Content available at: https://www.ipinnovative.com/open-access-journals

IP Indian Journal of Orthodontics and Dentofacial Research

Journal homepage: https://www.ijodr.com

Review Article

Micro-osteoperforation for accelerating orthodontic tooth movement

Subash Chandra Nayak[1]*, Kohinoor Acharya[2], Anshuman Mishra[1], Smruti Ranjan Biswal[1], Asutosh Pradhan[2]

[1]Dept. of Orthodontics and Dentofacial Orthopaedics, Hi-Tech Dental College and Hospital, Bhubaneswar, Odisha, India
[2]Dept. of Oral and Maxillofacial Surgery, Hi-Tech Dental College and Hospital, Bhubaneswar, Odisha, India

Abstract

One of the primary difficulties of orthodontics is the prolonged treatment time, which leads to the majority of patients dropping out. When orthodontic forces are applied to the teeth, they cause an inflammatory reaction in the periodontal tissues and pulp, which leads to bone remodelling. The pace of bone remodelling, on the other hand, is slow, resulting in a lengthier treatment time. Micro-osteoperforations (MOP) have been shown to improve the process of bone remodelling and expedite tooth movement in recent studies on orthodontic journals. It is a minimally invasive treatment that stimulates the inflammatory response by activating pro-inflammatory mediators. This eventually enhances the rate of tooth movement under controlled orthodontic stresses by increasing the rate of alveolar bone remodelling. Its application is simple and quick, and it can be done by the orthodontist.

Keywords: Orthodontics, Accelerated tooth movement, Micro-osteoperforation, Minimally-invasive technique.

Received: 22-01-2025; **Accepted:** 06-02-2025; **Available Online**: 28-06-2025

1. Introduction

Patients' first concern before beginning orthodontic treatment is how long it will take to complete the procedure. The most significant setback comes in the treatment of class II patients who require first premolar extractions in order to distalize the canines. As a result of this surgery, the treatment period will be prolonged. The lengthy period of orthodontic therapy has a number of negative consequences, including soreness, irritation, recession, root resorption, and cavities.[1] As a result, tooth movement acceleration is critical for reducing orthodontic treatment time. Over time, orthodontists have devised a variety of methods to help with the problem, with surgical techniques, particularly corticotomy, proving to be the most clinically beneficial.[2] New treatments for accelerating tooth movement have also been launched recently, such as corticotomies and the administration of prostaglandin E2, however these procedures are expensive and painful because they require the assistance of another expert. Due to the intrusive nature of corticotomy, which necessitates flap elevation and suturing, as well as its link to post-operative pain, edoema, and interdental bone loss,[3] there is a need for minimally invasive therapeutic options. Micro-osteoperforations are one such procedure that involves monitored micro trauma to the bone in order to speed up tooth movement.[4]

2. Historical Background

The main barrier to tooth movement was the interference of the continuity of the cortical plates of the bones. The procedure begins with the reflection of total thickness flaps to expose buccal and lingual alveolar bone, followed by interdental cuts through cortical bone and barely penetrating into medullary bone to speed up orthodontic movements.[5] CTOR created MOP less than a decade ago as a concept and technique. CTOR scientists and clinicians conducted animal and human studies to demonstrate its effectiveness and efficiency in accelerating tooth movement. CTOR then patented the technique/device and licenced it to Propel Orthodontics (Ossining, NY, USA) for commercialization. Since their inception in 2010, Propel has experienced

*Corresponding author: Subash Chandra Nayak
Email: kohinoor.acharya96@gmail.com

https://doi.org/10.18231/j.ijodr.2025.018

exponential growth in the global market, with annual sales in the millions of dollars.[6]

2.1. Biology of orthodontic tooth movement

The biological response is crucial in controlling orthodontic tooth movement.[7] Force applied to teeth causes an aseptic, inflammatory cascade involves a sequence of molecular and cellular events that result in osteoclast formation and activation, which activates bone remodelling machinery and enables teeth to move. During the inflammatory response, a sequence of chemokines and cytokines are stimulated, resulting in the recruitment of inflammatory cells and osteoclast precursors into the space; in turn, more inflammatory markers are released, which actively or passively activate the RANK-RANKL route to osteoclast differentiation and activation.(**Figure 1**) As a result, the rate of tooth movement is decided by the rate of bone resorption in direction of movement; meanwhile, the rate of bone resorption is determined by the rate of osteoclast formation.[8-10]

