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Orthodontic Tooth Movement and Role of Vitamin D....Are we listening?

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ABSTRACT

Vitamin D is an essential component which is required for growth and development of bones and teeth. Its role in general body growth has been well documented and understood. However, the role Vitamin D plays in the movement of teeth during orthodontic treatment has often been overlooked. This paper summarises the role of vitamin D in successful orthodontic treatment and explains the role of its optimal content in the body for ideal tooth movements when orthodontic forces are applied.

Keywords: Orthodontics, Tooth movement, Vitamin D

Introduction

Orthodontic tooth movementis a periodontal ligament phenomenon[1]dependant on physical characteristics of the applied force, and the size and biological response of the ligament.[2]By altering thevascularity of the periodontal ligament, local synthesis and release of various neurotransmitters, cytokines, growth factors, colony-stimulating factors, and arachidonic acid metabolitestakes place, thus providing a favourable microenvironment for remodelling.[3]

The treatment time generally exceeds an year for orthodontic therapy.[4,5] In today's world, hectic schedules, travel and job issues, this treatment timing seems to be very extensive to adult patients and discourages them from undergoing the treatment. However, adult patients typically re-quire longer treatment time due to slower metabolism as compared to younger patients.[6] Accelerating the rate of tooth movement is also desirable to orthodontists as prolonged treatment duration has been associated with increased risk of gingival inflammation, decalcification,dental caries, and especially, root resorption.

A number of attempts have been made to create different approaches both in vivo and in vitro to accomplish quicker results. These can broadly be categorized into biological, physical, biomechanical, and surgical approaches for accelerating tooth movement.*Biological approach* includes use of molecules like prostaglandin E (PGE), cytokines that include lymphocytes and monocyte-derived factors, receptor activator of nuclear factor Kappa B ligand (RANKL) and macrophage colony-stimulating factor (MCSF) to modulate orthodontic tooth movement. *Physical approach* includes direct electric currents, pulsed electromagnetic field, static magnetic field, resonance vibration and low level laser therapy (LLLT). Several *Surgical techniques* such as interseptal alveolar surgery, osteotomy, corticotomy, piezocision technique etc. have been undertaken with promising results.

Effect of Vitamin D on tooth movement

The maintenance of calciumhomeostasis by vitamin D, a steroid hormone with specific receptorsin many target organs and tissues[7,8] has been well documented.It exerts its actionby activating DNA and RNA within the target cell toproduce proteins and enzymes that can be used in thebone resorption process. In particular, the activeform of vitamin D (1,25-dihydroxycholecalciferol henceforth referred to as 1,25DHCC), is one of the most potent stimulators of osteoclastic activity known. It has been found to have a half life in plasma of 2 to 3 hours but its cellular activation effects may last for several days. It also is involved in the formation of osteoclasts from precursor monocytes and may produce these effects at much lower doses than other hormones such as prostaglandins.[9,10]

Collins and Sinclairas well as Seifi reported increased rates of tooth movement in cats[11] and rats[12] respectively with local administration of vitamin D. Kale emphasized that administration of vitamin D results in a well-modulated bone turnover compared to prostaglandin administration[13].In vitrostudies have shown that, upon administration of 1,25-DHCC, osteoblast cell cultures demonstrate a two- to fourfold increase in osteoclastic bone resorption compared to controls. In 2004, Kawakami and Takano-Yamamoto observed an increase in the mineral appositional rate on alveolar bone after

orthodontic force application hypothesising the local application of calcitriolto intensify the re-establishment of supporting alveolar bone, after orthodontic treatment[14].

Conclusion

About 3,000–5,000 IU of vitamin D is required daily for appropriate bone metabolism that can be attained through sunlight exposure and diet. A deficiency in vitamin D levels will lead to detrimental effects to the normal mineralization of bone, muscle contraction, and nerve conduction.Unregulated levels can lead to the "rachitic tooth", which is a defective and hypomineralized organ highly susceptible to fracture and decay [15,16].In Orthodontics, vitamin D deficiency may lead to a slower rate of tooth movement, as evidenced by several laboratory-based investigations.[13,14] Further exploration is needed to determine the safety of vitamin D administration in orthodontic patients, the optimal amount and site of application for this purpose. Also, given the high prevalence of vitamin D deficiency worldwide, it is important for researchers to investigate the clinical application of these findings, including the potential use of vitamin D metabolites to enhance the rate of tooth movement during orthodontic therapy or to enhance stability post treatment as some studies suggest its possible role in the reestablishment of bony tissue supporting the teeth after Orthodontic Tooth Movement[17].

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