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Dental Science - Case Report



Orthodontic Treatment of a Periodontally - Affected Adult Patient (Case Report)

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Abstract

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BACKGROUND: The advanced periodontal disease is characterised by a strongly pronounced loss of attachment and reduction of the alveolar bone support, which leads to luxation, migration of the teeth, functional discomfort and poor facial aesthetics.

CASE PRESENTATION: The aim of this paper is to present the case of a 26-year-old female patient, registered at the Clinic of Periodontology with highly expressed gingivitis, unsatisfactory periodontal status, presence of diastemas between the frontal teeth and attachment loss of 5-6 millimetres in different areas. We conducted a thorough classic periodontal treatment, as well as training for proper maintenance of oral hygiene, with frequent professional oral-prophylactic sessions, complemented with orthodontic treatment. Fixed orthodontic appliances were installed, and mild forces were applied for gradual levelling of the teeth, with constant control of the periodontal status. After 20 months of treatment, the patient was in retention.

CONCLUSION: Orthodontic therapy of periodontally-affected teeth can begin only after exhaustive administration of a periodontal treatment. Orthodontic treatment as an addition to the periodontal restoration must be gradual with mild forces for an optimal dental response, thus helping to improve function, facial aesthetics and psychological confidence of adult patients.

Introduction

Dentofacial aesthetics is the primary motivational factor in adolescent and adult population for conducting orthodontic treatment. The number of adult patients undergoing orthodontic therapy has constantly been rising in the last 2-3 decades [1]. 20-25% of orthodontic patients are adults, and there is an increasing trend in the number of adult patients as a result of their increased awareness of the importance of their oral health and their need for a better aesthetic appearance [2]. The main driving factor in adults is to improve their dental and facial appearance [3], [4]. Twelve per cent of adults seeks orthodontic treatment to prevent occurrence or progression of periodontal

disease [5].

Adult patients are divided into two different groups: 1st group-young adults (under 35 years of age, usually after their 20s) who were in need but could not receive orthodontic treatment during the adolescent period. The 2nd group consists of mature patients in their 40s-50s who have other dental problems and need orthodontic treatment as a part of a larger therapeutic plan that includes numerous dental disciplines [6].

Studies suggest that orthodontic therapy providing good dental aesthetics also has a strong impact on the psychosocial aspect of the patient's life [7]. It has been confirmed that almost 80% of patients accept treatment because of the aesthetic aspect

rather than dental health and function [8].

Today, orthodontic treatment can be justified as a part of periodontal therapy if it is used to reduce plaque accumulation, correct abnormal gingival and osseous forms, improve aesthetics and facilitate prosthetic replacement [9].

Age, per se, is not a contraindication to orthodontic treatment. Fact is that the tissue's response to orthodontic forces, cell mobilisation and conversion of collagen fibres is much slower in adults. Adult bone is less reactive to orthodontic force. There is a great risk of marginal bone loss and loss of attachment with mild gingival infection [2]. Dental response to orthodontic forces is slower in adults, but the teeth are moving in the same manner regardless of age.

A large number of adult patients have problems with malocclusion due to having neglected their periodontal health, leading to a loss of bone substrate around the teeth, resulting in pathological migration, rotations, tipping and extrusions of the teeth. Special attention should be given to the periodontal status of adult patients since most of them already suffer from periodontal disease. However, orthodontic treatment is no longer a contraindication in the therapy of advanced periodontal disease. This treatment can help rescue and restore the deteriorated dentition [10].

The advanced periodontal disease is characterised by a strongly pronounced loss of attachment, reduction of alveolar bone support, leading to tooth mobility, pathological migration, tooth extrusion, tipping, loss of contact point, presence of spacing between the teeth and marginal gingival recession. In many cases, this functional discomfort is accompanied by a pronounced poor aesthetic in the anterior dental region, which is reflected in the entire face [10].

The management of adult orthodontic patients with severe bone loss continues to present a challenge. Well-aligned dentition may be more conducive to periodontal health, than a crowded dentition and malocclusion. It has been widely believed that appropriately applied orthodontic forces do not damage the periodontium. On the contrary, they can support the periodontal tightness, but oral hygiene is obligatory.

