Academic Journal of Research and Scientific Publishing | Vol 3 | Issue 32
Publication Date: 5-12-2021 ISSN: 2706-6495

Periodontally Accelerated Osteogenic Orthodontics (PAOO) vs Osteoperforations (A Review on Periodontal Reactions to Orthodontic Tooth Movement)

Dr. Miral Agrawal[1*], Dr. Shefali Sharma[2], Dr. Parmeshwari Rathod[3]

BDS, MDS, Agrawal's Dental Clinic, Dahod, India[1.2.3]

[*]Email: miral_agarwal@yahoo.co.in

Abstract

A high number of adult patients are undertaking orthodontic treatment now because of the newer methods, technology, and innovations available in the market. Orthodontic profession is continually looking for new ways to perform treatment effectively for such patients, as there are many differences in the biology, motivation, and treatment objectives between adults and children. Aligner therapy and mini-implants are some of the ways of managing orthodontic treatment for adult patients. Treatment time is a concern for adult patients and methods to accelerate the orthodontic tooth movement have been a focus in the orthodontic field. Periodontal accelerated osteogenic orthodontics (PAOO) is a surgical procedure that is performed with a combination of alveolar corticotomy, bone grafting, followed by orthodontic treatment. This procedure uses the principle of regional acceleratory phenomenon (RAP).

Another procedure commonly used for accelerated orthodontic tooth movement is osteoperforations. This is a minimally invasive procedure, which does not include a flap surgery.

The purpose of this article is to describe the differences between adult and children periodontal tissues, the use of different appliances for adult treatment, how orthodontic treatment has been modified for adult patients, and the detailed explanation of procedures for accelerating orthodontic tooth movement such as PAOO and osteoperforations and the potential complications

Keywords: Periodontics, orthodontics, Periodontal accelerated osteogenic orthodontics, adults**.**

1. Introduction

There has been an upsurge in the number of adult patients undertaking orthodontic treatment.[1] multiple differences have been identified in the biology of alveolar bone, periodontal tissues, and gingival health between adult and adolescent patients. The motivations for adult patients are different from that of children. The objectives of the treatment also have to be adjusted accordingly. Mainly the adults' patients are concerned about the facial and dental aesthetics, the color of orthodontic appliances, and the time of orthodontic treatment. Frequently, adults have missing teeth and therefore the treatment planning needs to include other specialties. Adults do not grow at the same rate as children and therefore is not an importance consideration while planning treatment.[2] at the same time, there is a higher amount of hyalinization that can occur due to orthodontic treatment in adult patients. When orthodontic force is applied, many cellular and vascular changes take place in the surrounding periodontal structures. In adults, the cell mobilization and conversion of collagen fibers in slower than in children. In adults, there is a higher chance of periodontal complications in adult patients.[3,4,5]

2. Materials and methods

An extensive literature search was done for the assessment of studies investigating the differences between biology, objectives, and treatment for children and adult patients.

The studies evaluating the new techniques such as aligner therapy, mini-implants, and acceleration of tooth movement were searched. Following these studies, the considerations for adult orthodontic treatment were compiled.

3. Results

Considerations in adult orthodontic treatment

Orthodontic treatment for adult patients is different as compared to children. For these reasons, in adult treatment the use of aligners which are esthetic, mini-implants, using light forces, and innovative design for reducing orthodontic treatment time is required.[6] Aligners are made of thermoplastic material and therefore are clear and an attractive esthetic option for most adult patients. Initially, aligners were used for limited orthodontic treatment. But nowadays, results have shown that aligners can be used to undertake complex orthodontic tooth movement as well.[7] Mini-implants can be used for the correction of complex malocclusion for orthodontic patients. Mini-implants can be used in adult patients for distalization procedures.[8] There are some applications with mini-implants in adults with open bite. In such cases, mini-implants can be used for posterior intrusion and result in correction of openbite especially in adult patients.[9] In some cases, mini-implants can be used for the correction of transverse discrepancies such as posterior crossbite with mini-implants supported rapid palatal expansion (MARPE) appliance. In adult patients, MARPE appliances give more skeletal expansion than dental expansion as the midpalatal suture is fused.[10] Expansion appliances used in children cannot be used in adults because of the differences in suture maturation.[11] MARPE appliances have high success rates, high stability and are found to be safe on Temporomandibular Joint.[12] MARPE appliances can be designed in different ways depending on the type of malocclusion.

