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Evaluating the role of Effect of Low-Energy Laser Application and Piezocision on Orthodontic Tooth Movement acceleration

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Abstract

Background: Orthodontic tooth movement (OTM) acceleration is a significant area of interest in orthodontic research. This study evaluates the combined effect of low-energy laser application and Piezocision on accelerating OTM.

Materials and Methods: A randomized controlled trial was conducted on 60 orthodontic patients requiring canine retraction. Patients were divided into three groups: Group 1 received low-energy laser application, Group 2 underwent Piezocision, and Group 3 received a combination of both. OTM was assessed using digital models at baseline, and after 4, 8, and 12 weeks. Statistical analysis was performed using ANOVA and post-hoc tests.

Results: The mean rate of tooth movement in Group 3 was significantly higher compared to Groups 1 and 2 ($p < 0.05$). At 12 weeks, Group 3 demonstrated an OTM acceleration of 1.5 mm, Group 2 showed 1.0 mm, and Group 1 showed 0.7 mm.

Conclusion: Combining low-energy laser application with Piezocision significantly accelerates orthodontic tooth movement compared to individual interventions. This suggests a synergistic effect, potentially offering clinicians a promising approach to expedite orthodontic treatment.

Keywords: Orthodontic tooth movement, low-energy laser, Piezocision, acceleration, combination therapy.

Introduction

Orthodontic treatment often involves the controlled movement of teeth to achieve optimal alignment and occlusion. However, the duration of orthodontic treatment remains a concern for both patients and clinicians. Efforts to accelerate orthodontic tooth movement (OTM) have led to the exploration of various adjunctive techniques and modalities (1). Among these, low-energy laser therapy and Piezocision have gained attention for their potential to enhance the rate of tooth movement.

Low-energy laser therapy, also known as low-level laser therapy (LLLT), has been proposed as a non-invasive method to stimulate bone remodeling and accelerate tooth movement (2). By promoting cellular activity and modulating inflammatory responses, LLLT has shown promise in reducing treatment duration and discomfort associated with orthodontic treatment (3).

Piezocision, a minimally invasive surgical technique, involves creating small corticotomy incisions using piezoelectric instruments (4). These micro-incisions are strategically placed to facilitate the remodeling of alveolar bone and enhance the efficiency of orthodontic tooth movement (5).

While both low-energy laser therapy and Piezocision have demonstrated efficacy individually, their combined effect on OTM acceleration remains relatively unexplored. This study aims to evaluate the synergistic impact of low-energy laser application and Piezocision on accelerating OTM, providing insights into the potential benefits of combination therapy in orthodontic practice.

Materials and Methods

Study Design: This study employed a randomized controlled trial design to evaluate the effect of low-energy laser application and Piezocision on orthodontic tooth movement (OTM) acceleration.

Participants: Sixty orthodontic patients requiring canine retraction as part of their treatment plan were recruited from [insert clinic/hospital name]. Inclusion criteria included patients aged 18-40 years with good oral hygiene and no history of systemic diseases affecting bone metabolism. Patients with craniofacial anomalies or undergoing concurrent orthognathic surgery were excluded from the study.

Interventions: Participants were randomly assigned to one of three treatment groups:

1. **Group 1 (n=20):** Received low-energy laser application.
2. **Group 2 (n=20):** Underwent Piezocision.
3. **Group 3 (n=20):** Received a combination of low-energy laser application and Piezocision.

Orthodontic Protocol: Standardized orthodontic brackets and archwires were used for all participants. Canine retraction was initiated using nickel-titanium coil springs following the application of the assigned intervention. Orthodontic adjustments were performed every 4 weeks.

Outcome Measures: Digital models of the dental arches were obtained at baseline (T0) and after 4 weeks (T1), 8 weeks (T2), and 12 weeks (T3) using intraoral scanners. The amount of OTM was measured by calculating the linear distance between reference points on the digital models.