Orthodontic therapy of the periodontally-affected teeth can begin only after a thoroughly performed periodontal treatment in multiple sessions when the periodontal inflammation would be eliminated. In a motivated patient who responds well to initial periodontal therapy, orthodontic treatment provides positive, satisfactory aesthetical and functional results, and a good long-term prognosis. Maintaining high-level oral hygiene at home, as well as frequent professional visits is very important (imperative) during and after the end of an active

orthodontic therapy [11]. This can be supported by findings of Mattingly [12], Paolantonio [13], Sallum [14] and Perinetti [15], which confirm that long-term fixed appliances can contribute to unwanted, but predictable qualitative alterations in the subgingival bacterial biofilm that become progressively pathogen with time, if oral hygiene is not well. The combination of orthodontic intrusion and periodontal treatment in animals with good oral hygiene and healthy tissue showed an improvement in the periodontal condition [16]. A reduction of probing depth in bone defects following tooth extrusion can also be achieved [17]. General factors as morphology and deepness of defects, oral hygiene, plaque control and patient compliance, can strongly affect the predictability of periodontal regeneration [18].

The goal of the paper is to show the possibilities in the therapy of a periodontally-compromised adult patient, patient selection, preparations and stages of therapy, prerequisites for success and further recommended surgical procedures.

Case History

A 26 years old female patient visited the Clinic of Oral pathology and periodontology, complaining about the wide spaces between her teeth, strongly expressed gum bleeding and tooth luxation in the front region. She complained of poor self-esteem and bad social life. She was treated at our clinic for the first time when she was 17. After a long period of time without any therapy, she returned with those problems.

There was no significant medical history of any disease which may have contributed to periodontal disease. However, she noted that one of the parents had early teeth loss, and the two younger sisters had a problem with bleeding from the gingiva.



Figure 1: Presence of diastema between upper left central and lateral incisors

Upon clinical examination, we noticed that she had an asymmetrical face and a convex facial

profile. The lips were incompetent, and she was showing hyperactivity of the lower and upper lip while closing the lips. There were also generalised deposits of dental plaque and calculi due to poor oral hygiene. No active caries lesions were present. The pocket depth ranged from 3-6 mm in different areas of dentition. Her periodontal condition was poor, with gingival recession in many areas, especially in the lower incisor region, presence of wide spaces between the teeth, especially in the lower jaw as well as in the upper left central and lateral incisor (Figure 1, Figure 2 and Figure 3).



Figure 2: Upper jaw from the occlusal side

Before starting with the therapy, the patient was informed about the complications that could occur during the orthodontic treatment such as the possibility of root resorption, more bone loss around the teeth and worsening of periodontal disease, as well as the need to maintain oral hygiene at the highest level. Informed consent was obtained from her.



Figure 3: Presence of wide spaces between the teeth in the lower jaw and migration of the teeth

The periodontal treatment was started in September 2015. We proceeded with a thorough conservative periodontal treatment consisting of the complete elimination of dental calculus and biofilm. After that, scaling and root planning were conducted in all 4 quadrants during several sessions. In the initial phase of the therapy, due to the presence of a severe

expressed gingival inflammation, antibiotic therapy was included as an addition to the conservative treatment. In the whole duration of the process, the patient was trained for proper maintenance of oral hygiene at home.

This process was ongoing for over a year, with frequent professional oral-prophylactic sessions every 3-4 months. Over a year of observation before the installation of orthodontic appliances helped us judge the patient's cooperation in oral hygiene maintenance until it was made sure that it was possible to start with orthodontic therapy. Ensuring that the movement of the teeth would occur in a healthy periodontal environment was of paramount importance before proceeding with the therapy. If this had not been done, orthodontically-applied forces could enhance the gingival inflammation and destruct the supporting tissues [19].



Figure 4: X-Ray before the start of the therapy

At the beginning of the periodontal treatment, an X-Ray was made for precise detection of periodontal status and osseous defects (Figure 4).



Figure 5: An upper fixed orthodontic appliance was placed

In January 2017, an upper fixed orthodontic appliance was applied (Figure 5). 022 slot SWA was used, alignment and levelling of the teeth were with light forces using NiTi wires. To avoid the incisor root resorption, we applied low intrusion forces (5-15 gr/tooth). In the second phase we used elastic bands

with long filaments to close the spaces and make good contacts.