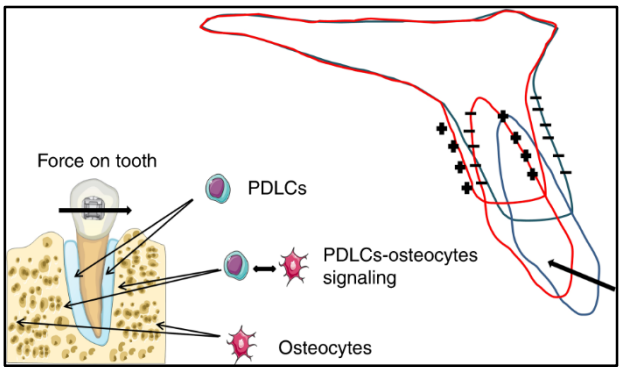

Figure 1: Diagram of cellular events in the compression side in response to application of orthodontic force.[11]

2.2. Micro osteoperforation

Micro osteoperforation is a safe, minimally invasive procedure which employs accelerating tooth movement, namely increasing the intensity of the body's natural inflammatory response through physical trauma. Micro osteoperforations are used to cause controlled micro trauma to the bone.[4]

2.3. Action mechanism

The theory behind micro osteoperforation is that micro trauma to the bone enhances the appearance of cytokines and chemokines that are normally released in response to orthodontic forces. This causes a rise in the number of osteoclasts to be recruited to the area. As a result, bone density decreases and bone resorption increases, resulting in easier and faster tooth movement.[12]

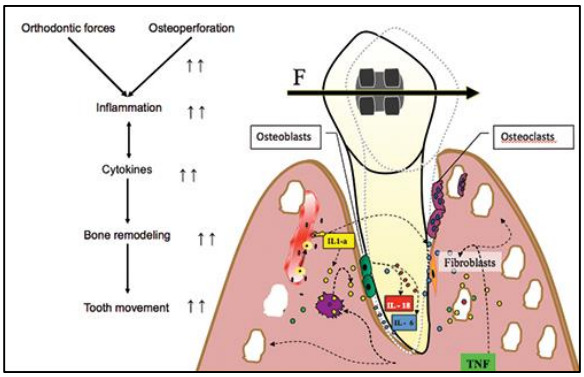

Figure 2: Mechanism Underlying Micro-osteoperforation.[19]

2.4. Micro-osteoperforation device

2.4.1. 3 types

1. Excellerator: it is made up of a single-use tip and a fine-grip handle. It has an adjustable depth dial with markings of 0mm, 3mm, 5mm, and 7mm that can be set to the desired depth by rotating clockwise. The LED light depth indicator adds to the user-friendliness of the design. However, the device is intended for single use and cannot be sterilised, raising the treatment cost.
2. Excellerator RT kit: One large handle, two closed tips, and one open tip are included. The handle has a textured grip and is sterilizable. The disposable closed tips have depth graduations of 3mm, 5mm, and 7mm, whereas the open tip does not.
3. The Excellerator PT kit includes a powered handpiece, a charging unit, a contra-angled head attachment, and disposable tips. The handpiece has a digital display that shows the battery level, speed in rpm, torque, and whether the device is in forward or reverse mode. The contraangled head attachment facilitates access throughout the entire mouth. Greater rotational speed easily drives the tips through the cortical bone without the need for pressure.

Figure 3: (Left) Excellerator fully disposable device; (Right) Excellerator RT — reusable handle; (center) Propel's newly launched Excellerator PT (power tip); (far right) Contra-angle head attachment.[20]

2.5. Indications

Micro-osteoperforations are a simple procedure that can be performed during a routine orthodontic visit. However, clinicians must carefully plan MOPs application to facilitate the movement that they are attempting to achieve at each visit, taking into account anchorage requirements, type of movement, bone anatomy, and so on. Micro osteoperforations have been shown to accelerate the rate of tooth movement around teeth that must be moved across long distances, such as ectopic canines, forced eruption, and edentulous space closure.

2.5. Contraindications

Micro osteoperforation should not be utilised near anchorage devices such as temporary anchorage devices because it reduces bone density in the affected area, resulting in device instability and anchorage loss. It should also not be utilised in patients who do not have a good periodontal condition or who have medical diseases like seizures, haematological disorders, or diabetes.

2.6. Method of application

One day before the treatment, the patient is instructed to use Chlorhexidine mouthwash twice daily. The patient is instructed to rinse for 1 minute with 0.12 percent Chlorhexidine digluconate prior to the procedure. It is necessary to determine the location and depth of micro-osteoperforations. Local anaesthesia should be achieved through the use of local infiltration. For the anterior, premolar, and molar regions, a depth of 3mm, 5mm, or 7mm should be set on the device by rotating the depth dial clockwise. Gentle pressure is applied while the tissues are held taut and the device is positioned so that the tip is perpendicular at the contact point. When the desired depth is reached, the LED indicator turns red, and the device should be removed by rotating counterclockwise. To achieve the best results, one to three micro-osteoperforations should be performed on the buccal or lingual aspect of the interdental bone.