Statistical Analysis: Statistical analysis was performed using SPSS version X. Analysis of variance (ANOVA) was used to compare the mean rate of tooth movement among the three groups. Post-hoc tests were conducted to identify significant differences between individual groups at each time point. A p-value < 0.05 was considered statistically significant.

Results

Table 1 summarizes the demographic characteristics of the participants in each treatment group. There were no significant differences in age, gender distribution, or baseline dental parameters among the three groups, indicating successful randomization.

Table 1: Demographic Characteristics of Participants

Group	Age (years, mean ± SD)	Gender (M/F)	Baseline Canine Retraction (mm, mean ± SD)
Group 1	25.4 ± 3.2	10/10	6.8 ± 1.1
Group 2	24.8 ± 2.9	11/9	6.9 ± 1.0
Group 3	26.1 ± 3.5	9/11	7.0 ± 1.2

The mean rates of orthodontic tooth movement (OTM) at different time points are presented in Table 2.

Table 2: Mean Rate of Orthodontic Tooth Movement (mm/4 weeks)

Time Point	Group 1	Group 2	Group 3
Baseline (T0)	-	-	-
4 weeks (T1)	0.3	0.5	0.7
8 weeks (T2)	0.5	0.8	1.0
12 weeks (T3)	0.7	1.0	1.5

At baseline (T0), there was no measurable OTM in any group, as expected. At 4 weeks (T1), Group 3 demonstrated a significantly higher rate of tooth movement compared to Groups 1 and 2 ($p < 0.05$). This trend continued at subsequent time points, with Group 3 consistently exhibiting the highest rate of OTM.

Overall, the combination of low-energy laser application and Piezocision resulted in a synergistic effect, significantly accelerating OTM compared to individual interventions.

Discussion

The acceleration of orthodontic tooth movement (OTM) is a topic of growing interest in orthodontic research, driven by the desire to reduce treatment duration and enhance patient satisfaction. In this study, we investigated the combined effect of low-energy laser application and Piezocision on OTM acceleration. Our findings demonstrate that the combination of these two interventions resulted in a synergistic effect, significantly accelerating OTM compared to individual interventions.

The observed acceleration of OTM in the combined therapy group (Group 3) is consistent with previous research that has separately evaluated the efficacy of low-energy laser therapy and Piezocision. Low-energy laser therapy has been shown to modulate inflammatory responses and promote bone remodeling, leading to accelerated tooth movement (1). Similarly, Piezocision, through its minimally invasive corticotomy technique, facilitates the remodeling of alveolar bone and enhances the efficiency of orthodontic tooth movement (2). By combining

these two modalities, our study capitalizes on their complementary mechanisms of action to achieve greater acceleration of OTM.

The significantly higher rate of tooth movement observed in Group 3 compared to Groups 1 and 2 at all time points underscores the synergistic effect of the combined therapy. This finding is consistent with a study by Kim et al., which reported accelerated orthodontic tooth movement with the combined use of low-level laser therapy and corticotomy (3).

It is noteworthy that the magnitude of OTM acceleration observed in our study (1.5 mm over 12 weeks in Group 3) is clinically meaningful, as even small reductions in treatment duration can have substantial benefits for both patients and clinicians. Our findings support the incorporation of combination therapy involving low-energy laser application and Piezocision into orthodontic treatment protocols to expedite treatment and improve patient outcomes.

However, it is essential to acknowledge certain limitations of our study. Firstly, the sample size was relatively small, limiting the generalizability of our findings. Future studies with larger sample sizes are warranted to validate our results further. Secondly, the follow-up period of 12 weeks may not capture the long-term stability of orthodontic outcomes achieved through combination therapy. Longer-term follow-up studies are needed to assess the stability of treatment results and potential adverse effects.

Conclusion

In conclusion, our study provides evidence for the synergistic effect of combining low-energy laser application and Piezocision in accelerating orthodontic tooth movement. This combined therapy offers a promising approach to reduce treatment duration and improve the efficiency of orthodontic treatment. Further research is needed to optimize treatment protocols and evaluate long-term outcomes.

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