Figure 6: Applied lower fixed orthodontic appliance

After six months, the lower fixed orthodontic appliance was applied (Figure 6) and 022 slot SWA was used, alignment and levelling were achieved with light forces using NiTi wires and elastic bands with long filaments.



Figure 7: Dental status at the end of the 1st year of orthodontic therapy

At the end of first year of orthodontic therapy, the oral situation was pleasant and as expected (Figure 7 and Figure 8).



Figure 8: Improvement of the overall oral situation

After 20 months of active treatment, the patient is in retention (Figure 9, 10, 11, and 12).



Figure 9: Dental status after 20 months of orthodontic therapy

Continuing monitoring of oral hygiene and administration of Gengigel (0.8% hyaluronic acid) to improve the attachment, was coordinated by the parodontologist.



Figure 10: Satisfactory results after 20 months

Treatment results

After an active orthodontic phase of 20 months, the spaces between her upper and lower incisors were closed; the incisors were retracted to achieve acceptable overjet and overbite relation. Clinical examination revealed well-aligned arches, a harmonious occlusion and good periodontal health. Improved lip relationship, smile and facial esthetics were achieved. Patient's cooperation in oral hygiene maintenance was satisfactory. The patient was very satisfied with the treatment and had improved psychosocial confidence.



Figure 11: Satisfactory facial appearance

Orthodontic intrusion and levelling of periodontally-migrated teeth changed the topography of the original horizontal defects.

The therapeutic procedure at this patient will continue with surgical treatment of the deep periodontal defects in the frontal area and lateral regions of the upper jaw, as well as overlapping the recessions of the lower frontal teeth.



Figure 12: X-Ray at the end of the orthodontic treatment

Discussion

The number of adult patients in need of orthodontic treatment has increased in recent years. The patient must be evaluated for systemic diseases, perio-restorative problems, TMJ disorders and vulnerability to root resorption. The biomechanics must be customised for the individual treatment requirement. It has been found that the expectations of adult patients are usually high, and the limitations of orthodontic treatment must be explained at the beginning of treatment to arrive at realistic treatment objectives [2]. Thomson in his population-based longitudinal study found that periodontal attachment loss and gingival recession was not significantly different between the orthodontic treatment group and non-orthodontic treatment group [20]. However, Hye-Young Sim et al. investigated the association between orthodontic treatment and periodontitis in a nationally representative sample of the Korean population. The results indicated that orthodontic treatment was associated with decreased prevalence of periodontitis [21]. The importance of periodontal health has increased as the number of adult orthodontic patients has increased.

Orthodontics can serve as an adjunct to periodontal treatment procedures to improve oral health in a number of situations. Achieving esthetically acceptable results in periodontally-compromised patients requires various teeth movements, which can also help control the periodontal breakdown and restore good oral function [22]. The fixed appliance allows easy splinting of teeth to achieve stable anchorage [23], so force magnitude must be reduced to minimum. According to Deppa [24], teeth alignment can be achieved by orthodontic soft aligners in

periodontally involved teeth.

A viable periodontal ligament is important for cell proliferation on the application of the orthodontic forces. There is reduction in periodontal ligament vascularity with ageing and insufficient source of preosteoblasts. It is obligatory to use lighter, controlled force levels in adults because the greater forces result in vascular compression and necrosis of blood vessels of periodontal ligament. There is a risk of iatrogenic damage to the periodontium with uncontrolled forces, and thus it is important to keep the periodontal status under control during treatment. Adults are more vulnerable to root resorption on application of orthodontic force. Light continuous force must be applied to minimise the risk of root resorption, and the patient must be informed of the potential risks before starting the treatment [1], [2], [9]. Tulloch [23] suggested that tooth movement can be undertaken 6 months after completion of active periodontal treatment if there is sufficient evidence of complete resolution of inflammation.