2.6. Mops postoperative care

In the event of discomfort, the patient is recommended to take pain relievers such as acetaminophen. Anti-inflammatory medications (such as non-steroid anti-inflammatory drugs) must not be prescribed since they interfere with the inflammatory effect of MOPs, deeming the procedure unproductive. Chlorhexidine rinses are recommended as part of poor oral hygiene or in patients with compromised health. Remind the patient not to alter their brushing and flossing habits in the area where MOPs have been used.

3. Discussion

Interactions between periodontics and orthodontics are mutually beneficial. In many cases, the combined approach can significantly improve periodontal health and dentofacial aesthetics. Given the ongoing demand for reduced waiting times from patients across the world, researchers have been looking for new ways to improve orthodontic treatment quality. Kole reported in 1949.[13] that interproximal cuts in the bone cortex were incredibly beneficial in increasing tooth movement and yielding acceptable results. The drawback was that the method, which was very aggressive at the time, was not well recognised. Alikhani M et al. conducted a study on 20 patients receiving canine retraction who had Angles Class 2 Division 1 malocclusion. In the treatment group, micro-osteoperforation was executed on either the right or left side of the maxilla. After 28 days, canine retraction and the behaviour of inflammatory markers in the GCF were evaluated. The treatment group had a faster rate of tooth movement and greater levels of inflammatory markers.[14] Aboul-Ela,[15] conducted a study in which they performed modified corticotomy with buccal flap reflection. On one side, micro-osteoperforations were made with a round bur in a slow speed hand piece, and on the other, the traditional system for canine retraction was used. Perforations were made from the lateral incisor to the first premolar region. In this research, they discovered that the experimental side retracted at a faster rate. Zamora EY et al. performed research on 10 patients who underwent canine distalization after removal of first premolars; mini-implants were used to provide anchorage. Micro-osteoperforation was done on one side of the arch, whereas traditional retraction was used as a control. The results revealed that space closure was 41 percent quicker on the side where micro-osteoperforation was conducted.[16]

3.1. Clinical applications of micro‑osteoperforation

Some teeth are meant to move at specific phases, while others are designed to function as anchors. MOP is a simple addition to our orthodontic procedures. It can be administered precisely to specific locations to improve tooth movement in one area while limiting anchoring loss in another, depending on the treatment plan. Methods that can only be used once or twice all throughout therapy, such as corticotomy and piezocision, are unfavourable due to the progressive aspect of orthodontic treatment mechanics. These techniques can result in more widespread trauma across a larger area, triggering a higher level of proinflammatory cytokines. The level of inflammatory markers reduces considerably 2–3 months following surgery, despite the fact that they may be advantageous in certain clinical settings. MOP is the method of choice if a great distance of tooth movement is necessary, as it can be done periodically till the required movement is obtained. MOP can also help with root movement, which is regarded as the most challenging orthodontic movement to achieve. MOP decreases the pressure on the root throughout movement by triggering osteoclasts and reducing bone density, which reduces the risk of root resorption.

3.2. Future outlook of micro‑osteoperforation

Even though a tooth can be pushed through the cortical plate if the orthodontic load applied to it is large enough, directed, and long enough, cortical bone remodelling is slow enough that adequately directed pressures seldom put any tooth in danger of breaching the cortical bone's physical limit. MOP applied in the reverse direction of orthodontic tooth movement can induce osteoclasts, which will first reduce cortical bone density and then promote osteoblast activity in the direction of motion. The cortical plate drifts into a new position as a result of this approach, with considerable bone growth in the path of tooth movement. Although MOP is increasingly being used in rapid orthodontics, its applications are not restricted to tooth mobility. In orthodontics, MOP can indeed broaden therapeutic horizons. It enables us to address adult, complex cases that might otherwise require surgery with a nonsurgical approach. MOP has been shown in several trials to be a safe approach for facilitating root movement, inducing cellular activity, and speeding tooth movement without generating bacteremia.[17] MOP with miniscrews is a minimally invasive, flapless surgical intervention that improves patient acceptance and reduces risk of side effects.[18]

4. Conclusion

Micro-osteoperforation has been shown in this study to substantially boost the production of inflammatory markers that acquire osteoclast precursors and induce osteoclast differentiation. MOP is a minimally invasive technique that greatly increases canine retraction and can shorten orthodontic treatment time. When picking cases for MOP, a rigorous case analysis should be performed. Consider the bordering anatomical limitations, such as maxillary sinus pneumatization or a narrowed alveolar ridge. The reliability, convenience, and low cost of micro-osteoperforations are among some of the benefits provided by this technique to simplify accelerated orthodontics, which is becoming inventive and convenient, but also within the reach of all orthodontists due to their easiness of performance and low cost. However, more research further into effect of the count of MOPs on the frequency of tooth movement is needed.

5. Source of Funding

None.

6. Conflicts of Interest

There were no reported potential conflicts of interest relevant to this article.

