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Original Research

An evaluation of root resorption during retraction phase using micro osteoperforation technique and low-level laser therapy: A split mouth study

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ABSTRACT:

Objective: To evaluate the level of apical root resorption of maxillary canine during individual canine retraction when tooth movement is accelerated by application of two different methods viz Micro osteoperforation and Low-level laser therapy. **Methods:** Patient's written concern form were taken before the study. Routine records were collected and analysed for all the subjects. For this study a split arch method were used. 40 patients was selected as per the inclusion criteria. Treatment will be initiated by the extraction of first maxillary premolars followed by bonding fixed orthodontic appliance in both arches with 0.022 MBT prescriptions. Leveling and alignment were done till 0.019x0.025"SS wire could be placed passively before the onset of individual canine retraction. Before starting retraction, patients were randomly allocated for intervention therapy. The first intervention MOP was done on one side and on the other side LLLT was given. Patients was recalled every 3 weeks for 3 months for the intervention and for radiographs to check any apical root resorption. The data thus obtained was put to significant statistical analysis and the results thus obtained was carried out to achieve the aim and objective of study. Apical root resorption was evaluated by comparing post-treatment root length from the pre-treatment root length. Thus, pre-treatment radiograph and post-treatment radiographs were traced and examined to calculate the change in the root length according to which grading were assigned. Levender and Malmgren grading system were used in this study. First visit was denoted as T1, 21st day after intervention was denoted as T2, 42nd day was denoted as T3, 63rd day was denoted as T4, and 84th day was denoted as T5. Different grading were obtained at different interval of time during MOPs and LLLT intervention process. **Results:** The present study evaluated the level of apical root resorption during canine retraction while closing extraction space while comparing both MOP and LLLT done at different interval of time. All 40 subjects had successfully completed the four months comparative study with no loss to follow up. Comparison of total root resorption between MOP and LLLT group showed no significant differences statistically whereas LLLT group showed less apical root resorption as compared to MOP group. **Conclusions:** It can be concluded, there are various factors which effects the root resorption. Rate of tooth movement is one of the crucial factors among them. Increased rate of tooth movement due to accelarated methods such as Micro Osteoperforation and Low-level laser therapy might cause root resorption which was seen in this study. In this study 2D radiographs (OPG) was used for root resorption evaluation. So it can be suggested that for further investigation using 3D radiograph like CBCT and better randomization along with increased number of samples might provide more precise results.

Keywords: Apical root resorption, Micro-osteoperforation, Low-level laser therapy, Space closure.

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INTRODUCTION

The duration of orthodontic treatment is the primary concern of most patients. Unfortunately, long orthodontic treatment time poses several disadvantages like higher predisposition to dental caries, gingival recession and root resorption. Therefore, this increases the call on to find the best method to increase rate of tooth movement with the least possible drawback[1]. Classic orthodontic treatment time ranges between 18-24 and 19-28