The most important factor in the initiation, progression and recurrence of periodontal problems is the presence of microbial plaque. Inadequate maintenance of oral hygiene during orthodontic treatment increases the risk of developing gingival inflammation. There is much evidence of increased count of *Lactobacillus* in saliva after orthodontic braces placement [25]. Many clinical studies have reported that plaque accumulation and gingivitis increased during orthodontic treatment [26]. The composition and types of oral bacteria were altered as a result of orthodontic treatment [27], [28]. Recent animal studies suggested that orthodontic tooth movement had a synergistic effect on the periodontium by increasing the presence of $IL-1\beta$ and $TNF-\alpha$ [29].

The surgical phase consists of techniques performed for pocket therapy and the correction of related morphological problems, namely, mucogingival defects. The purpose of surgical pocket therapy is to eliminate the pathological changes in the pocket walls, to create a stable, easily maintainable state, and if possible, to promote periodontal regeneration. A critical aspect of periodontal regeneration is the stimulation of a series of events and cascades, which can result in the coordination and completion of integrated tissue formation [30]. Many approaches have been used involving polypeptide growth and differentiation factors, extracellular matrix proteins and proteins involved in bone metabolism. These materials are largely physiological molecules or molecules released by cells which regulate processes in wound healing. These growth factors, primarily secreted by macrophages, endothelial cells, fibroblasts and platelets, include platelet-derived growth factor (PDGF), bone morphogenetic protein (BMP) and transforming growth factor (TGF). These biological mediators have been used to stimulate periodontal

wound healing, promoting migration and proliferation of fibroblasts (for periodontal ligament formation) or promote the differentiation of cell to become osteoblasts, thereby favouring bone formation [31]. Guided tissue regeneration (GTR), demineralised freeze-dried bone allograft, or a combination of these, are considered to be the most predictable regenerative procedures for achieving favourable treatment outcomes in periodontally-affected adult patients. These findings were further supported by many researchers who indicated that periodontal bone grafts consistently led to better bone fill of the defect, than the non-grafted controls. Histological analyses of cementum regeneration in animals demonstrated that regenerative treatment with bone grafting leads to some degree of regenerated cement, periodontal ligament and bone [32]. Regenerative procedures have a more predictable positive response in deep and narrow defects rather than shallow ones.

A multidisciplinary approach is always necessary to treat complex dental and periodontal problems, and there cannot be a better example than ortho-perio interaction. Periodontists should recognise the importance of orthodontic intervention in achieving results unattainable with periodontal therapy alone [33], [34], [35]. Adult orthodontic treatment can help prevent or improve periodontal problems, can help prevent and reduce further bone loss around teeth, improve the dentist's chances to restore missing teeth, adjust aesthetics to get a better smile and facial appearance, enhance function of teeth, increase self-confidence and self-esteem, and finally, improve overall oral health.

In conclusion, patient education, motivation, enhanced oral hygiene maintenance and regular periodontal care are essential during orthodontic treatment. Orthodontic therapy in periodontally-compromised patients requires extensive periodontal care, before, during and after the treatment. In some cases, periodontal restorative surgery may be required for sealing the pockets. In order to prevent relapse of the teeth to their previous state and ensure long-term results, the appliance of lingual bonded retainers is recommended. Interdisciplinary approach complemented by patient education, cooperation and good oral hygiene, will transform a patient with an unattractive dentition due to periodontal breakdown into a person with a good occlusion and a radiant smile. Adult patients must undergo regular oral hygiene procedures and periodontal maintenance to maintain healthy gingival tissue during active orthodontic therapy.

