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To evaluate the displacement contours of the maxillary molar after applying an intrusive force using a mousetrap appliance: AFem study

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Abstract: *Mousetrap appliance is an effective treatment modality for anterior open bite that utilizes implants inserted into the anterior palate and brings about open bite correction by intruding the maxillary molars. This is a finite element study that assesses the displacement contours of maxillary molars when they are intruded by a mousetrap appliance.**Materials and Methods:**A finite element model of the maxilla and the mousetrap appliance made of 288332 elements and 64771 nodes was generated using software tools like MIMICS and HYPERMESH. A simulated force of 100 grams was applied to the maxillary molar through the appliance and the displacement of the molar was assessed in three planes X,Y and Z..**Results:** Maximum intrusion of the maxillary molar was found to be 0.005mm along the Z-direction.**Conclusion:**It is therefore concluded that the mousetrap appliance which exerts a force within the range of recommended force for molar intrusion brings about desirable displacement of the tooth.*

***Keywords**: TADs, molar intrusion, mousetrap appliance.*

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I. Introduction:

An absence of vertical overlap between the maxillary and mandibular incisors, known as anterior open bite, has proven to be the most challenging malocclusion in the vertical plane.[1] Most cases are treated by extracting molars or premolars followed bymesialization of the posterior teeth that results in counterclockwise rotation of the mandible.Le Fort I osteotomy and mandibular osteotomy are the surgical options that can be considered in certain cases. Other treatment modalities e.g. vertical elastics or extrusion arches, multiloop edgewise archwires, can also be undertaken.An effective treatment modality for the correction of an anterior open bite is a "Mousetrap appliance". It utilizes TADs inserted in the anterior palateattached to abeneplate, from which two lever arms arise that are connected to the molars. To avoid impingement during and after molar intrusion and to prevent undesirable tipping of the molars a modified Goshgarian TPA with distal loop is fabricated with sufficient clearance from the palatal mucosa. In the passive form the distal ends of lever arms are present cranial to the centre of resistance of the maxillary molars. They are activated by pulling them downwards and then connecting them to the molars thereby resulting in a constant intrusive force.[2] (Figure 1)

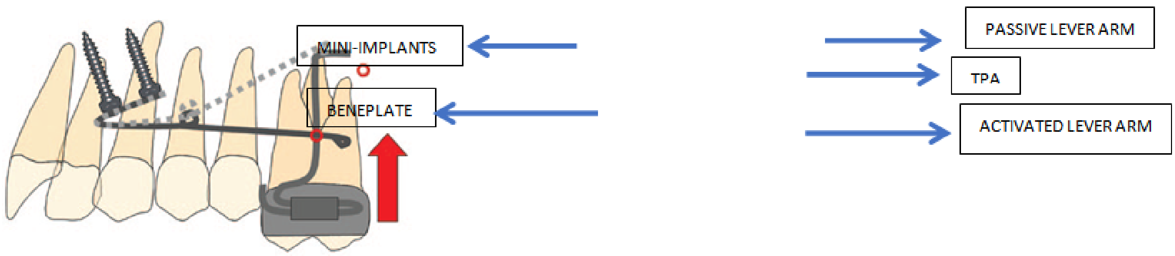


Figure 1

This article intends to investigate the maximum displacement contours of the maxillary molars on application of an intrusive force by Mousetrap appliance on a 3Dimensional finite element model.

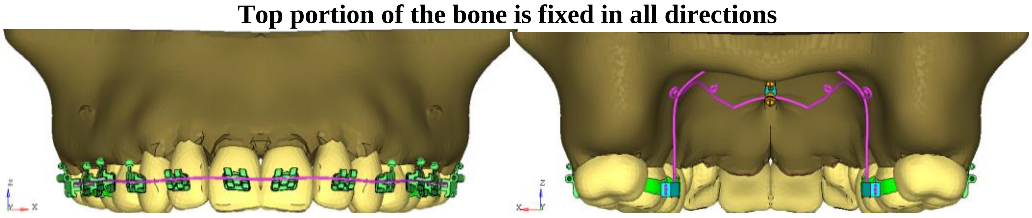
II. Materials And Methods

Finite element analysisconstructscomplicated three dimensional models of tissues having characteristic biomechanical properties.[3] In the present study Computed Tomography images of human cranium obtained from an X-force/SH spiral CT scan machine were used to generate such a model. MIMICS i.e. Materialize Interactive Medical Image Control Systemsoftware was used to create the geometrical model which was then converted into FEM model using the modelling tool known as ‘Hypermesh’. The model consisted of 288332 elements and 64771 nodes and the material properties assigned to the various parts were acquired from an existing study.[4] (Table 1). The boundary conditions were defined by constraining the top portion of the maxillary bone in all directions to prevent any displacement or stress in that area (Figure 2a, 2b).A simulated intrusive force of 100 grams was applied to the model through the appliance and the resulting effect was assessed by a finite element software known as ANSYS.