months for non- extraction and extraction therapies, respectively.[2] Accelerating the rate of tooth movement is beneficial to reduce this time since the long treatment duration has been associated with an increased risk of gingival inflammation, decalcification, dental caries, root resorption and also reduced patient co- operation.[3] Orthodontic treatment related risk factors include treatment duration, tooth movement direction, force magnitude and method of applied force. The way orthodontic treatment stimulates root resorption is unknown. Apical root resorption is an undesirable outcome of orthodontic therapy that may affect the result of treatment in some cases. [9]Orthodontic treatment may be continued, modified, or discontinued when root resorption is detected during treatment. Early detection of root resorption during orthodontic treatment is important for identifying teeth at risk of severe resorption. Prolonged treatment times may lead to an increased risk of several undesirable outcomes such as caries, periodontal disease and root resorption, which is why many adult patients refuse orthodontic treatment. At present, it is mysterious how orthodontic treatment influences root resorption. The etiological factors for root resorption are complex and multifactorial, but it appears that apical root resorption results from a combination of individual, biologic, variability, genetic predisposition, and the effect of mechanical factors. Root resorption is undesirable because it can affect the long-term viability of the dentition, and the patients undergoing orthodontic treatment with prolonged time duration are more likely to have severe apical root shortening.[4] Finding the optimal technique to accelerate tooth movement with the fewest drawbacks is therefore more important. Conventionally, orthodontic treatment process is slow and can range anywhere between 12-48 months. By enhancing the body's response to these forces, tooth movements can be accelerated. Accelerated orthodontic tooth movement is not something that has recently emerged; it has been studied and tried out for many years. In an attempt of producing faster tooth movement during orthodontic treatment, there are numerous methods of accelerating tooth movements that have been introduced over the years which range from surgical means to the use of laser therapy. Acceleration of tooth movement during orthodontic treatment has increasing demand now a days, because of patient's interest to get the treatment completed in less span of time and to decrease the number of visits. Accelerated tooth movement has been preferred for its numerous prospective benefits like shorter treatment duration, differential tooth movement, enhanced envelop of tooth movement, improved post treatment stability and reduced side effects. Adult orthodontics has more demand of reduced treatment time as the numbers of patient are increasing. Accelerating orthodontic techniques can be highly useful for fastening the treatment time as in every technique being used; there is increased rate of tooth movement and hence decreasing the treatment time.[5] LASER (light amplification by stimulated emission of radiation) – is the most promising approaches today. Laser light stimulates the proliferation of osteoclast, osteoblast and fibroblasts and thereby affects osseous remodeling and accelerates tooth movement.[6] The mechanism involved in the acceleration of tooth movement is by the production of ATP and activation of cytochrome C which improve the velocity of tooth movement via RANK/RANKL and the macrophage colony -stimulating factor and its receptor expression.[1] Low level laser therapy has a potential to increase the rate of tooth movement and may increase the rate of tooth movement during orthodontic treatment. The Low level (energy) laser therapy has been suggested to accelerate the turnover of periodontal tissue through its bio stimulatory effect, which in turn is postulated to accelerate tooth movement[6]. Use of low level laser therapy isa method for achieving this goal.[7] Micro-osteoperforation (MOP) is another accelerated method of tooth movement widely accepted as minor surgical procedure. MOPs are proving to be a minimally invasive, repeatable, relatively easily manage minor surgical procedure which can be done using normally available orthodontic appliances. MOPs approvingly increase the osteoclast numbers by inducing an aseptic inflammatory reaction, thus increasing tooth movement rates. The concept of MOPs originated the attempt of boasting normal inflammatory responses. The controlled micro trauma in the form of MOPs given in the alveolar bone amplifies the expression of inflammatory markers, leading to a increase in osteoclastic activity which increases tooth movement. MOP are an effective, comfortable, and safe procedure to accelerate tooth movement during orthodontic treatment.[8] MOP could reduce orthodontic treatment time by 62 percent.[1] Patients have reported very mild and insignificant discomfort and pain after receiving MOPs as compared with those who undergo conventional orthodontic treatment procedures indicating that patient compliance is high with this procedure. Also appreciative in the reporting of insignificant external root resorption with this procedure which makes it suitable.[10] There were no studies which compared the rate of tooth movement and severity of the iatrogenic effect i.e external root resorption with LLLT and MOP in the same individual. Therefore, this study was conducted using split mouth design and the rationale of using this method was to eliminate the biologic variation which determines different individual's susceptibility to root resorption. The intervention was only performed in canine area since our aim was only to compare the two approaches in the least invasive way possible. Thus, the objective of this study was to evaluate and compare the amount of root resorption during individual canine retraction in maxillary canine region accelerated by application of two methods LLLT and MOP.

MATERIALS AND METHODS

In this in vivo comparative study 40 patients were selected randomly from Department of Orthodontics and Dentofacial Orthopaedics of New Horizon Dental College and Research Institute, Sakri, Bilaspur, Chhattisgarh, undergoing fixed orthodontic treatment and those who required therapeutic extraction of upper first premolar at the minimum, as a part of orthodontic treatment. The study procedures were approved by the Scientific and Ethical committee of New Horizon Dental College and Research Institute, Sakri, Bilaspur, Chhattisgarh for carrying out the research work, followed by consent of patients which were recorded.The study was conducted to evaluate the root resorption in the process of accelerated tooth movement by the use of Low-Level Laser Therapy and Micro- Osteoperforation method in canine tooth of maxillary arch during space closure using individual canin e retraction technique.