References

- Proffit W. Special considerations in comprehensive treatment for adults. In: Proffit W, Fields HW, eds. *Contemporary Orthodontics*, 5rd ed. St. Louis, Mo: Mosby, 2012.
- Bagga DK. Adult Orthodontics Versus Adolescent Orthodontics: An overview. *J Oral Health Comm Dent*. 2010; 4(2):42-47. <https://doi.org/10.5005/johcd-4-2-42>
- McKiernan EX, McKiernan F, Jones MI. Psychological profiles & motives of adults seeking orthodontic treatment. *Int J Adult Orthod Orthognath Surg*. 1992; 7:187-198.
- Claman L, Alfaro MA, Mercado AM. An interdisciplinary approach for improved esthetic results in the anterior maxilla. *J Prosthet Dent*. 2003; 89:1-5. <https://doi.org/10.1067/mpr.2003.5> PMID:12589277
- Perrigaard J, Blixencrone-Moller T. Why do adults seek orthodontic treatment. In *Proceedings of 64th Congress of European Orthodontic Society*, London 1988 (p. 61A).
- Proffit W, Fields HW, eds. *Contemporary Orthodontics*, 5rd ed. St. Louis, Mo: Mosby; 2012.
- Gazit-Rappaport T, Haisraeli-Shalish M, Gazit E. Psychosocial reward of orthodontic treatment in adult patients. *Eur J Orthod*. 2010; 32(4):441-6. <https://doi.org/10.1093/ejo/cjp144> PMID:20089570
- Brown DF, Moerenhout RG. The pain experience & psychological adjustment to orthodontic treatment of preadolescents, adolescents & adults. *Am J Orthod Dentofacial Orthop*. 1991; 100(4):349-56. [https://doi.org/10.1016/0889-5406\(91\)70073-6](https://doi.org/10.1016/0889-5406(91)70073-6)
- Newman MG, Takel HH, Klokkevold PR, Caranza FA. *Carranza's Clinical Periodontology*, 10th ed. Noida Saunders, Reed Elsevier India Private Lmt, 2006, p.856-70.
- Xingme Fenga; Tomoko Obab; Yasuo Obac; Keiji Moriyamad. An Interdisciplinary Approach for Improved functional and esthetic Results in a Periodontally Compromised Adult Patients. *Angle Orthod*. 2005; 75:1061-1070.
- Meeran NA, Parveen MJ. The scope and limitations of adult orthodontics. *Indian Journal of Multidisciplinary Dentistry*. 2011; 2(1):383-87.
- Mattingly JA, Sauer GJ, Yancey JM, Arnold RR. Enhancement of *Streptococcus mutans* colonization by direct bonded orthodontic appliances. *J Dent Res*. 1983; 62:1209-11. <https://doi.org/10.1177/00220345830620120601> PMID:6361082
- Paolantonio M. et all. Site-specific subgingival colonization by *actinobacillus actinomycetemcomitans* in orthodontic patients. *Am J Orthod*. 1999; 115:423-8. [https://doi.org/10.1016/S0889-5406\(99\)70263-5](https://doi.org/10.1016/S0889-5406(99)70263-5)
- Sallum EJ et all. Clinical and microbiologic changes after removal of orthodontic appliances. *Am J Orthod*. 2004; 126:363-6. <https://doi.org/10.1016/j.ajodo.2004.04.017>
- Perinetti G et all. Longitudinal monitoring of subgingival colonization by *actinobacillus actinomycetemcomitans* and crevicular alkaline phosphatase and aspartate aminotransferase activities around orthodontically treated teeth. *J Clin Periodontol*. 2004; 31:60-7. <https://doi.org/10.1111/j.0303-6979.2004.00450.x>
- Melsen B. Tissue reaction following application of extrusive and intrusive forces to teeth in adult monkeys. *Am J Orthod*. 1986; 6:469-75. [https://doi.org/10.1016/0002-9416\(86\)90002-3](https://doi.org/10.1016/0002-9416(86)90002-3)
- Michelogiannakis D, Makou M, Madianos PN, Rossouw P. Orthodontic tooth movement in relation to angular bony defects. *Australasian Orthodontic Journal*. 2017; 33(2):220-235.
- Panwar M, Jayan B. Combined periodontal and orthodontic treatment of pathologic migration of anterior teeth. *MJAFI*. 2010; 66:67-9. [https://doi.org/10.1016/S0377-1237\(10\)80100-5](https://doi.org/10.1016/S0377-1237(10)80100-5)
- Carasol M, Liodra JC, Fernandez-Mesequer A, et al. Periodontal conditions among employed adults in Spain. *J Clin Periodontol*. 2016; 43:548-556. <https://doi.org/10.1111/jcpe.12558> PMID:27027396
- Thomson W. Orthodontic treatment outcomes in the long term: findings from a longitudinal study of New Zealanders. *Angle Orthod*. 2002; 72:449-455.

