Original article:

Laser assisted orthodontic tooth movement in Saudi population: a randomized clinical trial.

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Abstract

Objectives*:** This study aimed to assess laser assisted orthodontic tooth movement (OTM) among subjects undergoing fixed orthodontic treatment (FOT) of four different treatment modalities (TM). ***Materials and Methods*:** Following consort flow diagram, a total of 32 subjects randomly allocated in to 4 different group based on TM. Group A (GA): 8 subjects, FOT with self-ligating bracket (SLB) + low laser irradiation (LLLI), Group A (GB): 8 subjects, FOT with self-ligating bracket + Non-LLLI, Group C (GC): 8 subjects, FOT with conventional bracket (CB) + low laser irradiation (LLLI), Group D (GD): 8 subjects, FOT with CB + Non-LLLI. ***Results: Clinical photographs and diagnostic CBCT has been taken. Clinical observation of OTM, baseline, 1-day and 28-day afterFOT in all TM groups has been assessed by single calibrated specialist. Among 4 TM groups, best OTM results observed in GA and the lesser OTM observed in GD. ***Conclusion:*** Among all 4 TM groups,1-month after FOT GA revealed promising benefit in relation to OTM.

Keywords: Laser; Orthodontic tooth movement; self-ligating bracket; conventional bracket.

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Introduction

Bone is a specialized, hard, dynamic, connective tissue which is in a constant process of bone remodelling. Bone remodelling is a physiological process where the structure of bone is maintained/preserved by equilibrium between bone deposition and resorption related to functional stresses that it is subjected to. This characteristic property of bone is exploited by a clinician for orthodontic tooth movement. Hence, it should be understood that OTM is made possible due to a well-organized deposition and resorption of alveolar bone. In addition, the periodontal ligament that attaches the tooth to the alveolar bone also undergoes remodelling.

In orthodontics, when forces are applied, on the advancing side, the periodontal ligament (PDL) gets compressed and behind (on the opposite side) it, it gets stretched[1] eventually resulting remodelling of alveolar bone, PDL and gingival.[2]

Despite prolonged duration and associated discomfort during the treatment, orthodontics is popular and there is increase in the orthodontic treatment needs amongst the population. Though new techniques have been introduced to enhance the OTM, maximum of them are either invasive or have systemic side effects. Hence, introspection of various modalities is essential to such issues in the best interest of the patients.

The use of LLLI in orthodontics is a non-invasive procedure with promising results.[3-10] This treatment modality has been used in animal and human studies for various purposes with no adverse effects reported. However, it is always advised that the use of protective equipment and glasses is mandatory since International Electrotechnical Commission (IEC) has classified most of the lasers that are used in medical and dental practice are type 4 with potential effects on eyes and skin.[11]

The benefits of adopting LLLI in a routine orthodontic practice may accelerates the rate of OTM with less discomfort and without any disturbance in regular appoinments[9-10], this has to be investigated. The benefits of using passive SLB over CB system in terms of rate of OTM. It has become important to reassess the merits of using SLB and CB and explore the additional benefits of using LLLI and non-LLLI. Hence, the prime aim of this study is to determine and compare the OTM baseline, 1-day and 28-day after FOT among 4 different TM groups.

Materials and Methods

Study design

This was an experimental study, a randomized

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clinical trial with parallel mouth design.

Inclusion Criteria

Maxillary ectopic canine/canines requiring creating space or extractions of first premolars unilaterally or bilaterally in the upper arch.

Exclusion criteria[9-10]

1. Patients on medications such as Non-steroidal anti-inflammatory drugs (NSAID), corticosteroids, bisphosphonates that disturb the bone metabolism or tooth movement.
2. Presence of parafunctional habits.
3. Temporomandibular joint (TMJ) dysfunction.
4. Craniofacial malformation.
5. Multiple missing teeth.
6. Impacted teeth and
7. Periodontally compromised patients.

The total sample size for this research was calculated to be 32 with a minimum of 8 subjects in each group (**Figure 1**) using G*Power software version 3.0.10 with power 80%, α 0.05 and effect size (d) 0.22.

Ethical approval: The ethical approval for the research was obtained by ethics committee (LCBE#Jouf University#4-22-2/40). After elaborating the procedure verbally, written consents have been obtained from all patients. In case minor subjects (age below 18 years) parents or guardians of the patients signed the written consent.

Patients' recruitment and sampling method

The research was conducted in the division of orthodontics, College of Dentistry, Jouf University, KSA. Proper orthodontic record keeping were done and analyzed. The patients were allocated into four groups randomly.

Group A - FOT with LLLI + SLB
Group B - FOT without LLLI + SLB
Group C - FOT with LLLI + CB
Group D - FOT without LLLI + CB

Maxillary ectopic canine (Figure 2A), intra oral image of impacted maxillary canine (Figure 2B) and CBCT image of impacted maxillary canine (Figure 2C) and laser device used in this study (Figure 2D) are shown in **figure 2**.