Part	Elastic modulus (MPa)	Poisson’s ratio
Cortical bone	13700	0.3
Cancellous bone	1370	0.3
Teeth	20700	0.3
PDL	0.068	0.45
Brackets, Wires, beneplate (SS)	200000	0.3
Mini screws (Ti)	110000	0.29

Table 1

Top portion of the bone is fixed in all directions



(a) **(b)**

Figure 2

III. Results:

Displacement contours of maxilla and first molar ‘mm’:

Displacement of maxillary first molar was assessed in three directions: X, Y and Z. X denotes the movement in buccolingual direction, Y in mesiodistal direction and Z in the vertical direction. Maximum movement was observed in first molar along the Z-axis and was around 0.005mm. (Figure 3,4,5).

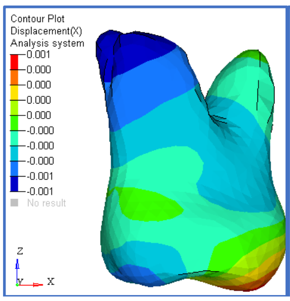


Figure 3- X direction

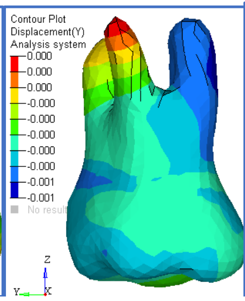


Figure 4- Y direction

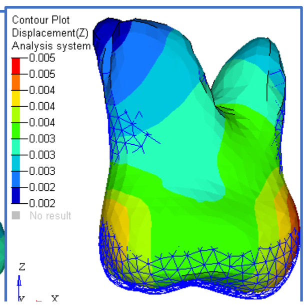


Figure 5- Z direction

IV. Discussion:

Conversion of mechanical stimulus created by the orthodontic force into a biological reaction initiates an orthodontic tooth movement. Application of orthodontic force gives rise to altered stress-strain relationship in the periodontal ligament as well as in the surrounding tissues leading to bending of bone and intra alveolar displacement of teeth, provided an optimum force is applied. Some investigators have pointed out that intrusive forces lead to pulpal changes like congestion, circulatory disturbances, vacuolization and fibrohyalinosis.[5],[6]Brodin et al concluded that there was a temporary reduction in pulpal blood flow when lateral incisors were intruded with a force of 2N.[7] Konno et al showed that skeletal anchorage leads to reversible histological changes during molar intrusion in dogs.[8]Proffit and Fields suggested that 10-20 grams of force was optimum for carrying out intrusion while as Woodside, Hanson and Berger recommended 50-10grams. Umemori et al suggested that an intrusive force of 500 grams should be applied for molar intrusion while as a force of 90 grams was suggested for growing subjects by Kalra et al.[9],[10]Melson and Fiorelli recommended a force of 50 grams buccolingually to intrude maxillary molars in adult subjects.[11] Li et al intruded two over erupted molars by using mini-implants and applying a force of 150 grams. They evaluated the root resorption using CBCT and the results showed that the mesiobuccal root of the first molar showed highest root resorption.[12] As it is very important for the stress to be within the physiological constraints of the tissues, in the existing literature, authors recommend intrusive forces within the range of 15-200 grams.[13] There are innumerable studies on different types of posterior intrusion mechanics, however their biomechanical effectsand displacement contours have not been evaluated in detail.

Finite element method is a viable mean for calculating these quantities. Originally the finite element method was devised for modelling in the field of Engineering but now it has also made its place in the field of dentistry to assess various materials and loading conditions. Yettram et al in 1972 introduced it into the field of orthodontics.[14] The basic philosophy behind the finite element method is breaking down complex structures into simpler pieces called elements that can be conveniently defined by differential equations.[15]

The present study is in accordance with the study conducted by Pekhale et al who found similar values of molar displacement: the palatal cusp of the first molar showed the maximum intrusion (0.0045mm) followed by the mesiobuccal cusps (0.0039mm) and distobuccal cusps (0.0035 mm). Moreover, palatal and buccal surfaces showed a displacement of 0.0057 mm.[4] Dawer Met al applied 200 gm of simulated intrusive force onto the first molars that resulted in 0.007 mm deformation in the occluso-gingival direction and an initial intrusion of 0.002mm which is less than the molar displacement observed in the present study.[16] Yao et al studied molar intrusion in three dimensions using mini-implant anchorage andachieved an average intrusion of 3-4 mm by applying a force of 150-200 gm.[17]Wilmes et al in 2013 carried out molar intrusion in two female subjects with the help of a mousetrap appliance that exerted an intrusive force of 100 grams and achieved a proper amount of intrusion.[2] In this study the movement of the maxillary first molar was assessed in three directions, X, Y and Z after applying a simulated force of 100 grams through a mousetrap appliance. X denotes the movement in buccolingual direction, Y in mesiodistal direction and Z in the vertical direction. (Figure 3.4 &5). The results showed maximum intrusion of around 0.005mm in the Z- direction which is similar to that observed by Pekhaleet al.[4]Thus mousetrap appliance is an effective appliance that can be used to bring about molar intrusion and treat anterior open bite.

