EFFECTS OF ORTHODONTIC TREATMENT ON PERIAPICAL HEALTH IN ENDODONTICALLY TREATED TEETH

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ABSTRACT

This retrospective study evaluated the impact of orthodontic treatment on endodontically treated teeth. 32 teeth from 25 patients were analyzed, focusing on CBCT evaluations. All endodontic treatments utilized EDTA and 5.25% NaOCl in conjunction with Er:YAG laser-activated irrigation. Post-treatment assessment revealed that 21 teeth (66%) had root canal fillings of correspondent length, while 10 teeth (31%) were insufficient, and 1 tooth (3%) was uncertain. In terms of density and homogeneity, 25 teeth (78%) were classified as correspondent, 5 teeth (16%) as inadequate, and 2 teeth (6%) as uncertain. The periapical bone destruction probability index (PRI) demonstrated a significant increase in periapical destruction following orthodontic treatment. Specifically, the odds ratios for bone destruction were 1.67 (90% CI: 1.16–2.49, P=0.008) for present versus absent and 1.77 (90% CI: 1.11–2.85, P=0.031) for present versus uncertain. The proportion of teeth without periapical destruction decreased from 15 (14.9%) during treatment to 14 (23.9%) post-treatment. These findings highlight the critical relationship between endodontic quality and treatment outcomes, emphasizing the need for meticulous endodontics during orthodontic therapies.

Keywords: endodontic treatment, orthodontic therapy, periapical bone destruction, laser-activated irrigation, CBCT

INTRODUCTION

The relationship between orthodontic and endodontic treatments has been acknowledged for a long time [1]. Microscopic root resorption is a prevalent and minor side effect observed in all permanent teeth during orthodontic treatment. Root resorption is rarely clinically significant and detectable on computed tomography [2]. It has become standard practice to handle patients with endodontic treated teeth during orthodontic treatment, fueled by growing awareness and a heightened desire for optimal aesthetics, particularly among older patients [3].

Endodontic treatment during orthodontic interventions can have several effects on teeth and surrounding tissues. Studies suggest that endodontic-treated teeth do not exhibit a higher risk of significant root resorption than vital teeth if orthodontic forces are controlled [3,4]. Teeth with endodontic treatment typically lack the nerve supply, reducing sensitivity to the forces applied during orthodontic movement [5]. It can make it harder to detect early signs of root resorption. Endodontic-treated teeth can be successfully moved orthodontically. Forces must be moderate to avoid complications such as root fractures. Teeth with endodontic issues might

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be more prone to complications if subjected to aggressive orthodontic forces. There's a risk of flare-ups in previously asymptomatic teeth or exacerbation of existing lesions, requiring close monitoring [3-5]. Other studies have indicated that teeth undergoing root canal treatment are less prone to apical root resorption during orthodontic movement. Bone and periodontal tissue surrounding endodontic treated teeth can still undergo remodeling during orthodontic movement. It allows for normal tooth movement, though healing may be slow [4,5].

Apical periodontitis (AP) is an inflammation of tissues around the tooth root, often caused by bacteria from caries, trauma, or dental procedures. It is a common endodontic issue and a major reason for root canal treatment, which can impact orthodontic outcomes. AP often lacks noticeable symptoms, making early detection crucial. Radiographic exams are the primary diagnostic tool, with conventional X-rays detecting AP in 15–30 days, while cone-beam computed tomography (CBCT) can identify it within 7 days [7].

Apical periodontitis (AP) affects 30% to 50% of the general population, with higher rates seen in developing countries due to limited access to healthcare. The condition is less common in anterior teeth than posterior teeth, with the highest occurrence in maxillary first molars, ranging from 40% to 54% [8].

In the literature, some authors did not find a statistically significant change in AP size during orthodontic treatment. Other authors evaluated it from a histological point of view of AP healing and concluded that orthodontic treatment delayed it [9]. According to our knowledge, until now there are no studies that evaluate the impact of laser root canal sterilization on teeth in orthodontic treatment.

An essential step in treating periapical lesions is the mechanical cleaning and proper sterilization of the root canals. The endodontic treatment depends on pulp debris removal and microorganisms from the root canal by chemical-mechanical methods. However, manual or rotary instrumentation systems cannot clean secondary canals, which leads to apical complications due to incomplete root fillings.

Laser use along with irrigating solution in endodontic treatment reduces postoperative pain. This effect is achieved by reducing inflammation and neuronal inhibition with an optimal laser dose between 0.3 and 19 J/cm² [10].

There are currently two ways of using lasers to clean and disinfect the root canal. The first method uses the laser in a dry canal, relying on photothermal interaction to remove debris and biofilm. The second method combines the laser with irrigation solutions, creating cavitation for fluid movement. The diode laser (810-1064 nm) is effective for sterilization, rapid healing, and post-treatment pain reduction.

An in vitro study by Benedicenti et al. [11] showed that the 810 nm diode laser, along with chelating irrigant solutions such as citric acid and EDTA, resulted in an almost complete (99.9%) reduction of E. faecalis. In another study, Pirnat and his team found that the 808 nm diode laser had a similar effect to Nd:YAG; Nd:YAG was more effective against pigmented microorganisms than the diode laser [12].