FOT

For all the patients, treatment started with bonding of the upper arch with preadjusted edgewise 0.022-inch slot MBT prescription brackets, Agility® self-ligating bracket system (Franklin, USA) and Ortho Organizers conventional type bracket system (Carlsbad, CA, USA). 0.012-inch super-elastic nickel-titanium (NiTi) wire was used for alignment and levelling which was followed by 0.014, 0.016 and 0.018 NiTi wires at 4-week intervals between each wire.

Laser application[9-10]

Starting from central incisor to the first molar, at 5 points laser beams was applied on the gingival mucosa for 3 seconds labially/buccally and palatally against each tooth. These points were mesial and distal over the cervical third, middle third and the apical third of the root. During the process, the fibre tip of the laser was placed against the gingival mucosa over the roots with light contact held perpendicular to the mucosa.

Results

Thirty-two healthy orthodontic patients of Saudi ethnic background with ages between 14 and 25 years were selected for the study. **Figure 3** shows the conceptual framework of the present study. Canine movement after 4 weeks of treatment has been observed clinically among all four TM groups.

Table 1. Approaches to reduce the orthodontic treatment duration

More efficient mechanics	Low friction mechanics Self-ligating brackets Preformed robotic archwires Micro-implants
Enhance bone remodeling	Biochemical Parathyroid hormone Osteocalcin dihydroxyvitamin D3 (1,25-(OH)2D3)
Physical stimulation	Micropulse and cyclic vibration Low level laser therapy Low Intensity Pulsed Ultrasound
Surgical approach	Corticotomy Periodontally assisted osteogenic orthodontics Piezocision assisted orthodontics

Discussion

This research evaluated the effects of LLLI and non-LLLI with SLB and CB system for FOT. The results are suggestive that orthodontic treatment with such novel non-invasive technique may result in faster and more comfortable tooth movement as compared to conventional orthodontics and also lend adequate knowledge about the effects of four different TM groups to the practitioners so that OTM may be brought at a faster rate with minimal or adverse effects. This study also gives information with respect to efficacy of the techniques when used with passive SLB and CB system and helps the practitioners to opt for the new techniques in their clinical practice.

The duration of the treatment can be reduced by two basic ways such as: by improving the treatment mechanics and secondly, by increasing the velocity of tooth movement **(Table 1)**. Different approaches