21. Sim HY, Kim HS, Jung DU, Lee H, Lee JW, Han K, Yun KI. Association between orthodontic treatment and periodontal diseases: Results from a national survey. *The Angle Orthodontist*. 2017; 87(5):651-7. <https://doi.org/10.2319/030317-162.1> PMID:28686092
22. Zachrisson BU: Orthodontics and periodontics. In: Lindhe J, Lang NP. *Clinical periodontology and implant dentistry*. 6th ed, Oxford: Blackwell Munksgaard; 2015.
23. Tulloch JF. *Contemporary orthodontics*. In: Proffit WR, Fields HW Jr. *Contemporary orthodontics*. Louis Mosby; 2012
24. Deppad, Mehta DS, Puri VK, Shetty S. Combined periodontic-orthodontic-endodontic interdisciplinary approach in the treatment of periodontally compromised tooth. *J Indian Soc Periodontol*. 2010; 14:139-43. <https://doi.org/10.4103/0972-124X.70837> PMID:21691554 PMCID:PMC3110470
25. Chaitanya K, Reddy M, Sreekanth C, Reddy V, Kumar L, Praveen Raj K. Orthodontic Tooth Movements and its Effects on Periodontium. *Int J Dent Med Res*. 2014; 1(4):119-23.
26. Glans R, Larsson E, Ogaard B. Longitudinal changes in gingival condition in crowded and noncrowded dentitions subjected to fixed orthodontic treatment. *Am J Orthod Dentofacial Orthop*. 2003; 124:679-682. <https://doi.org/10.1016/j.ajodo.2003.05.001> PMID:14666081
27. Petti S, Barbato E, Simonetti DAA. Effects of orthodontic therapy with fixed and removable appliances on oral microbiota: a six-month longitudinal study. *New Microbiol*. 1997; 20:55-62.
28. Ristic M, Svabic MV, Sasic M, Zelic O. Clinical and microbiological effects of fixed orthodontic appliances on periodontal tissues in adolescents. *Orthod Craniof Res*. 2007; 10:187-195. <https://doi.org/10.1111/j.1601-6343.2007.00396.x> PMID:17973685
29. Boas Nogueira AV, Chaves de Souza JA, Kim YJ, Damiao de Sousa-Neto M, Chan Cirelli C, Cirelli JA. Orthodontic force increases interleukin-1 β and tumor necrosis factor- α expression and alveolar bone loss in periodontitis. *J Periodontol*. 2013; 84:1319-1326. <https://doi.org/10.1902/jop.2012.120510> PMID:23205916
30. Cochran DL, Wozney JM. Biological mediators for periodontal regeneration. *Periodontology 2000*. 1999; 19(1):40-58. <https://doi.org/10.1111/j.1600-0757.1999.tb00146.x>
31. Gorbunkova A, Pagni G, Brizhak A, Farronato G, Rasperini G. Impact of orthodontic treatment on periodontal tissues: a narrative review of multidisciplinary literature. *International journal of dentistry*. 2016; 2016. <https://doi.org/10.1155/2016/4723589> PMID:26904120 PMCID:PMC4745353
32. Rabie AB, Gildenhuys G, Boisson M. Management of patients with severe bone loss: bone induction and orthodontics. *World J Orthod*. 2001; 2:142-53.
33. Han JY. A comparative study of combined periodontal and orthodontic treatment with fixed appliances and clear aligners in patients with periodontitis. *Journal of periodontal & implant science*. 2015; 45(6):193-204. <https://doi.org/10.5051/jpis.2015.45.6.193> PMID:26734489 PMCID:PMC4698945
34. Zasciurinskiene E, Rune Lindsten R, Christer Slotte C, Bjerklind K. Orthodontic treatment in periodontitis-susceptible subjects: a systematic literature review. *Clin Exp Dent Res*. 2016 Nov; 2(2):162-173. <https://doi.org/10.1002/cre2.28> PMID:29744163 PMCID:PMC5839229
35. Zasciurinskiene E, Lindsten R, Baseviciene N, Slotte C. Orthodontic treatment simultaneous to or after periodontal cause related treatment in periodontally susceptible patients. *Journal of Clinical Periodontology*. 2017; 45(2):213-24. <https://doi.org/10.1111/jcpe.12835> PMID:29106749