INCLUSION CRITERIA

- Age of subjects 16 to 30 years seeking orthodontic treatment.
- Patients with Angle's Class I malocclusion with bimaxillary protrusion and class II division 1.
- The full complement of teeth presents except 3rd molar.
- Cases which needed therapeutic extraction of 1st premolars in both upper/lower as a part of Orthodontic diagnosis and treatment planning requiring canine retractions to close the space.
- Healthy Periodontal conditions.
- Patients with no radiographic evidence of bone loss in either sides of mouth.

EXCLUSION CRITERIA

- No history of root resorption due to any cause.
- No history of any orthodontic treatment.
- Patient under medications.
- Presence of parafunctional habits.
- Presence of TMJ dysfunction.
- Any Systemic disease.

Patient's written consent forms were taken before the study and also explained about the procedure in details and the purpose of the study. Photographs and radiographs were collected and analysed for all the subjects. For this study a split arch method was used. 40 patients were selected as per the inclusion criteria. The first molars were banded and treatment was initiated by the extraction of first maxillary premolars at the beginning to allow relief of crowding in some patients followed by bonding fixed orthodontic appliance in both arches with 0.022 MBT prescriptions. MBT wire sequence was followed in each patient. For reinforcement of the anchorage Trans Palatal arch and Lingual arch were placed in upper and lower arch respectively. Leveling and alignment were done till 0.019 x 0.025" SS working arch wire were placed passively before the onset of individual canine retraction using sliding mechanics. Maximum anchorage was ensured by placing Mini-screw Implant measuring 1.6 mm diameter and 8 mm in length with a driver, bilaterally between the maxillary second premolars and first molars (fig.5). The mini-screws were placed under local anaesthesia and self-drilled into the bone using implant driver. Canine retraction was initiated using nickel-titanium (Ni-Ti) closed-coil spring. Spring was attached from mini-screw implant to power arm of canine bracket to deliver the retraction force of 150 g which was measured using dontrix gauge. Force level was evaluated and maintained by periodic recall once every 21 days till retraction of canine was completed. Before starting retraction, patients were randomly allocated for intervention therapy. The first intervention MOP was done on one side of each patient whereas the other side was exposed to LLLT. Patients were blinded for MOPs and LLLT side.

Figure-1 Bonding kit

Figure-2 Dontrix gauge, Niti-coil spring, SS Wire (19 x 25 SS Wire)

Figure-3 Mini-screw Implant measuring 1.6 mmdiameter and 8 mm in length with a driver, mouthmirror and periodontal

