Orthodontic Tooth movement in Osteogenesis Imperfecta: A Bisphosphonate model

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Abstract (300 word limit)

Statement of the Problem: Osteogenesis Imperfecta (OI) is characterized by low bone mass that predisposes affected individuals to musculoskeletal fragility due to genetic mutations in type I collagen (Col1A1 and Col1A2). The most common therapeutic treatment for OI patients is the administration of Bisphosphonates. 50% of patients with OI have skeletal class III malocclusion with an open bite and require orthodontic treatment. Previous studies have found that the Index of Orthodontic Treatment Need for OI patients are 88.5% compared to 24.8 % in the control patients. Thus, OI patients have multitude of dental problems and they require orthodontic treatment to achieve proper function, stability and esthetics. However, literature lacks the evidence regarding the nature of Orthodontic Tooth Movement (OTM) in an OI individual. Additionally, how the treatment with bisphosphonates affect the OTM is yet to be studied. Thus, the aim of this study was to decipher the cellular and molecular mechanisms behind the OTM and the rate of OTM with Alendronate treatment in an OI mice model. Methodology: All procedures were approved by the UConn Health IACUC. The animals (Col1a2 oim/J OI mice) were injected with saline or Alendronate for 2 weeks giving rise to four groups (age:10 weeks; n=8 in each group). (i) Alendronate male (AM), (ii) Saline male (SM), (iii) Alendronate female, (AF) and (iv) Saline female (SF). OTM was performed by tying maxillary right first molar to the NiTi closed coil spring applying 3 cN to 5 cN of force. After OTM, the maxilla was harvested and stored at 4^0 C in 10% formalin for microCT (Bone volume fraction (BVF) and Tissue Density) and histological evaluation. Findings: AM and Female AF showed significantly decreased OTM compared to SM and SF ($P<0.05$). Alendronate treatment resulted in decreased number of osteoclasts than saline. Female OI treated with saline exhibited more rapid resorption than males. The PicroSirius Red staining showed the higher intensity and thickness of collagen fibers in the Alendronate groups. Conclusion & Significance: Alendronate results in decreased rate of OTM in OI mice. There is an increase in the hyalinization zone and decrease in the number of osteoclasts in the Alendronate mice after OTM compared to saline groups. There is significantly rapid resorption of hyalinized zones in the female OI mice compared to the male OI mice treated with saline. Alendronate might be helpful in restoring the integrity and quality of collagen fibers in OI.

Image

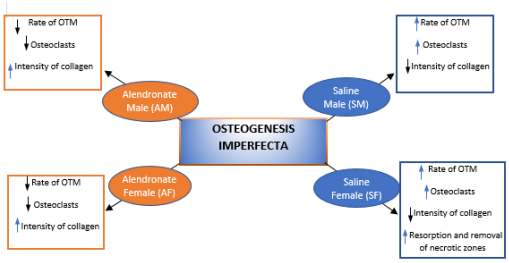


Figure 1 – Effects of orthodontic tooth movement in Osteogenesis Imperfecta. Orthodontic tooth movement (OTM) ↑ Increase or enhancement, ↓ Decrease or deterioration

Recent Publications (minimum 5)

1. Powell KM, Skaggs C, Pulliam A, Berman A, Allen MR, Wallace JM. Zoledronate and Raloxifene combination therapy enhances material and mechanical properties of diseased mouse bone. Bone. 2019 Oct;127:199-206.
2. Andersson K, Dahllof G, Lindahl K, Kindmark A, Grigelioniene G, Astrom E, Malmgren B. Mutations in COL1A1 and COL1A2 and dental aberrations in children and adolescents with osteogenesis imperfecta - A retrospective cohort study. PLoS One. 2017 May 2;12(5):e0176466. doi:10.1371/journal.pone.0176466.
3. Blouin S, Fratzl-Zelman N, Glorieux FH, Roschger P, Klaushofer K, Marini JC, Rauch F. Hypermineralization and High Osteocyte Lacunar Density in Osteogenesis Imperfecta Type V Bone Indicate Exuberant Primary Bone Formation. J Bone Miner Res. 2017 Sep;32(9):1884-1892.
4. Kamoun-Goldrat A, Ginisty D, Le Merrer M. Effects of bisphosphonates on tooth eruption in children with osteogenesis imperfecta. Eur J Oral Sci. 2008 Jun;116(3):195-8.
5. Nguyen MS, Binh HD, Nguyen KM, Maasalu K, Koks S, Martson A, Saag M, Jagomagi T. Occlusal features and need for orthodontic treatment in persons with osteogenesis imperfecta. Clin Exp Dent Res. 2017 Feb 9;3(1):19-24.

Photograph



Biography (150 word limit)

Dr Mehta has his expertise in biology of orthodontic tooth movement and passion in improving the health and wellbeing of Osteogenesis Imperfecta. His experience in orthodontic tooth movement with biological models and clinical trials has created new pathways for improving orthodontic treatment. He has built this model after years of experience in research, evaluation, teaching and administration both in clinical practice and education institutions. He has done extensive research on the Orthodontic Tooth Movement (OTM) in animal model and on effects of alendronate on load response of the TMJ cartilage in Osteogenesis Imperfecta (OI) mice model. In addition, he has conducted randomized controlled clinical trial for the evaluation of the effect of photo biomodulation on orthodontic tooth movement. He is the first clinician-scientist to do in vivo quantification of the orthodontic tooth movement and orthodontically-induced root resorption in an OI mice model with and without alendronate The knowledge gained from his research is invaluable for clinicians treating OI individuals and will help them make informed decisions in providing better care to an OI individual seeking orthodontic treatment.

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