MARPE appliance uses palatal mini implants which have shown high success rates compared to buccal mini implants.[13] It can also be designed with mini-implants on only one side of the mid-palatal suture so that the expansion takes place on only one side.[14] This kind of innovative biomechanical designs can help in decreasing the duration of orthodontic treatment.[14] Mini-implants can also be used for correction of protrusive teeth in adult patients by maximum retraction of anterior teeth.[15] For class III patients, mini-implants can be used to move the maxilla forward and counterclockwise rotation of mandible by intermaxillary elastics on maxillary and mandibular mini-implants.[16] The development of surgical procedures for acceleration of orthodontic treatment has provided new solutions for the limitations of orthodontic treatment in adults. Some of prominent methods are the periodontally accelerated osteogenic orthodontics (PAOO) and osteoperforations. The aim of this article is to present comprehensive review of the literature, including the historical background, contemporary clinical techniques, indications, contraindications, complications and side effects.

4. Discussion

Periodontal accelerated osteogenic orthodontics (PAOO)

With PAOO, there is an increase in the net alveolar volume once the orthodontic treatment is completed. This technique utilizes a combination of selective decortications and alveolar augmentations.[17] There are multiple advantages with this technique such as a decrease in the treatment duration, increased in the maxillary expansion, conducting differential tooth movement leading to higher desired tooth movement and lower undesired tooth movement, faster and predictable movement for impactions, and finally higher stability after orthodontic treatment.[18] The PAOO technique enables the orthodontist to move the teeth in situations with low preexisting alveolar volume. It also increases the extent of movement that can be achieved safely by 2 to 3 times and reduce the time with orthodontic treatment.[19]

In PAOO technique, surgical scarring of the cortical bone is performed on the labial-aspects and the lingual-aspects of teeth.[20] This is followed by grating of the alveolar bone. The procedure is performed on the teeth that need to be moved more extensively for the purpose of orthodontic treatment. The teeth that do not required movement are not included in the procedure. For example, in a patient with extractions of four first premolars, if the treatment objective is to retract the maxillary incisors to the full extent possible and reduce the amount of anchorage loss of maxillary molars, the procedure is performed only for the anterior teeth. However, if the objective is to protract mandibular second molar in the missing mandibular first molar space, then the PAOO technique will be performed for the mandibular second molar and not on the anteriors. In this way, selective and differential tooth movement can be achieved for the desired objectives. After the PAOO technique is performed, the patient is recalled after 2 weeks to identify the tooth movement and perform the necessary changes with more frequent orthodontic adjustments. The rapid tooth movement that occurs with PAOO is difference than that with normal tooth movement. It has been reported that a localized osteoporosis like condition occurs after PAOO as a healing process.[21] This occurs due to a regional accelerator phenomenon (RAP) which was first described by Robert Frost.[22] RAP occurs after a normal injury to tissues such as fracture, or it can be induced due to surgical procedures such as osteotomy, bone-grafting, or osteoperforations.[22,23]

Osteoperforations

A less invasive manner of inducing RAP is to do minimally invasive surgery like osteoperforations. Osteoperforations are performed by penetrating the mucosa and alveolar bone in the region of interest.[24] This method is performed adjacent to the teeth where increased rate of tooth movement is desired. It is not performed on the teeth where minimal orthodontic tooth movement is desired to allow the utilization of the differential tooth movement process. This can be done by perforating the gingiva and bone at three locations around the teeth to be moved.