Figure-4 Diode Laser unit

Figure- 5 Mini-screw implant was placed for maximum anchorage

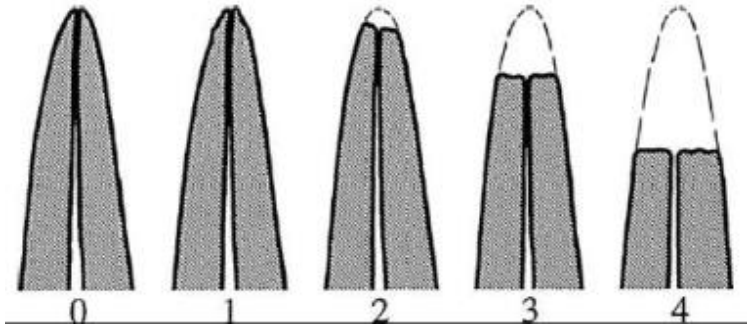


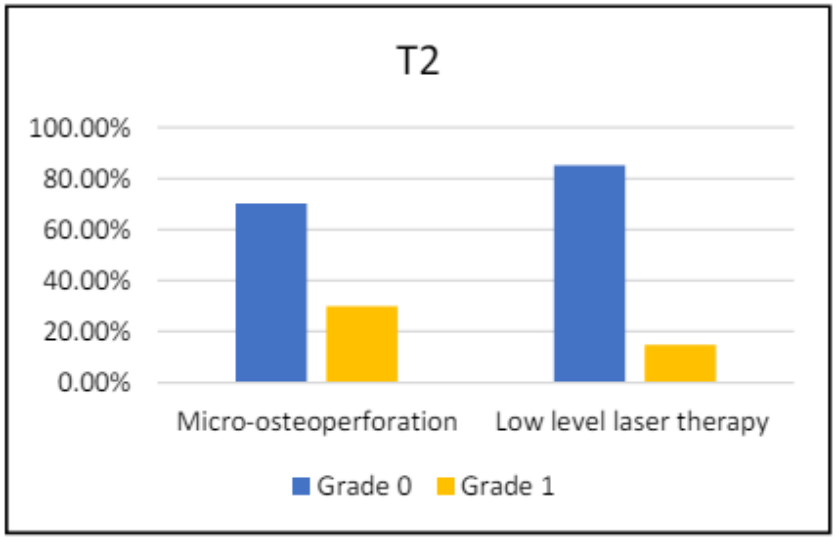
Figure 6 Levender and Malmgren (1988) scoring system for root resorption

STATISTICAL ANALYSIS

The data are tabulated in Microsoft excel and analysed with SPSS V.24 software. The variables are presented with frequency and percentage. Chi square test is used for the statistical analysis. The p value ≤0.05 is considered statistically significant.

Table 1: Comparison of apical root resorption at T2

Time	Grade		Group		Total	P value
			Micro-osteoperforation	Low level laser therapy		
T2	Grade0	N	28	34	62	0.108
		%	70.00%	85.00%	77.50%	
	Grade1	N	12	6	18	
		%	30.00%	15.00%	22.50%	
Total		N	40	40	80	
		%	100.00%	100.00%	100.00%	



At T2, both the groups showed more number of Grade 0 root resorption than Grade 1. The difference was not statistically significant (p=0.108).

Table 2: Comparison of apical root resorption at T3

Time	Grade		Group		Total	P value
			Micro-osteoperforation	Low level laser therapy		
T3	Grade0	N	9	32	41	0.082
		%	22.50%	80.00%	51.20%	
	Grade1	N	31	8	39	
		%	77.50%	20.00%	48.80%	
Total		N	40	40	80	
		%	100.00%	100.00%	100.00%	

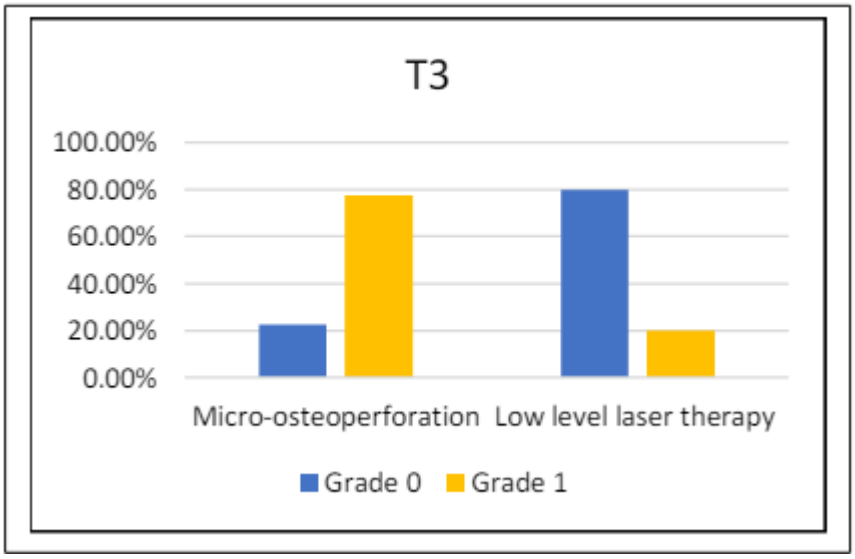
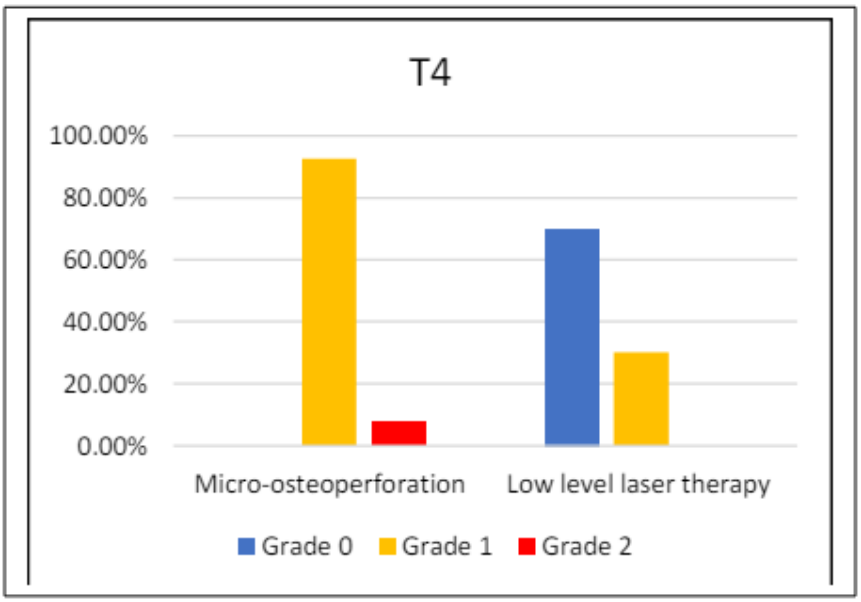