V. Conclusion:

Maximum intrusion of the maxillary molar was found to be 0.005mm in the Z-direction.
It is therefore concluded that the mousetrap appliance whichexertsa force within the range of recommended force for molar intrusion brings about desirable displacement of the tooth and can be used as an effective treatment modality for anterior open bite cases.

References

[1]. A V-Hernandez, R Lopez-Garcıa, V Garcıa-Sanz, V Paredes-Gallardo, F Lasagabaster-Latorre. Nonsurgical treatment of skeletal anterior open bite in adult patients: Posterior build-ups. Angle Orthod 2017; 87: 33–40.

[2]. Wilmes B, Nienkemper MA, Ludwig B, Nanda R, Drescher D. Upper-molar intrusion using anterior palatal anchorage and the Mousetrap appliance. J Clin Orthod. 2013 May;47(5):314

[3]. Nanda R. Biomechanics and Esthetic Strategies in Clinical Orthodontics, 1st ed., Ch. 8. New York: Elsevier Inc.; 2005. p. 156-76.

[4]. Pekhale N, Maheshwari A, Kumar M, Kerudi VV, Patil H, Patil B. Evaluation of stress patterns on maxillary posterior segment when intruded with mini implant anchorage: a three-dimensional finite element study. APOS Trends Orthod. 2016 Jan 1;6:18-23

[5]. Stenvik A, Mjor I (1970) Pulp and dentin reactions to experimental tooth intrusion: a histologic study of the initial changes. Am J Orthod 57, 370-385

[6]. Mostafa T, Iskandar K G, EI Mangoury N H (1991) Iatrogenic pulpal reactions to orthodontic extrusion. Am J Orthod Dentofacial Orthop. 99, 30-34

[7]. Brodin P, Linge L, Aars H. Instant assessment of pulpal bloog flow after orthodontic force application. J OrofacOrthop . 1996 57, 306-309.

[8]. Konno Y, Daimaruya T, Iikubo M, Kanzaki R, Takahashi I, Sugawara J et al. Morphological and hemodynamic analysis of dental pulp in dogs after molar intrusion with the skeletal anchorage system. Am J Orthod Dentofacial Orthop.2007; 132,199-207

[9]. Umemori M, Sugawara J, Mitani H, Nagasaka H, Kawamura H. Skeletal anchorage system for open-bite correction. Am J Orthod Dentofacial Orthop. 1999 Feb 1;115(2):166-74.

[10]. Kalra V, Burstone CJ, Nanda R. Effects of a fixed magnetic appliance on the dentofacial complex. Am J Orthod Dentofacial Orthop. 1989;95:467–478.

[11]. Melsen B, Fiorelli G. Upper molar intrusion. J Clin Orthod. 1996;30:91–96

[12]. Li W, Chen F, Zhang F, Ding W, Ye Q, Shi J et al Volumetric measurement of root resorption following molar mini-screw implant intrusion using cone beam computed tomography. PloS one. 2013 Apr 9;8(4) : e60962.

[13]. Al-Zubair N. Orthodontic intrusion: a contemporary review. J Orthod Res. 2014 Sep 1;2(3):118.

[14]. Yettram A L, Wright K W, Houston W J, Centre of rotation of a maxillary central incisor under orthodontic loading. Br J Orthod 1977; 4:23-7
[15]. Çifter M, Saraç M. Maxillary posterior intrusion mechanics with mini-implant anchorage evaluated with the finite element method. Am J Orthod Dentofacial Orthop. 2011 Nov 1;140(5): e233-41.
[16]. Dawer M, Kumar C H S, Kumar M, Ansari A, Jain A K, Gandhi R. Placement of mini implants for the intrusion of maxillary molar- A FEM study. TMU J Dent. 2015 Jul-Sep;2(3).
[17]. Yao CC, Lee JJ, Chen HY, Chang ZC, Chang HF, Chen YJ. Maxillary molar intrusion with fixed appliances and mini-implant anchorage studied in three dimensions. Angle Orthod. 2005 Sep;75(5):754-60.

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