When osteoperforations are performed, it is found that the alveolar bone volume decreases.[25] This results due to increase in the number of osteoclasts. Because of the increased osteoclasts, there is increased rate of resorption of bone.[25] The inflammatory process after osteoperforations last for a period of 2-3 months.[26] This is the period when there is a higher rate of bone resorption. The rate of bone resorption is important in modulating the increase or decrease in the rate of tooth movement.[27] The effects of osteoperforations can be extended for a longer duration if the osteoperforations are made again after a period to increase the inflammatory response. The downside of accelerating tooth movement with these methods is the root resorption that accompanies the tooth movement.[28] This has been a concern for most clinicians since a long time with the osteoperforation procedures and its utility in clinical practice. A recent study has found a solution to this problem. It has been shown that when the osteoperforations are performed 5 mm farther to the molar tooth, then the root resorption is reduced significantly.[29] With osteoperforations farther from the molars, there is still a significant acceleration of the tooth movement.[29]

Complications and Side effects

PAOO is a surgical procedure and therefore there have been reports of adverse effects to the periodontium after the procedure. The patients may present with no symptoms to interdental bone loss, reduced attached gingiva, periodontal defects specially if there is short interdental distance before the surgery.[18, 30-32] With corticotomies, there have been reported incidences of hematomas developing subcutaneously in the head and neck region.[33, 34] There is also post-operative swelling and pain after such a procedure.[35-39] On the other hand, osteoperforations are a minimally invasive procedure. It does not require to raise a surgical flap like in PAOO. This leads to less complication rate than PAOO.

5. Conclusion

Adult orthodontic treatment is different than children. The techniques of aligner therapy and mini-implants have opened a lot of new treatment options and appliance designs for orthodontists. Acceleration of orthodontic tooth movement can be achieved in different ways. PAOO technique is one such option that helps in rapid alignment of teeth and decreased the treatment duration. With a combination of periodontal surgery and orthodontic treatment, the esthetics of patients can be affected positively to as a significantly degree. The downside of PAOO is the surgical complications and the associated cost. Osteoperforations can be performed as a less invasive method for acceleration of tooth movement when indicated.

6. References

1. Mathews DP, Kokich VG. Managing treatment for the orthodontic patient with periodontal problems. Semin Orthod. 1997;3:21-38.
2. Johnson D. (2003). Periodontic and orthodontic treatment in adults. American journal of orthodontics and dentofacial orthopedics. 123(2), 13A. https://doi.org/ HYPERLINK "https://doi.org/10.1067/mod.2003.99"10.1067 HYPERLINK "https://doi.org/10.1067/mod.2003.99"/mod. HYPERLINK "https://doi.org/10.1067/mod.2003.99"2003.99
3. Melo, A. C., Carneiro, L. O., Pontes, L. F., Cecim, R. L., de Mattos, J. N., & Normando, D. (2013). Factors related to orthodontic treatment time in adult patients. Dental press journal of orthodontics, 18(5), 59–63. https://doi.org/ HYPERLINK "https://doi.org/10.1590/s2176-94512013000500011"10.1590 HYPERLINK "https://doi.org/10.1590/s2176-94512013000500011"/s HYPERLINK "https://doi.org/10.1590/s2176-94512013000500011"2176-94512013000500011.

4. Dyer, G. S., Harris, E. F., & Vaden, J. L. (1991). Age effects on orthodontic treatment: adolescents contrasted with adults. American journal of orthodontics and dentofacial orthopedics. 100(6), 523–530. https://doi.org/ HYPERLINK "https://doi.org/10.1016/0889-5406(91)70092-B"10.1016 HYPERLINK "https://doi.org/10.1016/0889-5406(91)70092-B"/ HYPERLINK "https://doi.org/10.1016/0889-5406(91)70092-B"0889-5406 HYPERLINK "https://doi.org/10.1016/0889-5406(91)70092-B"(HYPERLINK "https://doi.org/10.1016/0889-5406(91)70092-B"91 HYPERLINK "https://doi.org/10.1016/0889-5406(91)70092-B") HYPERLINK "https://doi.org/10.1016/0889-5406(91)70092-B"70092 HYPERLINK "https://doi.org/10.1016/0889-5406(91)70092-B"-B.

