

Microosteo Perforations in Accelerated Orthodontics

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Abstract:- Short orthodontic treatment is one of the major objective for both orthodontist and patients. The Accelerated orthodontics is one of the emerging concept which focus on methods in which tooth movement can be accelerated. Various surgical methods have been developed to accelerate tooth movement. But these surgical methods are highly invasive and they include some complication risks. Microosteoperforation is a minimally invasive technique which literally means puncturing of bone. Studies have shown that microosteoperforation accelerate the tooth movement by increasing the cellular response

Keywords:- Microosteoperforation, Accelerated orthodontics, Tooth movement

I. INTRODUCTION

Reducing the duration of orthodontic treatment is still challenging. It is one of the objectives of both orthodontists and patients because long treatment may cause caries, root resorption, gingival recession, and time loss^[1]. Patients who cannot undergo a lengthy orthodontic treatment either avoids treatment or opts shorter alternate procedures which can compromise the over-all results of the treatment. Hence a lot of researches are focusing in the treatment options aimed to decrease the treatment timings without affecting the outcome of the orthodontics^[2]. Micro-osteoperforations is one such procedure involving controlled micro trauma to the bone in order to accelerate tooth movement^[3]. Micro-osteoperforation technique has been found successful both on humans and animals^[4]. The aim of the current article is to discuss the microosteoperforation method which can be used to accelerated orthodontic tooth movement (AOTM) and to critically analyse this method.

II. BIOLOGIC BASIS OF ORTHODONTIC TOOTH MOVEMENT

Application of mechanical forces to teeth causes orthodontic tooth movement as a result of the biological responses of the periodontal tissues. Alveolar bone remodelling includes selective resorption in some areas and apposition in others. The biologic response to orthodontic

therapy includes not only the response of the periodontal ligament and alveolar bone but also the response of growing areas which are distant from the dentition. However, it can be stated that tooth movement is primarily a periodontal ligament phenomenon because the alveolar bone response is also mediated by the periodontal ligament^[5]

Application of orthodontic forces to teeth results in compression and tension of the periodontal ligament which causes deformation and constriction of blood vessels resulting in cell damage in the periodontal tissues. There is an acute inflammatory response which is characterized by release of chemokines and cytokines. These cytokines have shown to induce an influx of inflammatory cells and osteoclast precursors^[6]

The inflammatory cells work to maintain high cytokine and chemokine levels that are necessary to transform osteoclast precursors to multi nucleated giant cells that are finally responsible for bone resorption^[7]

III. METHODS TO ACCELERATE ORTHODONTIC TOOTH MOVEMENT

Acceleration of tooth movement can be brought about by 2 ways. First being application of stimulants. In this method the stimulant activates certain pathways that cause bone formation and resorption but it is not like the natural process that occurs due to orthodontic forces. The second method increases the intensity of the natural bone remodelling pathways that usually occurs by means of orthodontic forces^[3]

Methods to accelerate orthodontic tooth movement can be studied under different categories^[8]

1. Biological / Pharmacological
2. Physical / Biomechanical stimulation
3. Surgical

In this microosteoperforation comes under the surgical method

IV. HISTORY AND BACKGROUND OF MICRO-OSTEOPERFORATION

The concept of Micro-osteoperforation was developed by the Consortium for Translational Orthodontic Research (CTOR). Several animal and human clinical trials were performed to determine the effectiveness of Micro-osteoperforation in accelerating orthodontic tooth movement. After a number of successful clinical studies CTOR patented the technique, later Propel Orthodontics (Ossining, NY, USA) gained the license to commercialize the device in 2010. Since then the device has gained popularity and is being marketed across the globe^[9]

Micro-Osteoperforations (Alveocentesis) Micro osteoperforation is a safe, minimally invasive procedure that utilizes the second method of acceleration of tooth movement i.e. it increases the intensity of natural inflammatory response of the body by means of physical trauma. It involves controlled micro trauma to the bone by means of micro osteoperforations^[3]

➤ *Mechanism of Action:*

Micro osteoperforation is based on the premise that micro trauma to the bone increases the expression of cytokines and chemokines that are usually released due to orthodontic forces. This results in increased number of osteoclasts being recruited to the area. As a result there is decrease in the bone density and increase in bone resorption resulting in easier and faster tooth movement. Also this process of faster bone remodelling is not just around the affected area but is also extended to the surrounding tissues. Therefore the micro osteoperforation may not necessarily be placed very close to the tooth to be moved^[10]

➤ *Micro-osteoperforation Device:*

Propel Orthodontics introduced a device called Propel, to further decrease the invasive nature of surgical irritation of bone. This process was called Alveocentesis, which exactly translates to puncturing bone. This device is available as sterile disposable ready to use device. The device has a variable depth dial and indicating arrow on the body of driver. Depth dial can be placed to 0 mm, 3 mm, 5 mm, and 7 mm of tip depth according to the area of action^[9].

➤ *Method of Use:*

The patient is advised to use Chlorhexidine mouth wash twice daily, one day prior to the procedure. Immediately before the procedure the patient is asked to rinse for 1 minute using 0.12 % Chlorhexidine digluconate. The placement and depth of micro-osteoperforations should be determined. Local anaesthesia should be achieved using local infiltration. The depth of 3mm, 5mm or 7 mm should be set on the device by rotating the depth dial in clockwise direction for anterior, premolar and molar region respectively. The tissues are held taught and the device is positioned such that the tip is perpendicular at the point of contact, gentle pressure is applied. The LED indicator turns red once the desired depth is obtained, rotating counter clockwise the device should be removed. One to three micro-osteoperforations should be

done either on the buccal or the lingual aspect of the interdental bone to obtain optimal results^[11]

➤ *Advantages of micro-osteoperforation over other surgical techniques*

When micro-osteoperforations are compared with several surgical techniques, which are proved to accelerate tooth movement, they are considered as more advantageous because they are less invasive with no need for removing flaps eliminating possible side effects of the surgery^[3, 12].

