Reciprocal force generated by two sliding jigs: An alternative mechanic for molar protraction

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Abstract

Objective: When a first molar is lost, orthodontic replacement with second and third molars would be an excellent treatment option. There are some side effects that tend to occur during molar protraction, such as mesial tipping of molar that could increase the time required to correct. These side effects can be avoided by understanding the biomechanical variables affecting molar protraction. The author tries to present the modification of sliding jigs, instead of the power arm function, with additional of lingual force, for molar protraction.

Methods: This case report describes the management of a 23-years-old woman who was missing left mandibular first molar, had class III skeletal profile, and anterior crossbite. After anterior crossbite

correction, the left mandibular first molar extraction spaces were closed by protraction of the second and third molars. Mesial tipping was detected in the early protraction phase when using conventional method. Consequently, uprighting procedure was done and protraction was continued using reciprocal force generated by two sliding jigs and lingual buttons to achieve bodily movement of tooth.

Results: The result was excellent, the space was closed without tipping and rotation.

Conclusion: The presented article provides an alternative mechanic for molar protraction using sliding jigs and how it can be designed to achieve predictable result.

Keywords: Lingual button, Molar protraction, Reciprocal force, Sliding jig

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Introduction

The mandibular first molar is the most frequently damaged tooth due to caries.¹ Some treatment options that are available after extraction of molar include implant, prosthesis, and space closure using orthodontic devices.² The treatment of choice in treating edentulous area should be the least invasive option that complies the expected esthetic and functional objectives.³ In orthodontic treatment option, the protraction of second molars to the edentulous area becomes the preferred choice, with the support of bones and good oral hygiene. Orthodontic movement could be an excellent way to regain new alveolar bone and soft tissue when closing spaces and avoid crestal bone damage mesial to the second molars.⁴ Furthermore, in some case, it is also advantageous for angular correction of impacted third molar that can be moved mesially to fulfill the available space instead of extraction.⁵ However, molar protraction generally can cause anchorage loss, molar tipping, and root resorption.⁶

In space closure mechanics, molar protraction is similar to canine retraction, which requires consideration of the main biomechanics associated with the translational movement of teeth in antero-posterior direction. Theoretically, the influence of dynamic relationships between applied forces, force moments, and coupling moments also determines the type of tooth movement. In addition,

the frictional force during sliding and deflection of archwire are also two important concepts that need to be understood. Friction during sliding can make the system unpredictable, but this can be controlled or minimized by applying force near the center of resistance of the tooth (C_{res}) during molar protraction.⁷

Molar teeth will be easily tipped when the force is applied far from the C_{res} . Conversely, the force acting on C_{res} will produce translational (bodily) movements. The power arm can help to produce bodily movement during anterior retraction and posterior protraction. In the case of molar protraction, placing the power arm on the buccal tube can help to place a force close to the C_{res} so that a bodily movement can be obtained.^{2,8}

Sliding jigs are commonly used to apply intra or intermaxillary forces in the procedure of tooth distalization or mesialization. Sliding jigs have two main functions; retraction of individual teeth and molar distalization.⁹ In this case report, the author tries to present the modification of sliding jigs, instead of the power arm function, with additional of lingual force, for molar protraction.

Cese Report

A 23-years-old female patient came to Dental Hospital Prof. Soedomo, Faculty of Dentistry,

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Figure 1 Intraoral photos, cephalogram, and OPG (before treatment)

Figure 2 Molar tipping movement was detected when using conventional technique. (Illustration; F: Force, M_f : Moment of force)

Universitas Gadjah Mada, with chief complaint of crowding and protrusion of her lower teeth. Clinical examination showed a normal, symmetrical straight profile of the face. Left mandibular first molar and mandibular right first premolar had been removed due to caries. The right molar relation showed Angle class III relationship, with normal overbite (2 mm) and negative overjet (-2 mm). Panoramic radiographs showed good alveolar bone condition, no excessive resorption, and signs of other pathological lesions [figure 1](#). Cephalometric analysis showed a class III skeletal profile with protrusion of mandible, normal maxilla, accompanied by bidental retroclination.

As compensation for the patient chief complaint, the treatment plan that was conducted was to

correct anterior crossbite with protraction of maxillary anterior teeth and retraction of mandibular anterior teeth. Space closure was finished at the end of the stage with mandibular left second and third molar protractions because the patient did not want to use implants or prostheses.

A 0.022" edgewise bracket was used. Leveling and unraevelling were performed using multi-looped 0.014"; 0.016"; 0.018"; and rectangular 0.016" × 0.016" stainless steel archwire. Anterior crossbite correction was performed using elastic class III together with maxillary incisor protraction using L-loop. After approximately 11 months of treatment, crowding and crossbite of anterior teeth were corrected. Anterior retraction of the mandibular teeth was continued using elastic chain to cover the remaining extraction space of the mandibular right first premolar. The space closure of the post extraction space of mandibular left molar was performed by protraction of the second molar using conventional method, that uses elastic chain placed on the buccal tube hook of the second molar to the anterior anchorage. Anterior anchorage was obtained by ligating all of teeth at the mesial of second molar.

After the next 6 months of treatment, the remaining space appeared to close, but tipping movement of second molar was detected [figure 2](#). Consequently, the second molar uprighting procedure is performed. The protraction process is continued using two sliding jigs and lingual buttons. Sliding jigs were placed on the archwire at buccal first premolar and buccal tube of the second molar with a hook positioned as high as the second molar root apex [figure 3A](#). As a source of force, elastic chain was applied to the sliding jig hooks on the buccal side and lingual buttons on the lingual side. Sliding jig in the first premolar can be moved more mesially to get enough distance to compensate the hooks deflection [figure 3B](#). The main principle of this mechanics is to make the moments of force acting on the system zero, both in the anteroposterior and bucolingual directions [figure 3C](#).

