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Root Resorption Caused by Thin Roots Combined with Reciprocal Movement: A Case Report and Nursing Care Points

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Abstract: Root resorption is a significant complication in orthodontic treatment, with thin roots and reciprocal movement being recognized as high-risk factors. This paper reports a case of a 19-year-old female patient who underwent orthodontic treatment for dental irregularity. The patient had thin roots in the maxillary lateral incisors 12 and 22. During treatment, tooth 22 experienced reciprocal movement of labial expansion followed by retraction, while tooth 12 adopted passive ligation to reduce reciprocal movement. After 23 months of straight-wire extraction treatment, good occlusal relationships were achieved, but significant root resorption occurred in teeth 12 and 22, with tooth 22 showing more severe resorption. This case confirms the synergistic effect between thin roots and reciprocal movement, demonstrating that thin roots are more sensitive to reciprocal movement stimulation, producing a synergistic amplification effect. Additionally, standardized nursing guidance and patient compliance management play important roles in reducing resorption risk. This case emphasizes the importance of pretreatment risk assessment, individualized treatment strategy formulation, and comprehensive nursing intervention throughout treatment, providing reference for clinical prevention of root resorption.

Keywords: Root resorption; Orthodontic treatment; Thin roots; Reciprocal movement; Nursing intervention; Case report

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1. Introduction

Root resorption is an inevitable biological response in orthodontic treatment, with an incidence rate of over 90% [1]. While mild resorption is usually of no clinical significance, moderate to severe resorption can seriously affect the long-term stability of teeth and may even lead to tooth mobility and loss. Among numerous risk factors, thin roots and reciprocal movement are considered two key factors leading to significant root resorption [2]. Thin roots increase resorption susceptibility due to stress concentration effects, while reciprocal movement exacerbates the resorption process by disrupting normal repair window periods [3]. When these two factors coexist, they often produce a synergistic amplification effect, resulting in more severe root damage. However, clinical evidence

regarding this synergistic effect is relatively limited, particularly lacking specific guidance principles in treatment strategy comparison and nursing management. This paper reports a typical case to analyze the occurrence process of severe root resorption caused by thin roots combined with reciprocal movement, explores its pathophysiological mechanisms, and combines nursing intervention points to provide prevention strategies and management experience for clinicians.

2. Case report

2.1. General information and clinical examination

Patient Wang, female, 19 years old, presented in March 2021 with the chief complaint of "dental irregularity affecting aesthetics". The patient had no history of trauma, no harmful habits such as bruxism or clenching, regular menstrual cycle, and no history of systemic diseases or drug allergies.

Facial examination showed a convex profile, basically symmetrical face, aligned upper midline, and underdeveloped mandible and chin. Intraoral examination revealed bilateral molars in neutral to mesial relationship, bilateral canines in distal relationship, normal anterior overbite and overjet (overbite 2 mm, overjet thin roots and reciprocal movement are considered two key factors leading to significant root resorption mm), severe crowding in upper and lower dental arches (maxillary crowding 8 mm, mandibular crowding 4 mm), teeth 13 and 23 positioned labially outside the arch, teeth 12 and 22 positioned palatally, teeth 35 and 45 lingually ectopic eruption, and good overall oral hygiene. Functional examination showed normal mouth opening and closing patterns, mouth opening of 38 mm, with no temporomandibular joint clicking or pain.

Radiographic examination showed complete dentition on panoramic radiograph, with the key finding being significantly thin roots of teeth 12 and 22 (root-crown ratio approximately 1:1, much smaller than the normal 1:5–2:1), presenting as short conical shapes [4]. Cephalometric analysis indicated SNA angle 82°, SNB angle 76° (2° smaller than normal), ANB angle 6° (2° larger than normal), suggesting normal maxillary development and mild mandibular deficiency. The diagnosis was skeletal Class II malocclusion with Angle Class I malocclusion and severe upper and lower dental crowding, with the high-risk factor of thin roots in teeth 12 and 22.

2.2. Treatment plan and nursing management

Straight-wire extraction treatment was employed, extracting teeth 14, 24, 34, and 44, with mini-implants for anchorage control. Given the high-risk characteristics of thin roots in teeth 12 and 22, differentiated treatment strategies were developed: tooth 12 adopted passive ligation with light force (25 g) to avoid reciprocal movement; tooth 22, due to anatomical position limitations, was directly incorporated into the treatment system and experienced reciprocal movement of labial expansion (50 g force for 3 months) followed by retraction (100 g force for 6 months), with a total movement distance of approximately 9 mm.

For nursing management, high-risk patient treatment files were established, standardized oral hygiene instruction was provided at each visit, emphasizing plaque control (PLI < 0.5), and patient compliance assessment scales were established. Strict 4–6 weeks follow-up intervals were maintained, radiographic monitoring was conducted every 6 months, and health education plans were developed, including dietary guidance and psychological support.

2.3. Treatment results and follow-up

After 23 months of treatment, the patient achieved good orthodontic results: upper and lower dental arches were well aligned, bilateral canine-molar neutral relationships were established, normal anterior overbite and overjet (overbite 2 mm, overjet 2.5 mm), aligned midlines, and good masticatory function.

Post-treatment radiographic evaluation showed significant root resorption in both teeth 12 and 22, with tooth 22 being more severely affected, presenting typical apical serrated resorption with resorption length approximately 1/3 of root length (about 4 mm), while tooth 12 had relatively milder resorption at approximately 1/4 of root length (about 3 mm). Although both teeth had the same thin root risk factor, significant differences existed in results after experiencing different treatment strategies. The roots of other teeth showed basically no abnormal changes.