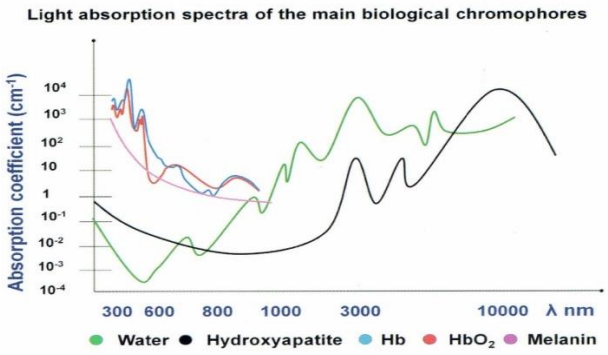

Fig.1 Absorption of laser waves in different media

Studies have shown that the Er:YAG laser is the most effective in removing the smear layer and opening the dentinal canals compared to other lasers and irrigants. It also has a superior bactericidal effect, more pronounced than Nd:YAG and diode laser, especially in the deep layers of dentin and straight canals [13].

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EDTA is the best solution alone and in combination with the laser (LAI), which activates the fluid and increases the effectiveness of the chelating agent and the smear layer removal. Use alongside NaOCI increases the decontamination effect. 5.25% NaOCl significantly decreased the fracture strength of root dentin from 172.10 ± 30.13 MPa to 114.58 ± 26.74 MPa, resulting in a 34.1% reduction in micro-hardness at the root canal wall [14]. This technology mitigates the thermal effect of the laser and provides a bacteriological and cleaning action, thanks to the circulation of the liquid induced by the photon energy.

Our study aimed to evaluate the periapical area of teeth that underwent endodontic treatment with Er:YAG laser and EDTA during orthodontic treatment.

MATERIALS AND METHODS

Our retrospective study included 32 endodontic-treated teeth from 25 patients who underwent fixed orthodontic treatment. The evaluation was done using CBCTs because they are the most frequently used modality clinically as diagnostic CBCT for the diagnosis and treatment planning of patients undergoing endodontic treatment. All images were extracted as JPEG files.

In all endodontic treatments, we used EDTA and 5.25% NaOCl in combination with the laser (LAI), which activates the fluid and increases the effectiveness of the chelating agent and the smear layer removal.

The total sample comprised teeth that had received endodontic treatment and root canal therapy (RCT) during orthodontic treatment, which were still intact after the orthodontic process without requiring re-treatment. CBCTs were taken after the root canal treatment, which occurred during the orthodontic treatment, as well as during the first month following the completion of the fixed orthodontic treatment.

The quality of the endodontic filling was examined and classified as correspondent, uncertain, or inadequate. Obturation was considered "correspondent" when all canals were completely occluded [15], "uncertain" if an additional unobstructed canal was present, and "inadequate" when there were unobstructed canals. The tightness of the root filling was monitored, and obturation was considered "correspondent" when it terminated at the radiographic apex over half of the apical third of the root. Over-obturation (figure 2) refers to filling beyond the radiographic apex, while under-obturation occurs when the filling covers less than half of the apical third of the root [3].

Fig.2 Overfilling and periapical lesion

The periapical bone destruction probability index (PRI) was evaluated in the studied teeth as described by Reit & Grondahl [16], considering periapical destruction as absent, uncertain, or present.

Changes in PRI scores during and after orthodontic treatment were analyzed using multinomial logistic regression and generalized estimating equations to account for score correlations. Odds ratios (OR) and percentages with 90% confidence intervals were reported. An OR > 1 indicated a higher likelihood of increased post-treatment scores. P-values < 0.05 were significant.

RESULTS

21 teeth (66%) had a root canal filling of correspondent length, 1 tooth (3%) was deemed uncertain, and 10 teeth (31%) were insufficient. Regarding the density and homogeneity of the root canal filling, 25 teeth (78%) were considered correspondent, 2 teeth (6%) were classified as uncertain, and 5 teeth (16%) were inadequate.

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The percentage of teeth showing periapical bone destruction, as assessed by the PRI, was significantly greater following orthodontic treatment (Table 3). Specifically, the post-treatment and during-treatment odds ratios for bone destruction present versus absent and present versus uncertain were 1.67 (90% CI: 1.16–2.49, P=0.008) and 1.77 (90% CI: 1.11–2.85, P=0.031), respectively.

Table 1. PRI during and after orthodontic treatment

PRI	During		After	
	n	% (90%CI)	*n*	% (90%CI)
Absent	15	14.9% (10.3%; 19.5%)	14	23.9% (16.6%; 31.2%)
Uncertain	12	45.8% (37.3%; 54.3%)	10	42.8% (33.9%; 51.7%)
Present	5	39.3% (29.0%; 49.6%)	8	33.3% (25.7%; 40.9%)

DISCUSSIONS

Evidence indicates that changes in PRI following orthodontic treatment varied based on the quality of the endodontic work. Teeth with inadequate endodontic treatment showed a greater risk of periapical bone destruction post-orthodontic therapy than those treated properly. This moderating effect was significant for factors such as the quality of the root canal treatment, length of the filled root, and density and uniformity of the root canal filling [17].