5. Beckwith, F. R., Ackerman, R. J., Jr, Cobb, C. M., & Tira, D. E. (1999). An evaluation of factors affecting duration of orthodontic treatment. American journal of orthodontics and dentofacial orthopedics, 115(4), 439–447. https://doi.org/ HYPERLINK "https://doi.org/10.1016/s0889-5406(99)70265-9"10.1016 HYPERLINK "https://doi.org/10.1016/s0889-5406(99)70265-9"/s HYPERLINK "https://doi.org/10.1016/s0889-5406(99)70265-9"0889-5406 HYPERLINK "https://doi.org/10.1016/s0889-5406(99)70265-9"(HYPERLINK "https://doi.org/10.1016/s0889-5406(99)70265-9"99 HYPERLINK "https://doi.org/10.1016/s0889-5406(99)70265-9") HYPERLINK "https://doi.org/10.1016/s0889-5406(99)70265-9"70265-9

6. Weir T. (2017). Clear aligners in orthodontic treatment. Australian dental journal, 62 Suppl 1, 58–62. https://doi.org/ HYPERLINK "https://doi.org/10.1111/adj.12480"10.1111 HYPERLINK "https://doi.org/10.1111/adj.12480"/adj. HYPERLINK "https://doi.org/10.1111/adj.12480"12480.

7. Mehta, S., Patel, D., & Yadav, S. (2021) Staging orthodontic aligners for complex orthodontic tooth movement. Turkish Journal of Orthodontics, 34(3): 202-206. DOI: 10.5152/TurkJOrthod.2021.20116

8. Miresmaeili, A., Sajedi, A., Moghimbeigi, A., & Farhadian, N. (2015). Three-dimensional analysis of the distal movement of maxillary 1st molars in patients fitted with mini-implant-aided trans-palatal arches. Korean journal of orthodontics, 45(5), 236–244. https://doi.org/ HYPERLINK "https://doi.org/10.4041/kjod.2015.45.5.236"10.4041 HYPERLINK "https://doi.org/10.4041/kjod.2015.45.5.236"/kjod. HYPERLINK "https://doi.org/10.4041/kjod.2015.45.5.236"2015.45.5.236.

9. Kalia A. (2018). Nonsurgical Correction of Class III Malocclusion and Anterior Open Bite with Mini-Implant anchorage. Journal of clinical orthodontics : JCO, 52(11), 629–638..

10. Mehta, S., Wang, D., Kuo, C. L., Mu, J., Vich, M. L., Allareddy, V., Tadinada, A., & Yadav, S. (2021). Long-term effects of mini-screw-assisted rapid palatal expansion on airway. The Angle orthodontist, 91(2), 195–205. https://doi.org/ HYPERLINK "https://doi.org/10.2319/062520-586.1"10.2319 HYPERLINK "https://doi.org/10.2319/062520-586.1"/ HYPERLINK "https://doi.org/10.2319/062520-586.1"062520-586.1

11. Angelieri, F., Cevidanes, L. H., Franchi, L., Gonçalves, J. R., Benavides, E., & McNamara, J. A., Jr (2013). Midpalatal suture maturation: classification method for individual assessment before rapid maxillary expansion. American journal of orthodontics and dentofacial orthopedics, 144(5), 759–769. https://doi.org/ HYPERLINK "https://doi.org/10.1016/j.ajodo.2013.04.022"10.1016 HYPERLINK "https://doi.org/10.1016/j.ajodo.2013.04.022"/j.ajodo. HYPERLINK "https://doi.org/10.1016/j.ajodo.2013.04.022"2013.04.022.