CONSORT
TRANSPARENT REPORTING of TRIALS

CONSORT 2010 Flow Diagram

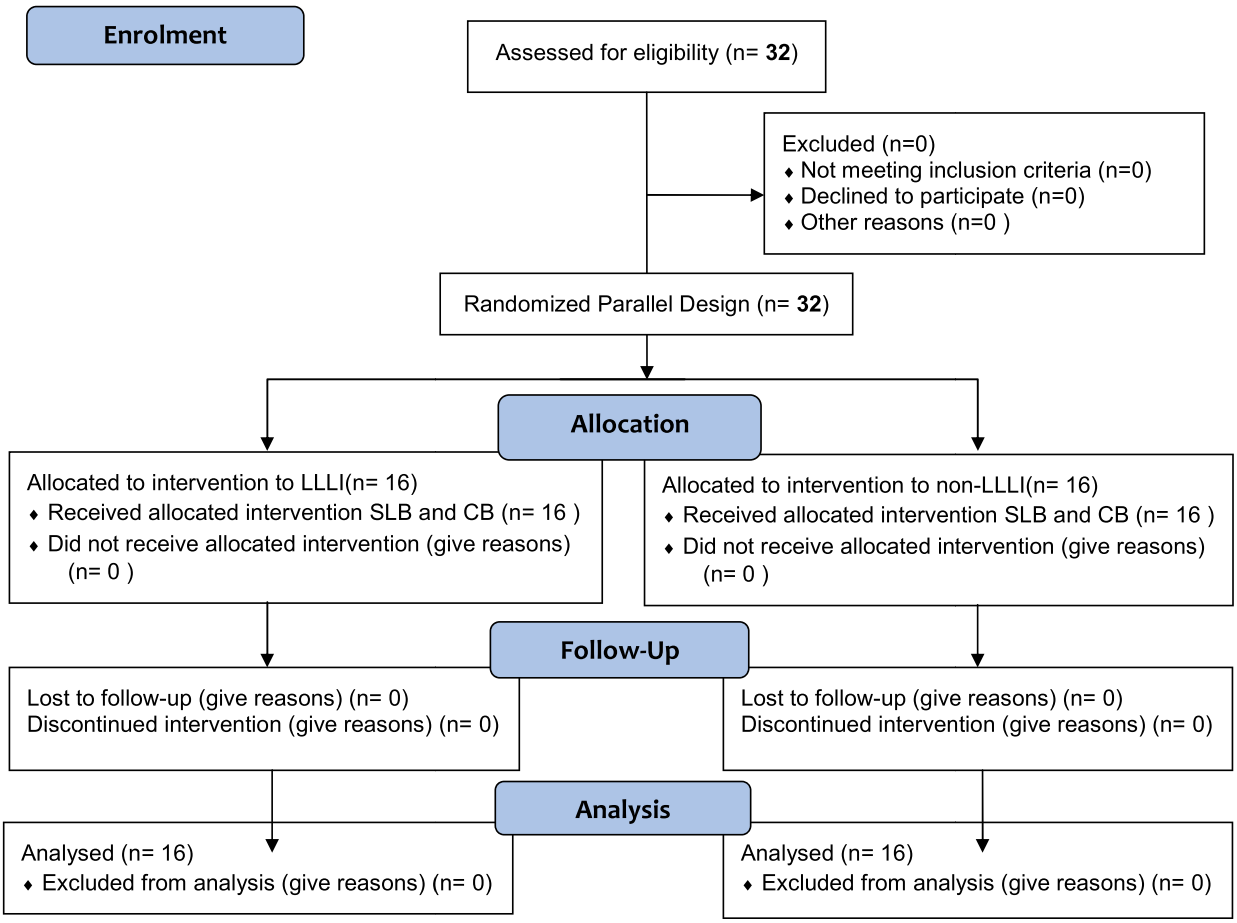

Figure 1. CONSORT Flow Diagram

Figure 2. A. Intra oral picture of a patient with buccally erupted ectopic canine, B. Intra oral picture of a patient with bilateral impacted ectopic canine, C. CBCT image of bilateral impacted ectopic canine and D. Laser device used in this study "Epic-X Biolase".

