcome- A Review. Int J Res Rev. 2018 May;5(5):46.
23. *En PL, SoYeon O, Nor NN, Mei L, Farella M, Prasad S. Dietary experiences during fixed orthodontic treatment. APOS Trends Orthod 2023;13:60-7.*
24. Anderson AC, Rothballer M, Altenburger MJ, Woelber JP, Karygianni L, Vach K, Hellwig E, Al-Ahmad A. Long-Term Fluctuation of Oral Biofilm Microbiota following Different Dietary Phases. Appl Environ Microbiol. 2020 Oct 1;86(20):e01421-20. doi: 10.1128/AEM.01421-20. PMID: 32801176; PMCID: PMC7531951.
25. Riordan DJ. Effects of orthodontic treatment on nutrient intake. Am J Orthod Dentofacial Orthop. 1997 May;111(5):554-61. doi: 10.1016/s0889-5406(97)70292-0. PMID: 9155815.