12. Mehta, S., Chen, P. J., Vich, M. L., Upadhyay, M., Tadinada, A., & Yadav, S. (2021). Bone-anchored versus tooth-anchored expansion appliances: Long-term effects on the condyle-fossa relationship. Journal of the World federation of orthodontists, S2212-4438(21)00031-X. Advance online publication. https://doi.org/ HYPERLINK

"https://doi.org/10.1016/j.ejwf.2021.07.001"10.1016 HYPERLINK "https://doi.org/10.1016/j.ejwf.2021.07.001"/j.ejwf. HYPERLINK "https://doi.org/10.1016/j.ejwf.2021.07.001"2021.07.001

13. Arqub, S. A., Gandhi, V., Mehta, S., Palo, L., Upadhyay, M., & Yadav, S. (2021). Survival estimates and risk factors for failure of palatal and buccal mini-implants. The Angle orthodontist, 91(6), 756–763. https://doi.org/ HYPERLINK "https://doi.org/10.2319/090720-777.1"10.2319 HYPERLINK "https://doi.org/10.2319/090720-777.1"/ HYPERLINK "https://doi.org/10.2319/090720-777.1"090720-777.1

14. Dzingle, J., Mehta, S., Chen, P. J., & Yadav, S. (2020). Correction of Unilateral Posterior Crossbite with U-MARPE. Turkish journal of orthodontics, 33(3), 192–196. https://doi.org/ HYPERLINK "https://doi.org/10.5152/TurkJOrthod.2020.20034"10.5152 HYPERLINK "https://doi.org/10.5152/TurkJOrthod.2020.20034"/TurkJOrthod. HYPERLINK "https://doi.org/10.5152/TurkJOrthod.2020.20034"2020.20034.

15. Becker, K., Pliska, A., Busch, C., Wilmes, B., Wolf, M., & Drescher, D. (2018). Efficacy of orthodontic mini implants for en masse retraction in the maxilla: a systematic review and meta-analysis. International journal of implant dentistry, 4(1), 35. https://doi.org/ HYPERLINK "https://doi.org/10.1186/s40729-018-0144-4"10.1186 HYPERLINK "https://doi.org/10.1186/s40729-018-0144-4"/s HYPERLINK "https://doi.org/10.1186/s40729-018-0144-4"40729-018-0144-4

16. Mehta, S., Chen, P. J., Upadhyay, M., & Yadav, S. (2021). Intermaxillary elastics on skeletal anchorage and MARPE to treat a class III maxillary retrognathic open bite adolescent: A case report. International orthodontics, S1761-7227(21)00107-8. Advance online publication. https://doi.org/ HYPERLINK "https://doi.org/10.1016/j.ortho.2021.08.001"10.1016 HYPERLINK "https://doi.org/10.1016/j.ortho.2021.08.001"/j.ortho. HYPERLINK "https://doi.org/10.1016/j.ortho.2021.08.001"2021.08.001

17. Wilcko, W. M., Wilcko, T., Bouquot, J. E., & Ferguson, D. J. (2001). Rapid orthodontics with alveolar reshaping: two case reports of decrowding. The International journal of periodontics & restorative dentistry, 21(1), 9–19.

18. Wilcko, M. T., Wilcko, W. M., Pulver, J. J., Bissada, N. F., & Bouquot, J. E. (2009). Accelerated osteogenic orthodontics technique: a 1-stage surgically facilitated rapid orthodontic technique with alveolar augmentation. Journal of oral and maxillofacial surgery, 67(10), 2149–2159. https://doi.org/ HYPERLINK "https://doi.org/10.1016/j.joms.2009.04.095"10.1016 HYPERLINK "https://doi.org/10.1016/j.joms.2009.04.095"/j.joms. HYPERLINK "https://doi.org/10.1016/j.joms.2009.04.095"2009.04.095.

19. Sebaoun, J. D., Ferguson, D. J., Wilcko, M. T., & Wilcko, W. M. (2007). Corticotomie alvéolaire et traitements orthodontiques rapides [Alveolar osteotomy and rapid orthodontic treatments]. L' Orthodontie francaise, 78(3), 217–225. https://doi.org/ HYPERLINK "https://doi.org/10.1051/orthodfr:2007025"10.1051 HYPERLINK "https://doi.org/10.1051/orthodfr:2007025"/orthodfr: HYPERLINK "https://doi.org/10.1051/orthodfr:2007025"2007025.

