Original Research Paper

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Biochemical Changes Between Rapid and Conventional Orthodontic Tooth Movement: A Comparative Study

Abstract:

Background: Accelerated orthodontics has revolutionized the field of orthodontic treatment. Reducing the overall treatment time remains the prime concern of an orthodontist. A good accelerating technique should be affordable, repeatable, practical, efficient and should not have any side effects on periodontium including root and alveolar bone. In the era of technology, many advances are made and newer techniques for accelerating orthodontic tooth movement have been introduced in order to reduce the length of treatment with minimal risk of side effects. This study was conducted to compare the biochemical changes in rapid and conventional orthodontic tooth movement.

Materials and Method: A split mouth study was conducted on thirty patients undergoing fixed orthodontic treatment requiring all four first premolar extraction. The extraction space closure, was carried out with micro osteoperforations on the distal aspect of both the maxillary canines along with orthodontic force application as experimental site on the right side and conventional orthodontic tooth movement as control site on the left side. GCF was collected before the micro osteoperforation (T0), at day 3 (T1), at day 7 (T2) and at 4 weeks (T3) of initiating canine retraction from the distal gingival crevice of both the maxillary canines. Quantitative analysis of IL-1 and Osteocalcin in GCF sample was assessed using enzyme linked immuno sorbent assay. The optical density of samples was calculated using a fully automated enzyme linked immunosorbent assay reader.

Result: The level of Interleukin-1and Osteocalcin was always higher at the micro osteoperforation site compared to that of baseline values.

Conclusion: A gradual increase in the levels of IL-1 and Osteocalcin was observed in both the conventional and micro osteoperforation site but statistically significant elevated levels of IL-1 and Osteocalcin were seen in micro osteoperforation site compared to conventional site.

Keywords: Orthodontic treatment, Tooth movement, Accelerated orthodontics

Introduction:

Extended treatment duration is one of the leading hindrance in pursuing orthodontic treatment for adult patients.[1] Rapid advances in all biological fields have enabled clinicians to better understand the mechanisms involved in orthodontic tooth movement. Various approaches are used in orthodontics to accelerate orthodontic tooth movement and to reduce the treatment duration. The methods used to accelerate orthodontic tooth movement are broadly classified as surgical methods, device assisted therapy and pharmcological agents.

Surgical methods include corticotomy, periodontally accelerated osteogenic orthodontics, piezocision, micro-osteoperforation, interseptal alveolar surgery, corticision, surgery first approach etc which are all based on Regional Acceleratory Phenomenon (RAP). Device assisted therapy includes low level laser therapy, cyclic vibrations, electric currents, electromagnetic field, LED device, therapeutic ultra sound, self-ligating brackets etc. The most commonly used pharmacological agents to enhance orthodontic tooth movement are Parathyroid hormone, Vitamin D3, Prostaglandin and Relaxin.[2]

In corticotomy, only the cortical bone is surgically perforated using a high-speed hand-piece with a No.1 or No. 2 round bur without any alteration to the medullary bone.[3] Periodontally accelerated osteogenic orthodontics is the same as

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corticotomy in which bone grafts are used which increases the limit of tooth movement and decreases the need for extraction.[4] Piezocision is a minimally invasive approach that involves micro-incisions, piezoelectric incisions and selective tunneling for grafting.[5] Micro-osteoperforations (MOPs) are the procedures carried out on the alveolar bone which enhances the expression of inflammatory markers leading to increase in the number of osteoclasts and the rate of tooth movement.[6]

Interseptal alveolar surgery works on the principle of distraction osteogenesis in which the interseptal bone distal to the tooth to be moved is surgically undermined.[7] Corticision is a technique in which a reinforced scalpel and a mallet are used to cut the bone through the gingiva without reflecting the mucoperiosteal flap.[8] Surgery first approach shortens the prolonged decompensation phase of orthognathic surgery.[9]