During follow-up, the root resorption situation was explained in detail to the patient, and an individualized retention plan was developed: maxillary lingual fixed wire (13–23) combined with nighttime vacuum-formed retainer, and mandibular canine-to-canine fixed retainer. A regular follow-up system was established with clinical examinations every 3 months and radiographic monitoring every 6 months.

3. Discussion

3.1. Analysis of synergistic effect mechanisms

This case provides valuable evidence for understanding the synergistic effect of thin roots and reciprocal movement in causing root resorption. By comparing the outcome differences between teeth 12 and 22 under the same conditions but with different treatment strategies, it clearly reveals the crucial role of reciprocal movement in root resorption. Tooth 22 experienced typical "expansion followed by retraction" reciprocal movement, while tooth 12 effectively avoided this risk through passive ligation strategy. The final difference in resorption severity (tooth 22: 1/3 root length vs tooth 12: 1/4 root length) confirmed the adverse effects of reciprocal movement.

From a pathophysiological perspective, thin roots create stress concentration that provides the anatomical basis for resorption. According to the stress formula ($\sigma = F/A$), thin roots experience exponentially increased unit stress, making the periodontal ligament and root surface more susceptible to ischemia, necrosis, and inflammation [5]. Reciprocal movement applies reverse stimulation during the repair window period, interrupting the normal repair process, with each new movement creating additional damage in vulnerable areas, forming cumulative pathological changes.

This case demonstrates the synergistic amplification effect of two risk factors, namely the "$1 + 1 > 2$" phenomenon. This synergistic effect involves multiple levels: at the molecular biology level, thin roots show higher sensitivity to inflammatory factors and resorption-related enzymes; at the cellular level, odontoblasts and periodontal ligament fibroblasts exhibit altered stress response patterns; at the tissue level, thin roots have low microvascular network density with insufficient local buffering capacity [6]. The destructive effects of reciprocal movement are significantly amplified under this susceptible background.

3.2. Nursing management and clinical translation value

In innovative nursing management practices, this case demonstrates that implementing individualized and systematic nursing intervention strategies for high-risk patients has irreplaceable value. Through establishing specialized high-risk patient management files and standardized operational procedures, implementing more frequent and comprehensive oral hygiene instruction, compliance monitoring, and psychological support, the

adverse effects of various promoting factors on root resorption can be reduced across multiple dimensions. Particularly noteworthy is the nursing team's use of multimedia teaching methods and individualized communication techniques in patient education, which not only improved patients' cognitive level regarding the disease and treatment process but more importantly cultivated patients' self-management abilities and treatment compliance. This comprehensive, all-around nursing model played a positive role in reducing inflammation levels, maintaining oral health homeostasis, and early identification of abnormal signs, providing important guarantees for treatment success.

From a clinical translational medicine perspective, the findings of this case have important implications for establishing individualized treatment decision-making models. By integrating patients' basic disease information, anatomical morphological characteristics, biomechanical parameters, and psychosocial factors, more precise risk prediction models can be constructed to achieve truly personalized medicine. Additionally, this case provides clear clinical demand orientation for developing new biomaterials and treatment technologies, such as developing bioactive materials with root repair-promoting functions and designing more precise force control systems.

3.3. Clinical guidance significance and development directions

The clinical insights from this case have important and far-reaching practical guidance value, which can be summarized into several key points: First, comprehensive pretreatment risk assessment is the key to preventing severe root resorption, which should include not only routine clinical and radiographic evaluations but also establish systematic risk scoring systems for comprehensive assessment and graded management of multiple factors such as root morphology, movement distance, and movement patterns. Second, differentiated and individualized treatment strategies should be developed for patients with different risk levels, minimizing unnecessary reciprocal movement and excessive force through precise biomechanical design, optimized movement path planning, and dynamic force adjustment. Third, dynamic monitoring and timely adjustment mechanisms during treatment are equally important; establishing standardized monitoring procedures and early warning systems with regular radiographic examinations and biological indicator detection can enable early detection of resorption signs and timely strategy adjustments. Fourth, multidisciplinary collaborative modern nursing management models play an irreplaceable core role in comprehensive management of high-risk patients, significantly improving treatment safety, effectiveness, and predictability through standardized nursing procedures, individualized intervention measures, and continuous health education.

Meanwhile, this case profoundly suggests that we need to continue efforts and improvements in the following aspects: establishing more scientific and comprehensive risk assessment systems and prediction models, developing more detailed and standardized nursing procedures and operational guidelines, developing more advanced and precise monitoring technologies and early warning systems, and cultivating more professional and comprehensive medical and nursing teams and management personnel. Only through these systematic improvements and enhancements can we truly improve the overall safety and predictability of orthodontic treatment, providing patients with higher quality, safer, and more individualized medical services, and promoting the continuous development and progress of orthodontics.

4. Conclusion

This case report systematically confirms the synergistic mechanism of thin roots and reciprocal movement in

root resorption after orthodontic treatment, providing important evidence-based medical evidence for this clinical phenomenon. The case deepened understanding of the pathophysiological mechanisms of root resorption at the theoretical level and provided prevention strategies and management experience for clinicians at the practical level. The study emphasizes that when facing patients with high-risk factors such as thin roots, cautious individualized treatment strategies must be adopted, maximally protecting root health while achieving ideal treatment outcomes through precise biomechanical control, standardized nursing management, and systematic monitoring mechanisms, providing patients with high-quality and safe medical services.

Disclosure statement

The authors declare no conflict of interest.

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