Table 3: Comparison of apical root resorption at T4

Time	Grade		Group		Total	P value
			Micro-osteoperforation	Low level laser therapy		
T4	Grade0	N	0	28	28	0.209
		%	0.00%	70.00%	35.00%	
	Grade1	N	37	12	49	
		%	92.50%	30.00%	61.20%	
	Grade2	N	3	0	3	
		%	7.50%	0.00%	3.80%	
Total		N	40	40	80	
		%	100.00%	100.00%	100.00%	

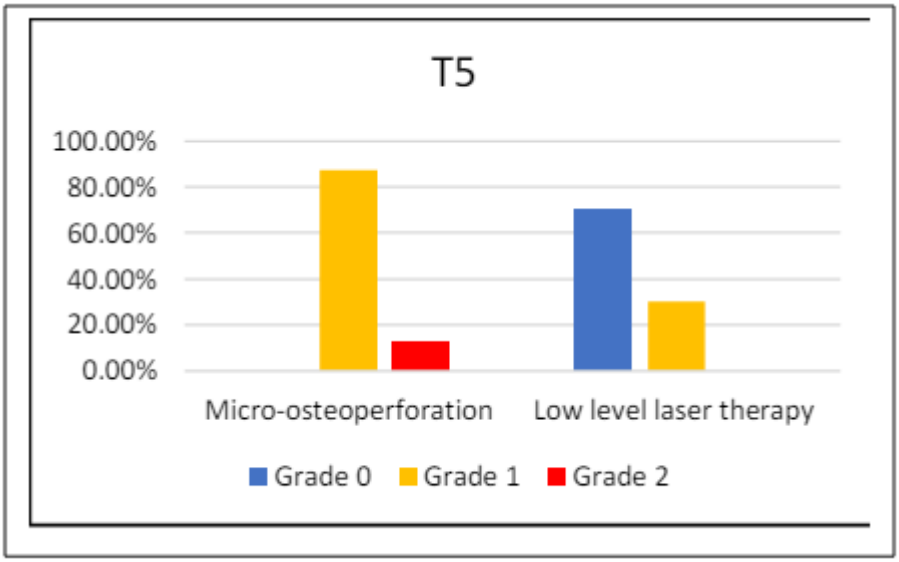
At T3, more number of Grade 0 root resorption was seen in Low level laser therapy group than Micro-osteoperforation group; more number of Grade 1 root resorption was seen in Micro-osteoperforation group than Low level laser therapy group. The difference was not statistically significant (p=0.082).



At T4, more number of Grade 0 root resorption was seen in Low level laser therapy group than Micro-osteoperforation group; more number of Grade 1 root resorption was seen in Micro-osteoperforation group than Low level laser therapy group; more number of Grade 2 root resorption was seen in Micro-osteoperforation group than Low level laser therapy group. The difference was not statistically significant (p=0.209).