Additionally, all techniques which make use of micro-osteoperforation do not include an invasive surgical procedure represent that they are easily applicable in the clinics by the orthodontists and can be added to clinical routine. Patients did not report any pain or discomfort in the clinical studies with micro-osteoperforations which shows that it is easily accepted and tolerated by the patients who are under orthodontic treatment^[12, 13]. These advantages also enable the micro-osteoperforations to be periodically repeated until the desired results are achieved^[3, 13]

➤ *The relation of micro-osteoperforations with pain and root resorption*

There is a limited number of studies that evaluate patients' pain and discomfort levels among the clinical studies in which micro-osteoperforations are applied. Alikhani et al.^[12] asked their patients to scale their pain and discomfort levels via a numeric rating scale on the day they replaced the device, the day they began canine distalization, 24 hours, 7th and 28th days after canine distalization in their study in which they evaluated the effect of micro-osteoperforations on canine distalization. Data analyses showed that the patients had the most pain in 24 h following canine distalization but no significant difference was observed between experimental and control groups. The similar feedbacks were taken in Boz's thesis study in 2018 concluding that micro-osteoperforations did not cause a significant pain or discomfort^[13].

➤ *The relation of micro-osteoperforations root resorption*

In the literature, there is a limited number of studies which evaluates the effects of microosteoperforation on root resorption. Tsai et al. reported in their study in which they compared the efficiency of micro-osteoperforations and cortication's that root resorption creation risk of minor surgical interventions is lower when compared with conventional orthodontic treatments. The haematoxylin and eosin analysis of the researchers showed that micro-osteoperforation-assisted accelerated tooth movement was resulted in decreased root resorption^[14]. Similarly, in the study in which Cheung et al. evaluated effects of microosteoperforation on experimental tooth movement in rats, root resorption was observed on the MOP application side on the samples which were colored with haematoxylin eosin reporting that 3D volumetric analysis did not show any volumetric difference in the root of upper molar teeth which was moved^[15]. Although all findings support the idea that micro-osteoperforations do not increase root resorption risk

showing that mini-implants can be safely used for MOP procedures in terms of root resorption, it is clear that there is a need for further supportive studies with increased sample number

V. CLINICAL STUDIES

A study was conducted by Mani Alikhani et al to study the effect of micro-osteoperforations on the rate of tooth movement and the expression of inflammatory markers twenty adults with Class II Division 1 malocclusion were divided into control and experimental groups. The control group did not receive micro-osteoperforations, and the experimental group received micro-osteoperforations on 1 side of the maxilla. Both maxillary canines were retracted, and movement was measured after 28 days. The study concluded that Micro-osteoperforations significantly increased the rate of tooth movement by 2.3-fold; this was accompanied by a significant increase in the levels of inflammatory markers. The patients did not report significant pain or discomfort during or after the procedure, or any other complications^[16]

A study was conducted by S. Aksakalli et al to study the effect of miniscrew on accelerated tooth movement. The study involved a split-mouth design. MOP was applied for one side with mini-screws, and the other side was control side. Three MOPs were applied distal to the canines and before canine distalization using mini-screws of 8mm length and 1.5mm diameter. Each perforation was 1.5mm wide and 5mm deep. The patient was examined in 2-week intervals, and the distalization forces were checked until Class I canine was established. The study concluded that microosteoperforation method with miniscrews accelerated canine distalization by showing no harmful defects on root and periodontal structures^[17]

A study was conducted by Emmanuel Chan et al to examine the effects of micro-osteoperforations on orthodontic root resorption with micro computed tomography. This prospective controlled clinical trial involved 20 subjects requiring extraction of the maxillary first premolars as part of their orthodontic treatment. A buccal tipping force of 150 g was applied to both premolars. Using the Propel appliance (Propel Orthodontics, San Jose, Calif), micro-osteoperforations were applied at a depth of

5 mm on the mesial and distal aspects in the midroot region of the experimental side of the first premolar root; the contralateral side served as the control.^[18]

A study was conducted by Sonal Attri et al To investigate the influence of micro-osteoperforation (MOP) on rate of orthodontic tooth movement and pain perception with fixed appliances. The study concluded that MOP appears to enhance the rate of tooth movement with no differences in pain perception^[19]

A study was conducted by Muhammad Khan Asif et al to investigate the effects of micro-osteoperforations (MOPs) on the mandibular bone volume/tissue volume (BV/TV) ratio changes and the rate of orthodontic tooth movement using

cone-beam computed tomography images. In 24 participants, 140-200 g of force was applied for mandibular canine retraction. Three MOPs were made according to the scheduled intervals of the 3 different groups: Computed tomography analyser software (version 1.11.0.0; Skyscan, Kontich, Belgium) was used to compute the trabecular alveolar BV/TV ratio. The study concluded that. The rate of orthodontic tooth movement can be accelerated by the MOP technique with frequently repeated MOPs throughout the treatment^[16]

VI. CONCLUSION

The concept of accelerating the orthodontic tooth movements have been gaining importance in the recent years. Microosteoperforation is a minimally invasive procedure to bring about the accelerated tooth movement Experimental studies have proved that micro-osteoperforations accelerated bone remodelling process and orthodontic tooth movement accordingly together with an increase in osteoclast number and new bone formation and a decrease on bone volume and density. A limited number of clinical studies also support the findings

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