Low-level laser therapy (LLLT) stimulates the multiplication of bone cells and thereby increases bone remodeling and accelerates tooth movement.[10] Cyclic vibrations are methods in which mechanical radiations create light alternating forces on the teeth.[2] Electric current of 15μA is reported to increase the osteoclast accumulation on the compression and osteoblast accumulation on the tension side in cats which accelerates the amount of bone turnover and hence increases orthodontic tooth movement.[11] Electromagnetic field increases the orthodontic tooth movement by decreasing the lag phase.[12] An intraoral LED device named Biolux utilizes light of 800-850 nm wavelength which can penetrate the soft tissue and gets directly infused into the bone tissue.[13] A low-intensity therapeutic pulsed ultrasound increases the orthodontic tooth movement by increasing blood flow in the PDL thereby increasing bone remodelling and tooth movement and also decreases root resorption.[14]

Gingival crevicular fluid (GCF) is an osmotically mediated inflammatory exudate in the gingival sulcus which could be an important predictor in orthodontic tooth movement. Various biomarkers found in GCF are Interleukin (IL), Tumor necrosis factor alfa (TNF-alfa), Prostaglandin E2 (PGE2), Osteocalcin (OC), Osteoprotegerin (OPG), Receptor activator of nuclear factor kappa-B ligand (RANKL), Transforming growth factor-beta 1 (TGF-β1), Alkaline phosphatase (ALP), Aspartate aminotransferase (AST), Interleukin-1 (IL-1), Interferon-gamma (IF-gamma) and others.[15] Various methods are used to collect gingival crevicular fluid such as gingival washing technique, Capillary tube method and absorbent filter paper.[16]

Several biochemical markers are expressed in GCF during orthodontic treatment. Hence, the quantification of the biochemical changes in gingival crevicular fluid is important during orthodontic tooth movement. Till date, few studies have been performed for the evaluation of biochemical changes of Osteocalcin and Interleukin-1 during Orthodontic tooth movement. This study was aimed at comparing the changes at Biochemical level between Rapid and Conventional Orthodontic tooth Movement.

Materials and Method:

A split mouth study was conducted on thirty patients undergoing fixed orthodontic treatment (MBT 0.022 x 0.028 inch slot) requiring all four first premolar extractions. All patients visiting the Department of Orthodontics and Dentofacial Orthopaedics who fulfilled the inclusion criteria were included in the study. Prior to the conduction of the study, approval was taken from the Institutional Ethics Committee and informed consent was taken from the patients. The study was conducted to compare changes at Biochemical Level (IL-1 and Osteocalcin) between Rapid and Conventional Orthodontic tooth Movement.

Patients requiring fixed appliance therapy involving extraction of all Maxillary first Premolars, with no signs or symptoms of temporomandibular joint disorder, no use of anti-inflammatory and antibiotic drugs, no grossly decayed or congenitally missing teeth except third molars, no history of systemic illness and with healthy periodontal tissue were included in the study. The exclusion criteria were patients who had undergone long term corticosteroid therapy or were

under medications that slows down bone metabolism such as bisphosphonates and NSAIDS and probing depth value greater than 3 mm in all the teeth.

Before the commencement of the study, patients were instructed to maintain good oral hygiene throughout treatment. After extraction of both maxillary 1st premolars, 0.022 x 0.028-inch MBT brackets were bonded to the teeth. After alignment and leveling, the surgical procedure was performed under local anesthesia (2% lignocaine with 1:100,000 adrenaline). The micro-osteoperforation device was held against the gingiva while keeping the tissue taut. Three micro osteoperforations each were performed distal to the maxillary canine and mesial to second premolar. Type 1 Active tie backs were given immediately on both the sides of the arch after completion of the surgical procedure.

The gingival area was dried with an air syringe, supra gingival plaque was removed and isolated with cotton rolls in order to minimize the contamination from saliva. Gingival crevicular fluid was collected from both the sides of the arch by placing the tip of the 3 µL Calibrated volumetric microcapillary pipette into gingival crevice for 5 minutes at the distal of the maxillary canine before the micro osteoperforation (T0), at day 3 (T1), at day 7 (T2) and at 4 weeks (T3) of initiating canine retraction .A standardized volume of 3 mL GCF was collected using the calibration on the micropipette. Atraumatic collection of GCF was ensured. Samples contaminated with blood or saliva were excluded from the study.

Quantitative analysis of IL-1 and Osteocalcin in GCF sample were assessed. The optical density of samples was calculated using a fully automated enzyme linked immunosorbent assay reader.