Table 4: Comparison of apical root resorption at T5

Time	Grade		Group		Total	P value
			Micro-osteoperforation	Low level laser therapy		
T5	Grade0	N	0	28	28	0.115
		%	0.00%	70.00%	35.00%	
	Grade1	N	35	12	47	
		%	87.50%	30.00%	58.80%	
	Grade2	N	5	0	5	
		%	12.50%	0.00%	6.20%	
Total		N	40	40	80	
		%	100.00%	100.00%	100.00%	



At T5, more number of Grade 0 root resorption was seen in Low level laser therapy group than Micro-osteoperforation group; more number of Grade 1 root resorption was seen in Micro-osteoperforation group than Low level laser therapy group; more number of Grade 2 root resorption was seen in Micro-osteoperforation group than Low level laser therapy group. The difference was not statistically significant (p=0.115).

RESULTS

The present study evaluated the level of apical root resorption during canine retraction while closing extraction space while comparing both MOP and LLLT done at different interval of time. All 40 subjects had successfully completed the four months comparative study with no loss to follow up. Comparison of total root resorption between MOP and LLLT group showed no significant differences statistically whereas LLLT group showed less apical root resorption as compared to MOP group.

DISCUSSION

Orthodontic tooth movement is influenced by the applied mechanical force that leads to tissue remodelling within the periodontium. One of the iatrogenic outcomes of orthodontic tooth movement is induced inflammatory root resorption. *Alikhani et al*,[11] stated in 2015 that shortening the orthodontic treatment time offers significant value to both orthodontist and patient. Less treatment time with fixed orthodontics reduces the risk for external apical root resorption. The efficiency of LLLT and MOP in increasing the rate of tooth movement is now widely accepted, but their iatrogenic effects on the periodontium were not well-documented which could be attributed to the fact that such procedures are done mostly on patients who can have either a high or low risk of root resorption[12].In this study, a split-mouth randomised clinical trial was designed to evaluate the apical root resorption during individual canine retraction when tooth movement is accelerated by application of MOP and LLLT. Laser and MOP were done in maxillary canine region both right and left side. The patient selection was restricted to a sample with the age range of 16-30 years since it has been found that the young patients (<15 years) demonstrated faster tooth movement than the older ones.[13]In a study comparing the effectiveness of the Malmgren index on 2D and 3D radiographs, *Hanne Michielsens* et al[14] discovered that the original Malmgren index is not appropriate for 3D pictures. In 2022, *Allen Joseph et al*[15] employed nickel titanium closed coil springs with a force of 150 grams per side in the upper and lower arches to study apical root resorption during en-masse retraction utilizing MOP

