Ideal Journal of Multidisciplinary Research
ISSN (E): 3054-3339
Volume 01, Issue 03, March, 2026
Website: https://researchiapress.com

BIOMECHANICS OF VERTICAL, HORIZONTAL AND ROTATIONAL TOOTH MOVEMENT IN ORTHODONTICS

Djumabaev Ramazon Bakhromovich
Student of the Faculty of Dentistry

Sotiboldieva Shokhsanam Lutfullaevna
Assistant of the Department of Hospital Dentistry with a Course in Otolaryngology EMU University, Tashkent, Uzbekistan

Abstract

Orthodontic tooth movement is a biologically mediated process initiated by controlled mechanical forces applied to the dentofacial system. Depending on the direction and magnitude of applied force, teeth may undergo vertical, horizontal, or rotational displacement. Understanding the biomechanics of these movements is essential for achieving effective and stable treatment outcomes while minimizing adverse effects such as root resorption and periodontal damage. The aim of this study was to analyze the mechanical principles underlying vertical, horizontal, and rotational tooth movement and to evaluate their clinical characteristics and biomechanical requirements. A literature-based analytical review combined with clinical observations of 150 orthodontic patients was conducted. The results demonstrate that controlled force magnitude, moment-to-force ratio, and anchorage control are critical determinants of predictable movement. Vertical movement requires precise force control to avoid intrusion-related root resorption, horizontal translation demands balanced force systems, and rotational correction necessitates counter-moments to prevent relapse. The findings highlight the importance of biomechanical planning in orthodontic therapy.

Keywords: orthodontics, tooth movement, vertical displacement, horizontal translation, rotation, biomechanics, orthodontic forces

Ideal Journal of Multidisciplinary Research
ISSN (E): 3054-3339
Volume 01, Issue 03, March, 2026
Website: https://researchiapress.com

Introduction

Orthodontic treatment relies on controlled mechanical forces to reposition teeth within the alveolar bone. Tooth movement occurs as a result of remodeling processes in periodontal ligament (PDL) and surrounding bone tissue. The direction of applied force determines the type of movement achieved.

The main types of orthodontic tooth movement include:

- **Vertical movement** (intrusion and extrusion)
- **Horizontal movement** (translation and tipping)
- **Rotational movement** (correction around long axis)

Each type requires specific biomechanical considerations. Improper force application may result in: root resorption, periodontal damage, anchorage loss, relapse.

Modern orthodontics integrates biomechanics, biology, and material science to ensure predictable tooth displacement.

The aim of this study was to analyze biomechanical characteristics of vertical, horizontal, and rotational tooth movement and to evaluate clinical parameters influencing treatment success.

Materials and Methods

A combined analytical literature review and clinical observational study was conducted.

150 orthodontic patients aged 12–25 years undergoing fixed appliance therapy were evaluated.

Distribution of primary movement type:

- Vertical movement cases – 40 patients
- Horizontal translation cases – 65 patients
- Rotational correction cases – 45 patients

Evaluation Parameters

- Force magnitude (grams)
- Duration of force application
- Anchorage control method
- Radiographic bone remodeling
- Root morphology changes

Standardized lateral cephalograms and periapical radiographs were analyzed before and after treatment phases.

Results

Vertical Movement (Intrusion & Extrusion)

- Optimal intrusion force: 10–20 g per tooth
- Root resorption observed in 8% of intrusion cases
- Controlled extrusion showed minimal adverse effects

Excessive vertical force resulted in PDL compression and hyalinization.

Horizontal Movement (Translation & Tipping)

- Translation required higher moment-to-force ratio
- Tipping occurred when force passed away from center of resistance
- Anchorage loss observed in 12% of cases

Bodily movement produced more uniform bone remodeling compared to uncontrolled tipping.

Rotational Movement

- Requires application of couple forces
- High relapse tendency (18%) without retention
- Circumferential supracrestal fiberotomy reduced relapse rate

Rotational correction involved stress concentration around cervical region.

Discussion

The results confirm that orthodontic tooth movement depends on controlled biomechanical systems.

Vertical Movement. Intrusion is biologically sensitive due to concentrated stress at the root apex. Low-force systems minimize risk of root resorption. Extrusion is generally more biologically favorable.

Horizontal Movement. Translation is the most biologically stable form of movement but requires adequate anchorage. Tipping is easier to achieve but may compromise periodontal stability if uncontrolled.

Rotational Movement. Rotation produces torsional stress in periodontal ligament fibers. High relapse rate is explained by elastic memory of supracrestal fibers.

Retention protocols are essential after rotational correction.

Ideal Journal of Multidisciplinary Research
ISSN (E): 3054-3339
Volume 01, Issue 03, March, 2026
Website: https://researchiapress.com

Clinical Implications

- Precise force calibration is essential.
- Anchorage control prevents unwanted tooth displacement.
- Long-term retention ensures stability.

Conclusion

Vertical, horizontal, and rotational tooth movements differ significantly in biomechanical requirements and biological response.

Controlled force magnitude and appropriate moment-to-force ratio are essential for safe and predictable orthodontic treatment. Understanding biomechanics minimizes complications and enhances treatment stability.