References

1. Shenava S, Nayak KUS, Bhaskar V. Accelerated orthodontics-a review. *Int J Scientific Stud.* 2014;1:35–9.
2. Frost HM. The regional acceleratory phenomenon: a review. *Henry Ford Hosp Med J*. 1983;31(1):3–9.
3. Hassan AH, Al-Fraidi AA, Al-Saeed SH. Corticotomy-Assisted Orthodontic Treatment: Review. *Open Dent J*. 2010;4:159–64.
4. Alikhani et al, Micro-osteoperforations: Minimally invasive accelerated tooth movement. *Semin Orthod*. 2015;21(3):162–9
5. Alghamdi AS. Corticotomy facilitated orthodontics: Review of a technique. *Saudi Dent J*. 2010;22(1):1–5.
6. Chou MY, Alikhani M. A successful story of translational orthodontic research: Microosteoperforation- from experiments to clinical practice. *APOS Trends Orthod*. 2017;7(1):6–11
7. Alikhani M, Alansari S, Sangsuwon C, Lee YB, Alikhani M, Khoo E, et al. Biological Mechanisms to Accelerate Tooth Movement. In: Ramalingam AVSS, editor. Stem Cell Biology and Tissue Engineering in Dental Sciences. Ch. 58. Boston: Academic Press; 2015. p. 787-98. Available from: http://www.sciencedirect.com/science/article/pii/B978012397157900062X. [Last accessed on 2017 Jan 11].
8. Alikhani M, Alyami B, Lee IS, Almoammar S, Vongthongleur T, Alikhani M, et al. Saturation of the biological response to orthodontic forces and its effect on the rate of tooth movement. *Orthod Craniofac Res*. 2015;18(Suppl 1):8–17.
9. Alikhani M, Raptis M, Zoldan B, Sangsuwon C, Lee YB, Alyami B, et al. Effect of micro‑osteoperforations on the rate of tooth movement. *Am J Orthod Dentofacial Orthop*. 2013;144(5):639–48.
10. Teixeira CC, Khoo E, Tran J, Chartres I, Liu Y, Thant LM, et al. Cytokine expression and accelerated tooth movement. *J Dent Res*. 2010;89(10):1135–41.
11. Li Y, Zhan Q, Bao M, Jianru Y, Yu L. Biomechanical and biological responses of periodontium in orthodontic tooth movement: up-date in a new decade. *Int J Oral Sci*. 2021;13(1):20.
12. Alikhani M, Raptis M, Zoldan B, Sangsuwon C, Lee YB, Alyami B, et al. Effect of micro-o steoperforations on the rate of tooth movement. *Am J Orthod Dentofacial Orthop*. 2013;144(5):639–48.
13. Robles-Andrade MS, Guerrero-Sierra C, Hernández-Hernández C. Ortodoncia acelerada periodontalmente: fundamentos biológicos y técnicas quirúrgicas. *Rev Mex Periodontol*. 2011;2(1):12–6.
14. Alikhani M, Raptis M, Zoldan B, Sangsuwon C, Lee YB, Alyami B, et al. Effect of micro osteoperforations on the rate of tooth movement,. *Am J Orthod Dentofacial Orthop.* 2013;144(5):639–48.
15. Yang C, Wang C, Deng F, Fan Y. Biomechanical effects of corticotomyapproaches on dentoalveolar structures during canine retraction: a 3-dimensionalfinite element analysis. *Am J Orthod Dentofacial Orthop*. 2015;148(3):457–65.
16. Zamora EY, Samper FJM. Micro-osteoperforations for accelerating tooth movement during canine distalization, split-mouth study *Revista Mexicana de Ortodoncia*. 2017;5(4):e201–9
17. Azeem M, Ul Haq A, Ilyas M, Ul Hamid W, Hayat MB, Jamal F, et al. Bacteremia after micro-osteoperforation. *Int Orthod*. 2018;16(3):463–9.
18. Cheung T, Park J, Lee D, Kim C, Olson J, Javadi S, et al. Ability of mini-implant-facilitated micro-osteoperforations to accelerate tooth movement in rats. *Am J Orthod Dentofacial Orthop*. 2016;150(6):958–67.
19. Feizbakhsh M, Zandian D, Heidarpour M, Farhad SZ, Fallahi HR. The Use of Micro-Osteoperforation Concept for Accelerating Differential Tooth Movement. *J World Fed Orthod*. 2018;7(2):56–60.
20. Brigham G. The Propel® System: the next generation orthodontic disruptor. Orthodontic Practice US. 2015. https://orthopracticeus.com/the-propel-system-the-next-generation-orthodontic-disruptor/

Cite this article: Nayak SC, Acharya K, Mishra A, Biswal SR, Pradhan A. Micro-osteoperforation for accelerating orthodontic tooth movement. *IP Indian J Orthod Dentofacial Res*. 2025;11(2):93-96.