and LLLT. CBCT was used in this study to assess root resorption in all teeth and the results showed that in the experimental groups canines had less root resorption than the control groups. The canine showed the least amount of root resorption compared to the lateral, central, and second premolars. In 2017, *Sweta Gupta*[16] and colleagues carried out research to assess the frequency and severity of orthodontically-induced apical root resorption using fixed appliances in permanent teeth following en-masse retraction, ranging from the central incisor to the first molar. During the en masse retraction of anterior teeth, root resorption was observed in every tooth, ranging from incisors to first molars. Premolars displayed the least amount of resorption in both arches, while lateral incisors displayed higher resorption than central incisors. Similar findings were seen in this study, though it was individual canine retraction, root resorption was less in both groups. MOP group showed more root resorption as compared to LLLT group but it was statiscally non-significant. OPG and Periapical radiography are the most commonly used radiographic methods to detect and monitor orthodontically induced inflammatory root resorption because they are easily accessible in dental clinics, reasonably priced, and have a low radiation dose. While 3D imaging can help diagnose root resorption more accurately than traditional 2D imaging, patients still need to be exposed to radiation repeatedly in order to monitor orthodontically-induced inflammatory root resorption. Therefore, to reduce the frequent radiation exposure on patients we opted for OPG over CBCT to identify root resorption in both the sides. Accelerating orthodontic techniques can be useful for fastening the treatment and there is increased rate of tooth movement and hence decreasing the treatment time[5]. Micro-OsteoPerforation (MOP) is a commonly used acceleratory orthodontic technique which needs minimal surgical intervention and works on the principle of Regional Acceleratory Phenomenon (RAP)[9]. MOPs significantly increased the expression of cytokines and chemokines known to recuit osteoclast precursors and stimulate osteoclast differentiation. Non-invasive methods of acceleratory orthodontics achieve similar results as surgical methods and are better accepted by patients. MOPs increased the rate of canine retraction by 2.3fold as compared with the control group. Patients reported only mild discomfort locally at the spot of the MOPs. At days 14 and 28, little to no pain was experienced. MOPs are an effective, comfortable and safe procedure to accelerate tooth movement during orthodontic treatment. MOPs could reduce orthodontic treatment time by 62%.[1]. MOP relies on decortications of bone to reduce the resistance and facilitate faster root movement. Another reason is that reduced hyalinisation and undermining resorption could lead to lesser cementum loss and reduced root resorption. Therefore if treatment time will be reduced, chances of root resorption will also be reduced simultaneously. Various studies on low level laser therapy, have shown orthodontic tooth movement to be increased by 30-60%. The variation amongst the studies seems to arise from variations in frequency of application of laser, intensity of laser, and method of force application on the tooth. They come with additional advantages such as reduced rate of relapse, reduced orthodontic pain and reduced root resorption.[1]The first human investigation on the impact of low-intensity laser therapy on orthodontic tooth movement was conducted in 2004 by *Cruz et al.* Over the course of 60 days, they demonstrated that the irradiated canines underwent a 34% greater rate of tooth retraction than the control canines[17] In a split mouth design, *Gauri Doshi Mehta et al.* (2013)[18] used a laser at 800 nm for 10 sec on the canine buccally and ligually, which needed to be distalized following the extraction of the first premolar. They used a Ni-Ti closed coil spring, which was fastened to the canine bracket with a ligature tie and supplied a continuous force of 150g from the first molar tube hook to the power arm. The laser type that was utilized was an 808±10nm semiconductor (aluminum gallium arsenide) diode that emitted infrared light. They also sought to investigate the analgesic effects of laser treatment. The configuration was changed to an 800 nm wavelength, continuous wave mode, 0.7 mW output power for an analgesic effect. Low intensity laser therapy has been shown by *Soghra Yassaei et al*[19] (2013) to increase the pace of tooth movement during orthodontic treatment. In 2021, *Junyi Zheng et al*[20] came to the conclusion that because of LLLT's biostimulatory effects—which caused the periodontium next to the tooth to respond more biologically—it might be clinically useful in hastening orthodontic tooth movement. Inter-individual variability has been studied and it was proposed that individuals who are extremely susceptible to External Root Resorption (ERR) may show root resorption even without an apparent cause.[21] An ethnic dichotomy has been reported between Asian and Caucasian patients where the former exhibited significantly less external root resorption.[22]

The literature has conducted research that compare the iatrogenic effects of MOP and LLLT independently, as well as their acceleratory effect on tooth movement, to traditional space closing mechanics.[1,9,23] The efficiency of LLLT and MOP in increasing the rate of tooth movement is now widely accepted, but their iatrogenic effects on the periodontium were not well-documented which could be attributed to the fact that such procedures are done mostly on patients who can have either a high or low risk of root resorption.[12] A split-mouth randomised clinical trial was used in this reseach to assess the degree and character of root resorption. A majority of the studies done so far have employed a laser with a lower wavelength spectrum in the 780-980 nm range, among which 810 nm was most commonly used.[17,24,25] According to *Demirsoy*