The interaction between endodontic and orthodontic treatments, especially during treatment, is still not fully understood [18]. This becomes particularly important when planning orthodontics for patients with endodontically treated teeth after periapical periodontitis. There is a need to explore whether applying orthodontic forces on such teeth impacts the healing process or alters the stability of the endodontic work. This raises an essential question: could orthodontic treatment influence the outcomes for teeth that have undergone endodontic procedures?

This study brings important insights into the effectiveness of the Er:YAG laser and EDTA in enhancing endodontic outcomes during orthodontic treatment [19]. The data highlights that the Er:YAG laser is highly effective for smear layer removal and dentinal canal opening, showing superior bactericidal effects compared to other laser types, particularly in deeper layers of dentin and straight canals. The laser-activated irrigation (LAI) system, combined with EDTA and NaOCl, enhances decontamination and minimizes bacterial persistence due to the chelating and bactericidal effects. However, the study also reveals that NaOCl at a concentration of 5.25% significantly decreases root dentin's fracture strength and reduces its micro-hardness, which may influence the longevity of the treated tooth [14].

The retrospective study data show that 66% of teeth (21 out of 32) had root canal fillings of the correct length, classified as "correspondent," while 31% (10 teeth) were deemed "insufficient" and 3% uncertain. This distribution of quality in root canal fillings correlates with increased periapical destruction post-orthodontic treatment.

In terms of density and homogeneity, the majority of teeth (78%) were classified as a correspondent, with fewer teeth falling under uncertain (6%) or inadequate (16%) classifications. Interestingly, these percentages differ slightly from the adequacy in length of filling. While a greater percentage of teeth had correspondent density and homogeneity (78%) compared to length (66%), the occurrence of periapical destruction was still significant, especially in cases with incomplete or suboptimal fillings. This could indicate that both filling length and density/homogeneity are critical factors in reducing the risk of periapical bone changes, especially under orthodontic stress.

Table 1 shows a clear change in PRI scores from during to after orthodontic treatment. The number of teeth without periapical destruction slightly decreased post-treatment (from 15 teeth to 14), reflecting a minor reduction in teeth without any visible periapical issues. Teeth classified as "unsure" dropped from 12 (45.8%) during treatment to 10 (42.8%) post-treatment, suggesting some resolution or progression in this intermediate category.

The most notable change occurred in the teeth with confirmed periapical destruction, which rose from 5 (39.3%) during treatment to

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8 (33.3%) post-treatment. These shifts are statistically significant, as indicated by odds ratios of 1.67 and 1.77 for present/absent and present/uncertain categories, respectively. These findings suggest that orthodontic treatment can increase the likelihood of periapical bone destruction, particularly in teeth with endodontic fillings of suboptimal quality.

The study's reliance on CBCT evaluations provides a clear diagnostic approach for treatment planning, allowing a standardized method for monitoring changes in periapical health. However, it could be beneficial to explore further how the structural changes in root dentin from NaOCl application might influence PRI scores over a more extended period. Additionally, extending research to varied orthodontic treatment durations could help clarify the long-term impacts of orthodontic forces on endodontically treated teeth.

This study makes a strong case for the critical role of laser-enhanced irrigation in endodontic treatment within orthodontic care settings. Er:YAG laser with chelators like EDTA provides enhanced bacterial control but also appears to reduce the risks of post-treatment complications when accompanied by optimal obturation quality. These findings underscore the importance of meticulous endodontic treatment, particularly in orthodontic patients, to reduce risks of periapical pathology over time.

The high odds ratios post-orthodontic treatment indicate a substantially increased risk of periapical bone destruction in teeth with uncertain or inadequate fillings. Teeth with correspondent fillings had lower odds of experiencing periapical issues, unlike those with uncertain or inadequate fillings. Poor root canal treatments, whether in terms of length or density, may leave teeth more vulnerable to bacterial infiltration, potentially exacerbated by the orthodontic forces applied.

CONCLUSIONS

Endodontically treated teeth with inadequate filling quality show a significantly higher risk of periapical bone destruction after orthodontic treatment, while those with optimal filling quality have a lower risk. The Er:YAG laser, in combination with EDTA and NaOCl, effectively enhances endodontic outcomes by removing smear layers and reducing bacterial presence, although high concentrations of NaOCl can decrease root dentin strength. CBCT evaluations reveal an increase in periapical bone destruction post-orthodontic treatment, particularly in teeth with uncertain or inadequate fillings. These findings emphasize the need for high-quality root canal therapy prior to orthodontic procedures and suggest further research on the long-term impacts of orthodontic forces on treated teeth.

Conflict of interest: the authors declare no conflict of interest associated with this paper.
Institutional Review Board Statement: the study was conducted according to the guidelines of the Declaration of Helsinki and approved by the Ethics Committee of SC Algocalm SRL, Târgu-Mureș, Romania, 916/24.05.2023.
Informed Consent Statement: informed consent was obtained from all subjects involved in the study.

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