20. KOLE H. (1959). Surgical operations on the alveolar ridge to correct occlusal abnormalities. Oral surgery, oral medicine, and oral pathology, 12(5), . https://doi.org/ HYPERLINK "https://doi.org/10.1016/0030-4220(59)90153-7"10.1016 HYPERLINK "https://doi.org/10.1016/0030-4220(59)90153-7"/ HYPERLINK "https://doi.org/10.1016/0030-4220(59)90153-7"0030-4220 HYPERLINK "https://doi.org/10.1016/0030-4220(59)90153-7"(HYPERLINK "https://doi.org/10.1016/0030-4220(59)90153-7"59 HYPERLINK "https://doi.org/10.1016/0030-4220(59)90153-7") HYPERLINK "https://doi.org/10.1016/0030-4220(59)90153-7"90153-7.

21. Schilling, T., Müller, M., Minne, H. W., & Ziegler, R. (1998). Influence of inflammation-mediated osteopenia on the regional acceleratory phenomenon and the systemic acceleratory phenomenon during healing of a bone defect in

the rat. Calcified tissue international, 63(2), 160–166. https://doi.org/ HYPERLINK "https://doi.org/10.1007/s002239900508"10.1007 HYPERLINK "https://doi.org/10.1007/s002239900508"/s HYPERLINK "https://doi.org/10.1007/s002239900508"002239900508.

22. Frost H. M. (1983). The regional acceleratory phenomenon: a review. Henry Ford Hospital medical journal, 31(1), 3–9..

23. Frost H. M. (1989). The biology of fracture healing. An overview for clinicians. Part I. Clinical orthopaedics and related research, (248), 283–293..

24. Alikhani, M., Raptis, M., Zoldan, B., Sangsuwon, C., Lee, Y. B., Alyami, B., Corpodian, C., Barrera, L. M., Alansari, S., Khoo, E., & Teixeira, C. (2013). Effect of micro-osteoperforations on the rate of tooth movement. American journal of orthodontics and dentofacial orthopedics, 144(5), 639–648. https://doi.org/ HYPERLINK "https://doi.org/10.1016/j.ajodo.2013.06.017"10.1016 HYPERLINK "https://doi.org/10.1016/j.ajodo.2013.06.017"/j.ajodo. HYPERLINK "https://doi.org/10.1016/j.ajodo.2013.06.017"2013.06.017.

25. Nanda, A., Chen, P. J., Mehta, S., Kalajzic, Z., Dutra, E. H., Allareddy, V., Nanda, R., & Yadav, S. (2020). The effect of differential force system and minimal surgical intervention on orthodontic tooth movement and root resorption. European journal of orthodontics, cjaa065. Advance online publication. https://doi.org/ HYPERLINK "https://doi.org/10.1093/ejo/cjaa065"10.1093 HYPERLINK "https://doi.org/10.1093/ejo/cjaa065"/ejo/cjaa HYPERLINK "https://doi.org/10.1093/ejo/cjaa065"065

26. van Gemert, L. N., Campbell, P. M., Opperman, L. A., & Buschang, P. H. (2019). Localizing the osseous boundaries of micro-osteoperforations. American journal of orthodontics and dentofacial orthopedics, 155(6), 779–790. https://doi.org/ HYPERLINK "https://doi.org/10.1016/j.ajodo.2018.07.022"10.1016 HYPERLINK

"https://doi.org/10.1016/j.ajodo.2018.07.022"/j.ajodo. HYPERLINK "https://doi.org/10.1016/j.ajodo.2018.07.022"2018.07.022

27. Azami, N., Chen, P. J., Mehta, S., Kalajzic, Z., Dutra, E. H., Nanda, R., & Yadav, S. (2020). Raloxifene administration enhances retention in an orthodontic relapse model. European journal of orthodontics, 42(4), 371–377. https://doi.org/ HYPERLINK "https://doi.org/10.1093/ejo/cjaa008"10.1093 HYPERLINK "https://doi.org/10.1093/ejo/cjaa008"/ejo/cjaa HYPERLINK "https://doi.org/10.1093/ejo/cjaa008"008.