KK et al[26]. in 2020, lasers with varying wavelengths and ranges have varied impacts on the tissues; 810 nm was the wavelength that was especially used to accelerate tooth movement[27]. *Yassaei S et al.,* in 2016 were the first to explore the effect of 980 nm laser on orthodontic tooth movement[19]. Using the same parameter, a previous unpublished study carried out by the authors, showed that use of LLLT with 975 nm laser caused 52% faster tooth movement compared to conventional orthodontics. But, in this study 810 nm wave length was used. The mode of delivery of the laser device is also a factor in the effect of the laser. While *Bradley et al.,* in 2000 and *Takeda et al.,* in 1988 have supported the use of continuous mode, *Kim et al.,* in 2009 and *Ng D et al.,* in 2017 have preferred the pulsed mode. Former claimed that the root resorption was 5% less with the pulsed mode and later claimed that laser units functioning in continuous mode show more biostimulatory response[25,28]. Therefore, in this study the irradiations were performed with a continuous mode. Lesser amount of root resorption seen in canine on LASER side was the result of the laser's preventive action against resorption or due to its reparative potential is debatable[25]. Only *Chan E et al.,* concluded that MOP leads to increased root resorption when used to accelerate tooth movement[29]. The least amount of resorption was shown by the canine in all the groups; showing less root resorption in the laser group compared to MOP but the values were not statistically significant. This leads to angiogenesis which in turn facilitates rapid expulsion of resorption causing agents. [24,25] LLLT also increases the rate of remodelling in which the anabolic activity is more than catabolic activity. These factors contribute in reducing root resorption. About 90% of patients receiving orthodontic treatment have some degree of root resorption, according to research by *Kurol J et al.* and *Taithongchai R et al.* Of them, 32% had moderate resorption (>3 mm) and 8% had severe resorption (>5 mm).[30,31] The levels of sex hormones in women are another confounding variable that can affect the rate of bone and cementum remodelling and tooth movement throughout the menstrual cycle. This could also have potential implications on the extent of root resorption[32,33]. Unfortunately, this variable could not be addressed because of the limited number of subjects willing to participate in this study. In this present study we have only evaluated the grade of root resorption with MOPs and LLLT interventions, at different interval of time. We have used 2D radiographs to evaluate root resorption. The sample size was restricted since an increased sample size would raise ethical concerns and even use of 3D CBCT radiograph to measure root resorption and the associated radiation exposure of the patients.The lack of a 3D radiographs in this study may have been a limitation of this study, as it would have provided a much more detailed review in the root resorption during canine retraction using MOPs and LLLT therapy. We acknowledge this as a potential limitation of the study.

CONCLUSION AND SUMMARY

The purpose of this study was to comparative evaluation of root resorption during canine retraction phase using MOPs technique and LLLT in a split mouth study. In this in vivo comparative study, 40 patients receiving fixed orthodontic treatment and those needing therapeutic extraction of the upper first premolar as part of orthodontic treatment were randomly selected. The aim of the study was to assess the impact of low-level laser therapy and the micro-osteoperforation technique on root resorption in cases with rapid tooth movement. For both the right and left sides of the extraction site, 40 individuals were chosen at random and assigned to receive the intervention therapy (MOPs and LLLT). It was a split mouth study, to evaluate root resorption at different intervals. After the extraction of both upper first premolars, initial levelling and alignment phase of treatment was initiated with bonded fixed appliances until reaching the 0.019 x 0.025-inch stainless steel arch wire. Then the upper right side was randomly assigned to receive 3 small MOPs labially between the canine and the second premolar. while the upper left side was assigned to receive LLLT. Before starting of intervention, first visit is denoted as T1, after 21st days it is denoted as T2, 42nd days is denoted as T3, 63rd days is denoted as T4 and 84th day is denoted as T5. Patients were recalled every 21days for the intervention and for radiographs to check any apical root resorption. Apical root resorption was calculated by subtracting post-treatment root length measurements from the corresponding pre-treatment measurements. Thus, pre- treatment radiograph and post-treatment radiographs were traced and examined to calculate the change in the root length according to which grading were assigned. Following grading system were used in this study. Different grading were obtained at different interval of time during MOPs and LLLT intervention process. Levender and Malmgren (1988) gave a scoring system for root resorption – an index for the quantitative assessment of radiographically detected root resorption, which was used in this study. Therefore, it can be concluded, there are various factors which effects the root resorption. Rate of tooth movement is one of the crucial factors among them. Increased rate of tooth movement due to accelarated methods such as Micro Osteoperforation and Low level laser therapy might cause root resorption which was seen in this study. In this study 2D radiographs (OPG) was used for root resorption evaluation. So it can be suggested that for further investigation using 3D radiograph like CBCT and better randomization along with increased number of samples might provide more precise results.

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