Statistical Analysis:

The data collected was entered in Microsoft Excel and subjected to statistical analysis using Statistical Package for Social Sciences (SPSS, IBM version 20.0). The data was evaluated using IBM SPSS version 21 for Windows. One-way ANOVA followed by Bonferroni post hoc tests were used for determining statistical significance between expressions of Biochemical marker levels at different time intervals.

Result:

The present study was carried out to compare changes at Biochemical Level (IL-1 and Osteocalcin) between Conventional and Micro-osteoperforation site in Orthodontic tooth movement. The results are based on analysis of 30 patients by evaluating the level of IL-1 and Osteocalcin in GCF.

Table 1: Comparison of IL-1 values at conventional and Micro osteoperforation site at different time intervals

Test Intervals	Site	Mean	SD	t value and significance	P value and significance
Baseline (T0)	Conventional site Micro osteoperforation site	29.04 28.38	1.80 3.80	0.405	0.670
3 days (T1)	Conventional site Micro osteoperforation site	51.80 130.57	12.17 20.90	10.128	00.00***
7 days(T2)	Conventional site Micro osteoperforation site	47.45 120.37	7.34 19.38	10.610	00.00***
4 weeks(T3)	Conventional site Micro osteoperforation site	43.74 110.56	7.95 16.17	10.900	00.00***

**p<0.001 – Very highly significant

Graph 1: Comparison of IL-1 values at conventional and Micro osteoperforation site at different time intervals

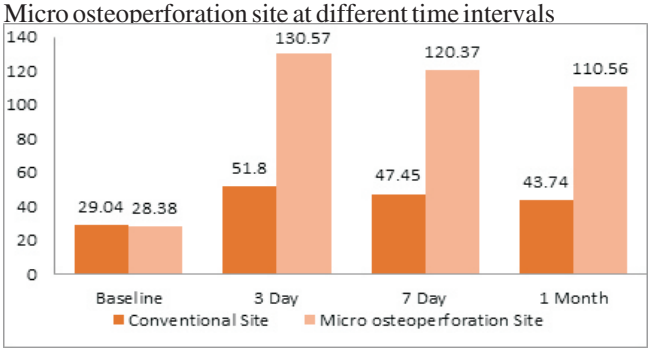

Table 1 and Graph 1 shows the level of IL-1 at the conventional and Micro osteoperforation site. Except for the comparison between baseline values, all other comparisons yielded statistically very highly significant results, indicating that the level of IL-1 was always higher at the micro

osteoperforation site.

Table 2: Comparison of Osteocalcin values at conventional and Micro osteoperforation site at different time intervals

Test Intervals	Site	Mean	SD	t- value and significance	Post - hoc value and significance
Baseline (T0)	Conventional site		2.26	0.247	0.766
	Micro osteoperforation site	35.43 35.16	2.01		
3 days (T1)	Conventional site		2.41	5.811	00.00***
	Micro osteoperforation site	38.46 46.06	3.16		
7 days (T2)	Conventional site		3.10	6.670	00.00***
	Micro osteoperforation site	39.70 50.71	3.66		
4 weeks (T3)	Conventional site		3.17	10.390	00.00***
	Micro osteoperforation site	37.01 53.18	3.57		

***p<0.001 – Very highly significant

Graph 2: Comparison of Osteocalcin values at conventional

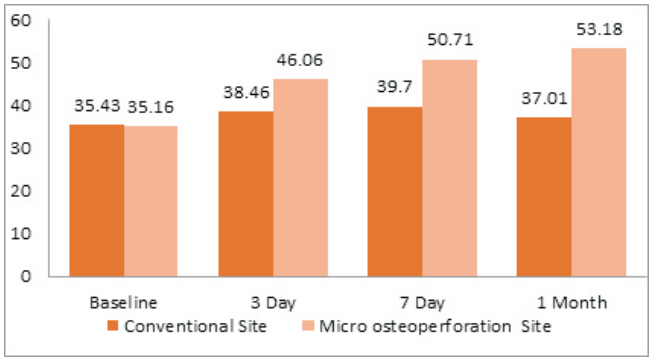

Table 2 and Graph 2 shows the level of Osteocalcin at the conventional and Micro osteoperforation site at different time intervals. Except for the comparison between baseline values all other comparisons yielded statistically significant results, indicating that the level of Osteocalcin was always higher at the micro osteoperforation site.