28. Asif, M. K., Ibrahim, N., Sivarajan, S., Heng Khiang Teh, N., & Chek Wey, M. (2020). Osseous evidence behind micro-osteoperforation technique in accelerating orthodontic tooth movement: A 3-month study. American journal of orthodontics and dentofacial orthopedics, 158(4), 579–586.e1. https://doi.org/ HYPERLINK "https://doi.org/10.1016/j.ajodo.2019.09.022"10.1016 HYPERLINK "https://doi.org/10.1016/j.ajodo.2019.09.022"/j.ajodo. HYPERLINK "https://doi.org/10.1016/j.ajodo.2019.09.022"2019.09.022

29. Mehta, S., Chen, P. J., Kalajzic, Z., Ahmida, A., & Yadav, S. (2021). Acceleration of orthodontic tooth movement and root resorption with near and distant surgical insults: An in-vivo study on a rat model. International orthodontics, S1761-7227(21)00125-X. Advance online publication. https://doi.org/ HYPERLINK "https://doi.org/10.1016/j.ortho.2021.10.002"10.1016 HYPERLINK "https://doi.org/10.1016/j.ortho.2021.10.002"/j.ortho. HYPERLINK "https://doi.org/10.1016/j.ortho.2021.10.002"2021.10.002

30. Iino, S., Sakoda, S., & Miyawaki, S. (2006). An adult bimaxillary protrusion treated with corticotomy-facilitated orthodontics and titanium miniplates. The Angle orthodontist, 76(6), 1074–1082. https://doi.org/ HYPERLINK "https://doi.org/10.2319/103105-384"10.2319 HYPERLINK

"https://doi.org/10.2319/103105-384"/ HYPERLINK "https://doi.org/10.2319/103105-384"103105-384.

31. Kwon, H. J., Pihlstrom, B., & Waite, D. E. (1985). Effects on the periodontium of vertical bone cutting for segmental osteotomy. Journal of oral and maxillofacial surgery : official journal of the American Association of Oral and Maxillofacial Surgeons, 43(12), 952–955. https://doi.org/ HYPERLINK "https://doi.org/10.1016/0278-2391(85)90009-6"10.1016 HYPERLINK "https://doi.org/10.1016/0278-2391(85)90009-6"/ HYPERLINK "https://doi.org/10.1016/0278-2391(85)90009-6"0278-2391 HYPERLINK "https://doi.org/10.1016/0278-2391(85)90009-6"(HYPERLINK "https://doi.org/10.1016/0278-2391(85)90009-6"85 HYPERLINK "https://doi.org/10.1016/0278-2391(85)90009-6") HYPERLINK "https://doi.org/10.1016/0278-2391(85)90009-6"90009-6.

32. Dorfman, H. S., & Turvey, T. A. (1979). Alterations in osseous crestal height following interdental osteotomies. Oral surgery, oral medicine, and oral pathology, 48(2), 120–125. https://doi.org/ HYPERLINK "https://doi.org/10.1016/0030-4220(79)90048-3"10.1016 HYPERLINK "https://doi.org/10.1016/0030-4220(79)90048-3"/ HYPERLINK "https://doi.org/10.1016/0030-4220(79)90048-3"0030-4220 HYPERLINK "https://doi.org/10.1016/0030-4220(79)90048-3"(HYPERLINK "https://doi.org/10.1016/0030-4220(79)90048-3"79 HYPERLINK "https://doi.org/10.1016/0030-4220(79)90048-3") HYPERLINK "https://doi.org/10.1016/0030-4220(79)90048-3"90048-3.