The result of molar protraction was excellent, the space was closed without tipping and rotation [figure 4A](#) and [figure 4B](#). Generally, the progress was good and the treatment was still continued to correct the lower left third molar and left posterior cross bite [figure 5A](#) and [figure 5B](#).

Discussion

Mandibular molar protraction is a challenging clinical procedure due to the large root surface area of the molar teeth, mandibular bone density, and the need for adequate anchorage.¹⁰ Although the concept of biomechanics gives a good indication

Figure 3 A. Configuration of sliding jig placed on archwire at first premolar and second molar, with elastic chain as the source of force, B. Sliding jig in the first premolar can be moved more mesially to get enough distance to compensate the hooks deflection, C. Illustration of force system using sliding jigs and lingual buttons in buccal and occlusal view

Figure 4 Oclusal photo of lower left posterior segment, A. The remaining post extraction space after molar uprighting, B. Configuration of sliding jigs and lingual buttons at occlusal view. The post extraction space was closed

Figure 5 Frontal view. A. Initial condition, B. Treatment progress

of the factors affecting molar protraction, other variables such as masticatory forces, individual variations in the rate of tooth movement, and

archwire permanent deformation add complexity to the force system. Understanding these concepts can help avoid potential side effects and improve treatment efficiency.⁷

In the treatment using fixed orthodontic devices, the bracket acts as an intermediary agent for forces and moments of force that affect the teeth. C_{res} of the tooth, approximately is located 10 mm apical to the bracket.¹¹ If the line of action of an applied force does not pass through the C_{res} , the force will produce some rotation. The potential for rotation is measured as a moment. The moment of force has the same magnitude as the force on the tooth multiplied by the distance perpendicular to the force with C_{res} .^{11,12} In the conventional method, there is only one force applied to the tooth at the height of the crown. The distance between the line of the force and C_{res} makes this condition potentially can produce tipping (rotation) movements of the tooth.

The reciprocal forces generated by sliding jigs and lingual buttons in this case provide an alternative mechanics for molar protraction. In the anteroposterior direction, a clinical approach is carried out by applying two forces acting at a certain distance to the C_{res} , the first force on the lingual buttons at the crown level of the tooth and the second on the sliding jig hooks approaching the root apex of tooth. If there are two parallel forces, the moments arising from these forces will eliminate each others, the moments must have the same magnitude but in the opposite directions. The simultaneous force is finally the resultant of the two parallel forces given.¹¹ To minimize the friction and deflection forces on archwire, stainless steel archwire and ligature wire on the buccal tube are used.

The addition of force on the lingual side can control rotation.¹⁰ Therefore, the lingual buttons are added at the lingual side of the first premolar and second molar in conjunction with sliding jigs at the buccal side to avoid rotation. In addition, this technique is advantageous because it does not require surgical procedure, inexpensive, but effective in controlling tooth movement in three-dimensional aspects, specifically in molar protraction.

Conclusion

Molar protraction in orthodontic treatment always becomes a challenge for orthodontists, due to the high incidence and long treatment time, also the need for a high understanding of the biomechanical variables associated with. The reciprocal forces generated by sliding jigs and lingual buttons in this case provide an alternative mechanics for molar protraction that can be applied clinically to achieve predictable result. Certainly, further studies and researches are needed to establish the efficiency and

effectiveness of this technique and its application in a broader scope of cases.

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Conflict of Interest

The authors report no conflict of interest.

References

1. MIMOZA C, VITO MA. The first permanent molar most affected by dental caries-a longitudinal study. *Int J Dent Med* 2018;4: 36-41.
2. Katta A, Karthik K, Vannala V, et al. Mandibular second molar protraction with temporary anchorage devices - a case report. *Int J Dent Sci Res* 2014;2: 1-4.
3. Marusamy KO, Ramasamy S, Wali O. Molar protraction using miniscrews (temporary anchorage device) with simultaneous correction of lateral crossbite: An orthodontic case report. *J Int Soc Prev Community Dent* 2018;8: 271-276.
4. Raveli TB, Raveli DB, de-Mathias AKC, et al. Molar uprighting: a considerable and safe decision to avoid prosthetic treatment. *Open Dent J* 2017;11: 466-475.
5. Pawinru AS. Angulation change of the third molar tooth in orthodontic treatment. *J Dentomaxillofac Sci* 2017;2: 32-36.
6. Stepovich M. A clinical study on closing edentulous spaces in the mandible. *Angle Orthod* 1979;49: 227-233.
7. Janakiraman N, Alrushaid S, Upadhyay M, et al. Biomechanics of lower second-molar protraction using a new appliance. *JCO Inc* 2016: 736-744.
8. Kojima Y, Fukui H, Miyajima K. The effects of friction and flexural rigidity of the archwire on canine movement in sliding mechanics: a numerical simulation with a 3-dimensional finite element method. *Am J Orthod* 2006;130: 275e1-275e10.
9. Modia P, Aggarwal S, Bhatia P, et al. Smart sliding hook as a ready to use auxiliary in orthodontist's inventory. *Singapore Dent J* 2016;37: 27-32.
10. Nihara J, Gielo-Perczak K, Cardinal L, et al. Finite element analysis of mandibular molar protraction mechanics using miniscrews. *Eur J Orthod* 2014: 1-6.
11. Bantleon HP. Modified lingual lever arm technique: biomechanical considerations. In: *Biomechanics in clinical orthodontics*. USA: Saunders Company; 1997.
12. Smith RJ, Burstone CJ. Mechanics of tooth movement. *Am J Orthod* 1984;85: 294-307.

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