Discussion:

In the present study, the levels of IL-1 from both the conventional and micro-osteoperforation sites are provided in Table 1. One-way ANOVA result yielded statistically significant difference between different time intervals. At conventional site, significant elevation in the level of IL-1 was observed on day 3 (T1) as compared to baseline (T0). A gradual decrease in the level of IL-1 was observed on day 7 (T2) and at four weeks (T3). At micro osteoperforation site, sudden increase in the level of IL-1 was observed on day 3 (T1) as compared to baseline (T0). A gradual decrease in the level of IL-1 was observed on day 7 (T3) and at four weeks (T4). The level of IL-1 was always higher at micro osteoperforation site as compared to conventional site at different time intervals except for the comparison between the baseline values. Similar results were found by Yijin Ren et al. (2007)[17], Alikhani et al. (2015)[1] and Kapoor et al (2014)[18]. Their results show that IL-1 level in GCF was significantly higher in micro osteoperforation site.

Yijin Ren et al. (2007)[17] conducted a study to measure a panel of pro-inflammatory cytokines in gingival crevicular fluid samples during tooth movement of short and long duration. They reported that the level of IL-1 Beta reached significant levels at 24 hours after orthodontic force application. They concluded that the levels of IL-1Beta, IL-6 and IL-8 and TNF-alfa play a significant role during the early stages of tooth movement but not during the linear stages.

Alikhani et al (2013)[1] studied the effect of MOPs in the rate of tooth movement and the expression of inflammatory markers. They reported that MOPs resulted in significant increase in the level of IL-1 after 24 hours of orthodontic force application which resulted in increased rate of tooth movement by 2 to 3 folds. Kapoor et al (2014)[18] conducted a systematic review to assess the association of cytokine and receptor levels or activity index in GCF with velocity of tooth movement. The level of IL-1 reached peak in GCF after 24 hours of orthodontic force application which displayed faster rate of orthodontic tooth movement.

The levels of Osteocalcin from both the conventional and micro osteoperforation sites are provided in Table 2. One-way ANOVA result yielded statistically significant change between different time intervals. At conventional site, gradual increase in the level of Osteocalcin was observed at day 3(T1) as compared to baseline(T0). The level of Osteocalcin showed a peak value at day 7(T2). A gradual decrease in the level was observed after four weeks(T3). At micro osteoperforation site, the level of Osteocalcin was increased on day 3(T1) and day 7(T2) as compared to baseline. The level of Osteocalcin showed a peak value after 4 weeks(T3). The

level of Osteocalcin was always higher at micro osteoperforation site as compared to conventional site at different time intervals except for the comparison between the baseline values.

The same results were found in the study conducted by Hashimoto et al. (2001)[19]. They reported that on administration of Osteocalcin, orthodontic tooth movement was accelerated due to enhancement of osteoclastogenesis on the pressure side. Holland (2019)[20] found that Osteocalcin level was highest in PDL at day 4 of orthodontic tooth movement.

Their results show that the level of Osteocalcin in GCF was significantly higher in experimental group than in the control group. In contrast to the results of the present study, Isik et al. (2005)[21] reported a decrease in the level of Osteocalcin in GCF during orthodontic intrusion of maxillary premolar teeth. Intrusive force applied to the premolars results in hyalinization of the surrounding tissues, which in turn slows down the bone turnover process taking place around the tooth thereby, decreasing the bone markers in gingival crevicular fluid.

Conclusion:

The study was intended to compare the Biochemical changes between Rapid and Conventional Orthodontic tooth movement. The following conclusions can be drawn from the results:

1. The levels of bone-resorbing IL-1 peaked at the third day in both conventional and micro osteoperforation site.
2. The levels of Osteocalcin peaked at 4th week in micro osteoperforation site whereas on 7th day in conventional site.
3. There was a gradual increase in the levels of IL-1 and Osteocalcin in both conventional and micro osteoperforation site but statistically significant elevated levels of IL-1 and Osteocalcin was seen in micro osteoperforation site compared to conventional site.