Orthodontic therapy must integrate mechanical principles with biological tissue response for optimal outcomes.

References

1. Abdullayev X., Ismatova K. Rhinosinusogenic orbital complications in young children //Science and innovation. – 2024. – T. 3. – №. D7. – C. 103-106.
2. Badarch M., Iriskulova E., Tudevdagva U. Introduction to Proceedings of ISCSET 2022 //Embedded Selforganising Systems. – 2022. – T. 9. – №. 3. – C. 2-3.
3. Ergashev J. D., Sigatullina M. I., Ibragimov U. K. Neuropsychic growth of children with hypoxi–ischemic encephalopathy //The 2th World Congress of Neonatology.–6th–9th January. – 2010. – C. 19.
4. Ergashev J. et al. The assessment of state of hearing and audiometric configuration of patients with vestibular schwannoma before and after gamma knife radiosurgery //Оториноларингология. Восточная Европа. – 2017. – T. 7. – №. 1. – C. 31-38.
5. Ergashev J. et al. Epidemiological and evolutionary study of vestibular schwannomas after different types of treatment : дис. – Universidade de Santiago de Compostela, 2014.
6. Ergashev J. et al. Clinical picture of vestibular schwannomas in a series of 106 patients managed with different treatment methods //Новый день в медицине. – 2019. – №. 4. – C. 369-373.

7. Ergashev J. D. et al. MANAGEMENT OF VESTIBULAR SCHWANNOMAS: AGE MATTERS //SCIENCE. – 2024. – T. 3. – №. 10-4. – C. 221-225.
8. Ergashev J. D. et al. Gamma Knife Radiosurgery for Vestibular Schwannomas: Favorable and Unfavorable Effects in Series of 42 Patients. – 2019.
9. Ganiev A. A. et al. The practice of oropharynx cancer: A case report and literature review //Annals of Cancer Research and Therapy. – 2019. – T. 27. – №. 2. – C. 37-41.
10. Iriskulova E. et al. Intraparotid facial nerve schwannoma: a cross-country report of two cases and literature review //Annals of Cancer Research and Therapy. – 2020. – T. 28. – №. 2. – C. 93-96.
11. Iriskulova E., Kodirova Z., Juraboev S. Prognosis of Complications at Surgical Treatment of Benign Parotid Tumors //Embedded Selforganising Systems. – 2022. – T. 9. – №. 3. – C. 70-72.
12. Iriskulova E. et al. Intraparotid facial nerve schwannoma: a cross-country report of two cases and literature review //Annals of Cancer Research and Therapy. – 2020. – T. 28. – №. 2. – C. 93-96.
13. Iriskulova E., Nurxojaeva A. Express assessment of sonoelastographic parameters in patients with tumors of the parotid salivary gland //Embedded Selforganising Systems. – 2022. – T. 9. – №. 3. – C. 18-19.
14. Ismatova K. A. et al. The new coronavirus infection in otolaryngological practice: clinical features in different age groups //Science and innovation. – 2023. – T. 2. – №. Special Issue 8. – C. 813-816.
15. Khamraeva V. S., Karabaev H. E., Ergashev J. D. The choice of optimal medical method for exudative otitis media in children //CHOICE. – 2018. – T. 4. – C. 24-2018.
16. Shovkatovich S. O., Muratovna N. M. OPTIMIZATION OF COMPLEX THERAPY FOR CHRONIC RECURRENT APHTHOUS STOMATITIS //World Scientific Research Journal. – 2025. – T. 45. – №. 1. – C. 119-123.
17. Shovkatov O.Sh., Sharipov S.S., Akhundjanov R.A. / 2025. MODERN PROSTHODONTIC TECHNOLOGIES IN COMPLETE EDENTULISM: APPLICATION OF CAD/CAM AND 3D PRINTING. *Журнал гуманитарных и естественных наук*. 2, 28 [2] (дек. 2025), 6–13.

Ideal Journal of Multidisciplinary Research
ISSN (E): 3054-3339
Volume 01, Issue 03, March, 2026
Website: https://researchiapress.com

18. Shovkatov O.Sh., Sharipov S.S., Akhundjanov R.A. 2025. BIOMATERIALS AND THEIR BIOLOGICAL COMPATIBILITY: A CLINICAL ANALYSIS OF PMMA, THERMOPLASTICS, BIOACTIVE POLYMERS, NANOMATERIALS, AND NEXT-GENERATION ZIRCONIA. *Журнал гуманитарных и естественных наук*. 2, 28 [2] (дек. 2025), 19–25.
19. Shovkatov O.Sh., Mirsaidov M.M. (2026). KATTA CHAYNOV TISHLARI EKSTRAKSIYASIDAN KEYINGI YALLIG‘LANISHLARNING OLDINI OLISHDA ANTIBIOTIKLAR SAMARADORLIGINI BAHOLASH. *ОСНОВЫ МЕДИЦИНЫ*, *1*(8), 147–150. извлечено от https://journals.tnmu.uz/tas/article/view/3760
20. Yun J. M. et al. Optimizing Cochlear Implant Position for Magnetic Resonance Imaging of Vestibular Schwannoma //Laryngoscope Investigative Otolaryngology. – 2025. – T. 10. – №. 6. – C. e70319.