33. Oztürk, M., Doruk, C., Ozeç, I., Polat, S., Babacan, H., & Biçakci, A. A. (2003). Pulpal blood flow: effects of corticotomy and midline osteotomy in surgically assisted rapid palatal expansion. Journal of cranio-maxillo-facial surgery, 31(2), 97–100. https://doi.org/ HYPERLINK "https://doi.org/10.1016/s1010-5182(02)00188-9"10.1016 HYPERLINK "https://doi.org/10.1016/s1010-5182(02)00188-9"/s HYPERLINK "https://doi.org/10.1016/s1010-5182(02)00188-9"1010-5182 HYPERLINK

"https://doi.org/10.1016/s1010-5182(02)00188-9"(HYPERLINK "https://doi.org/10.1016/s1010-5182(02)00188-9"02 HYPERLINK "https://doi.org/10.1016/s1010-5182(02)00188-9") HYPERLINK "https://doi.org/10.1016/s1010-5182(02)00188-9"00188-9.

34. Gantes, B., Rathbun, E., & Anholm, M. (1990). Effects on the periodontium following corticotomy-facilitated orthodontics. Case reports. Journal of periodontology, 61(4), 234–238. https://doi.org/ HYPERLINK "https://doi.org/10.1902/jop.1990.61.4.234"10.1902 HYPERLINK "https://doi.org/10.1902/jop.1990.61.4.234"/jop. HYPERLINK "https://doi.org/10.1902/jop.1990.61.4.234"1990.61.4.234.

35. Ren, A., Lv, T., Kang, N., Zhao, B., Chen, Y., & Bai, D. (2007). Rapid orthodontic tooth movement aided by alveolar surgery in beagles. American journal of orthodontics and dentofacial orthopedics, 131(2), 160.e1–160.e1610. https://doi.org/ HYPERLINK "https://doi.org/10.1016/j.ajodo.2006.05.029"10.1016 HYPERLINK "https://doi.org/10.1016/j.ajodo.2006.05.029"/j.ajodo. HYPERLINK "https://doi.org/10.1016/j.ajodo.2006.05.029"2006.05.029.

36. Kamal, A. T., Malik, D., Fida, M., & Sukhia, R. H. (2019). Does periodontally accelerated osteogenic orthodontics improve orthodontic treatment outcome? A systematic review and meta-analysis. International orthodontics, 17(2), 193–201. https://doi.org/ HYPERLINK "https://doi.org/10.1016/j.ortho.2019.03.006"10.1016 HYPERLINK "https://doi.org/10.1016/j.ortho.2019.03.006"/j.ortho. HYPERLINK "https://doi.org/10.1016/j.ortho.2019.03.006"2019.03.006

37. Mandelaris, G. A., Richman, C., & Kao, R. T. (2020). Surgical Considerations and Decision Making in Surgically Facilitated Orthodontic Treatment/Periodontally Accelerated Osteogenic Orthodontics. Clinical advances in periodontics, 10(4), 213–223. https://doi.org/ HYPERLINK "https://doi.org/10.1002/cap.10116"10.1002 HYPERLINK

"https://doi.org/10.1002/cap.10116"/cap. HYPERLINK "https://doi.org/10.1002/cap.10116"10116

38. Dab, S., Chen, K., & Flores-Mir, C. (2019). Short- and long-term potential effects of accelerated osteogenic orthodontic treatment: A systematic review and meta-analysis. Orthodontics & craniofacial research, 22(2), 61–68. https://doi.org/ HYPERLINK "https://doi.org/10.1111/ocr.12272"10.1111 HYPERLINK "https://doi.org/10.1111/ocr.12272"/ocr. HYPERLINK "https://doi.org/10.1111/ocr.12272"12272

39. Rekhi, U., Catunda, R. Q., & Gibson, M. P. (2020). Surgically accelerated orthodontic techniques and periodontal response: a systematic review. European journal of orthodontics, cjz103. Advance online publication. https://doi.org/ HYPERLINK "https://doi.org/10.1093/ejo/cjz103"10.1093 HYPERLINK "https://doi.org/10.1093/ejo/cjz103"/ejo/cjz HYPERLINK "https://doi.org/10.1093/ejo/cjz103"103

Doi: doi.org/10.52132/Ajrsp.e.2021.32.2