References:

1. Alikhani et al. Effect of micro-osteoperforations on the rate of tooth movement. Am J Orthod Dentofacial Orthop 2013;144(5):639-648.
2. Unnam D, Sankar GS, Prasad M, Reddy GV. Accelerated Orthodontics– An overview. J Dent Craniofacial Res. 2018:3(4):1-6.
3. Sharma K, Batra P, Sonar S, Srivastava A, Raghavan S. Periodontically accelerated orthodontic tooth movement: A narrative review. J Indian Soc Periodontol 2019;23:5-11.
4. Wilcko MT, Wilcko WM, Bissada NF. An evidence-based analysis of periodontally accelerated orthodontic and osteogenic techniques: A synthesis of scientific perspectives. Semin Orthod 2008;14:305-16.
5. Bakathir MA, Hassan HA, BahammamMA. Piezocision as an adiunct to orthodontic treatment of unilateral posterior crossbite. Saudi Med J 2017;38(4):425-430.
6. Teixeira et al. Cytokine expression and accelerated tooth movement. J Dent Res 2010; 89:1135-41.
7. Liou EJ, Huang CS. Rapid canine retraction through distraction of the periodontal ligament. Am J Orthod Dentofacial Orthop 1998;114(4):372-382.
8. Kim JS, Park GY, Kang GS. Effects of corticision on paradental remodeling in orthodontic tooth movement. Angle Orthod 2009;79(2):284-291.
9. Liou EJ, Chen PH, Wang YC, Yu CC, Huang CS, Chen YR. Surgery first approach in surgical orthodontic treatment of mandibular prognathism- A case report. Chang Med J 2010;33:699-705.
10. Fujita S, Yamaguchi M, Utsunomiya T, Yamamoto H, Kasai K.Low-energy laser stimulates tooth movement velocity via expression of RANK and RANKL. Orthod Craniofac Res 2008;11:143-55.
11. Davidovitch Z, Finkelson MD, Steigman S, Shanfeld JL, Montgomery PC, Korostoff E. Electric currents, bone remodeling, and orthodontic tooth movement. I. The effect of electric currents on periodontal cyclic nucleotides. Am J Orthod. 1980;77(1):14-32.
12. Showkatbakhsh R, Jamilian A, Showkatbakhsh M. The effect of pulsed electromagnetic fields on the acceleration of tooth movement. World J Orthod 2010;11(4):e52-56.
13. Kau CH, Kantarci A, Shaughnessy T, Vachiramon A, Santiwong P, Fuente A et al.Photobiostimulation accelerates orthodontic alignment in the early phase of

treatment. Prog Orthod 2013;14:30.

14. Proffit WR, Fields HW, Sarver DM. The biologic basis of orthodontic therapy.In: Contemporary Orthodontics. 6th edition. New Delhi: Elsevier:2007.p. 278-281.
15. Oswal S, Dwarkanath CD. Relevance of gingival crevice fluid component in assessment of periodontal disease: A critical analysis. J IndSoc Periodontal 2010;14:282-86.
16. Griffiths GS. "Formation, collection and significance of gingival crevice fluid." Periodontology 2000;31:32–42.
17. Ren Y, Hazemeijer H, Haan B, Qu N, Vos P. Cytokine profiles in crevicular fluid during orthodontic tooth movement in short and long durations. J Periodontol 2007;78(3):453-8.
18. Kapoor P, Kharbanda OP,Kapila S. Effect of orthodontic forces on cytokine and receptor levels in gingival crevicular fluid: A systematic review. Prog Orthod 2014;15(1):65
19. Hashimoto F, Kobayashi Y, Mataki S, Kobayashi K, Kato Y, Sakai H. Administration of osteocalcin accelerates orthodontic tooth movement induced by a closed coil spring in rats. European Journal of Orthodontics 2001;23:535–545.
20. Holland R,Bain C, Utreja A. Osteoblast differentiation during orthodontic tooth movement. Orthod Craniofac Res. 2019;4(2):177-182.
21. Isik F, Sayinsu K, Arun T, Unlucerci Y. Bone marker levels in gingival crevicular fluid during orthodontic intrusive tooth movement: A preliminary study. Journal of Contemporary Dental Practice 2005;6(2):27-35.