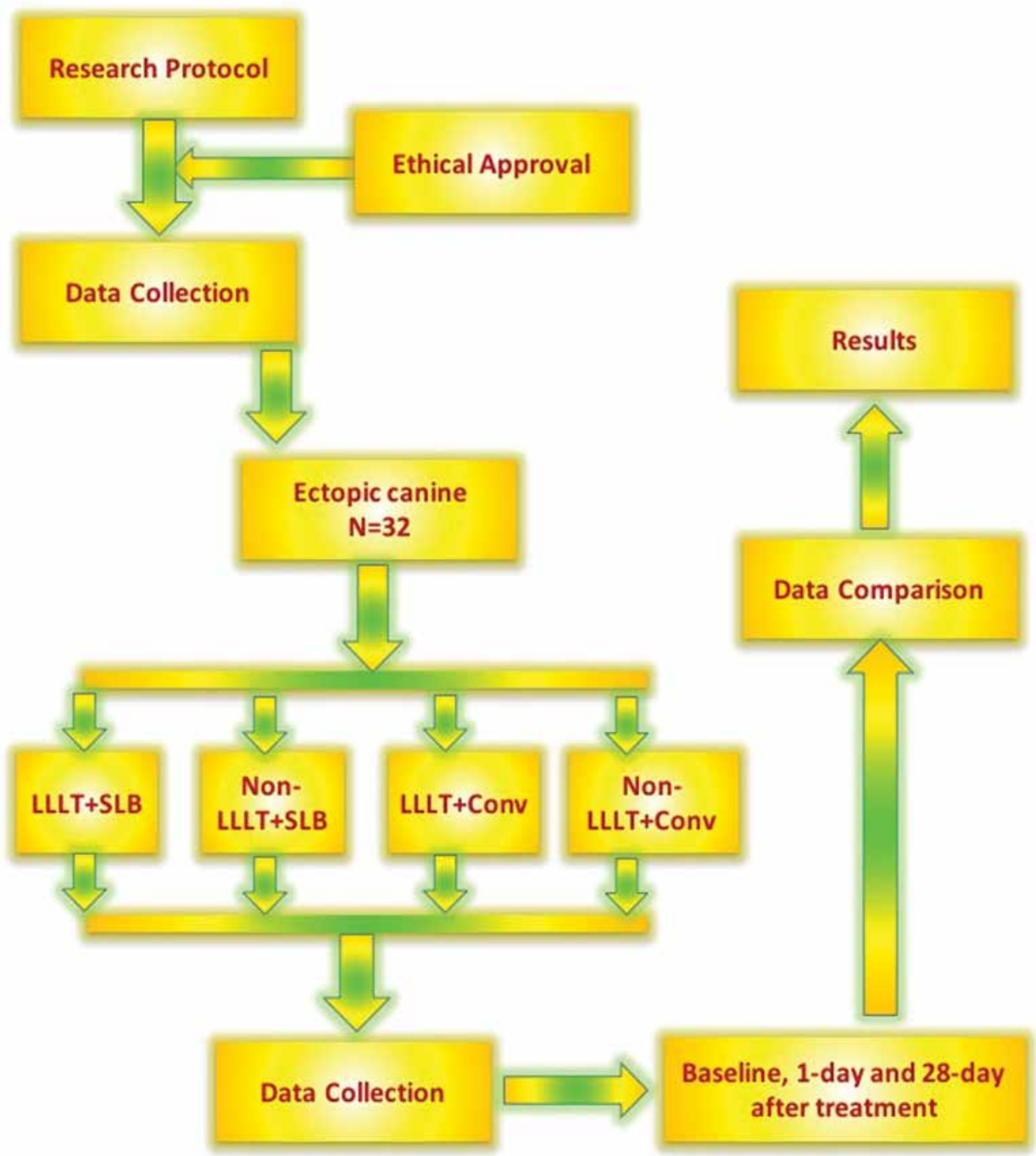

Figure 3. Conceptual framework of the study

have been tried to improve the treatment mechanics such as low friction and SLB, preformed robotic wires,[12] micro-implants etc.[13] Alternatively, the process of bone remodelling was enhanced to increase the rate of OTM. Such intervention can be achieved by 1) using certain biochemicals, 2) stimulation of alveolar bone mechanically or physically through the use of magents, cyclic vibration,[14] or direct electric current[15] and 3) surgical interventions to hasten the tooth movement. Various biochemicals such as dihydroxyvitamin D3 (1,25-(OH)2D3),[16] parathyroid hormone prostaglandin E2 (PGE2), or osteocalcin[17] have been administered locally. But, since they had systemic effects on body metabolism, the use such biochemicals is not very encouraging. Study by Long *et al.*, 2012 also did not reveal any convincing evidence that the use of electric and electro-magnetic fields could improve the velocity

of the tooth movement.[18]Surgical interventions by alveolar corticitomies, rapid canine retraction or dental distraction may enhance tooth movement. However, such procedures are highly invasive and are associated with post-operative morbidity and might have untoward effects on the periodontal tissues[19] and the patient's acceptance for such procedures is remarkably low. Hence, the research is aimed to design a procedure that is minimally invasive, increase the tooth movement optimally, affordable, has minimal side effects and high patient's acceptance.

Low level laser has a wavelength that is near to infrared or low levels of red light that is used to treat a variety of conditions. Unlike the lasers that are employed for cutting, ablation and thermally coagulate the tissues, this laser does not elevate the temperature of the local tissues by more than 1°C due to low densities of light energy. Hence, it is generally referred to as "Cold Laser" or Low-level laser.[20, 3-10] Though the precise mechanism of its therapeutic action is obscure, it has been confirmed that its actions are at tissue, cellular and molecular levels. In the present study, infrared radiation of 940nm wavelength[8-10] and LLLT of wavelength close to lower end of infrared electromagnetic spectrum were used. As the infrared radiation has a low absorption coefficient in haemoglobin and water, it is generally agreed that it has deeper penetration. The laser beam was applied at 5 specific points facially and lingually as indicated by Qamruddin et al.[9-10]

In our study, the OTM was less in GD after 1 month which could be due to associated heavier forces and unavoidable adverse effects. According to Meling*et al*., the reason for such lesser movement could be due to high frictional resistance due to elastomeric ligatures.[21] However, in passive self-ligation system, such friction is lowest and is not directly delivered on teeth or periodontium. Hence, it is expected that lower frictional is directly proportional efficiency of the treatment. Increased efficiency in orthodontics refers to achieving better results with few appointments, shorter duration of treatment, more comfort, decreased anxiety and pain to the patient and technically easier to the orthodontist. In addition, other undesirable effects like root resorption, gingivitis, periodontal problems and decalcification are minimal.[22]

Current study also revealed better OTM, 1-month after FOT in GA. The passive SLB system has better claimed advantages such as least frictional resistance, full arch-wire engagement, reduced chair time, ease of faster ligation and removal, robust and secure and easier maintenance of oral hygiene.[23] Since our findings and conclusions are based on 1- month follow up in Saudi population, a study with longitudinal follow-up including different populations from different geographical regions may be necessary to confirm the findings of our study.

Limitation: Intervention operator and the patient received 4 different TM were not blinded to the intervention.

Conclusion

This clinical randomized trial of prospective intervention revealed, GA has promising benefit in relation to OTM, 1-month after FOT, among all 4 treatment modalities.

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Author Contributions

Conception and design: MKA
Analysis and interpretation of the data: MKA
Drafting of the article: MKA
Critical revision of the article for important intellectual content: MKA
Final approval of the article: MKA
Provision of study materials or patients: MKA
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Administrative, technical, or logistic support: MKA

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