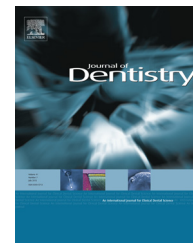


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## Effectiveness of non-conventional methods for accelerated orthodontic tooth movement: A systematic review and meta-analysis

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### ABSTRACT

**Objectives:** To assess the available evidence on the effectiveness of accelerated orthodontic tooth movement through surgical and non-surgical approaches in orthodontic patients.

**Methods:** Randomized controlled trials and controlled clinical trials were identified through electronic and hand searches (last update: March 2014). Orthognathic surgery, distraction osteogenesis, and pharmacological approaches were excluded. Risk of bias was assessed using the Cochrane risk of bias tool.

**Results:** Eighteen trials involving 354 participants were included for qualitative and quantitative synthesis. Eight trials reported on low-intensity laser, one on photobiomodulation, one on pulsed electromagnetic fields, seven on corticotomy, and one on interseptal bone reduction. Two studies on corticotomy and two on low-intensity laser, which had low or unclear risk of bias, were mathematically combined using the random effects model. Higher canine retraction rate was evident with corticotomy during the first month of therapy (WMD = 0.73; 95% CI: 0.28, 1.19,  $p < 0.01$ ) and with low-intensity laser (WMD = 0.42 mm/month; 95% CI: 0.26, 0.57,  $p < 0.001$ ) in a period longer than 3 months. The quality of evidence supporting the interventions is moderate for laser therapy and low for corticotomy intervention.

**Conclusions:** There is some evidence that low laser therapy and corticotomy are effective, whereas the evidence is weak for interseptal bone reduction and very weak for photobiomodulation and pulsed electromagnetic fields. Overall, the results should be interpreted with caution given the small number, quality, and heterogeneity of the included studies. Further research is required in this field with additional attention to application protocols, adverse effects, and cost-benefit analysis.

**Clinical significance:** From the qualitative and quantitative synthesis of the studies, it could be concluded that there is some evidence that low laser therapy and corticotomy are associated with accelerated orthodontic tooth movement, while further investigation is required before routine application.

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## 1. Introduction

Reduced treatment duration is important for care providers and orthodontic patients. It is also desirable that aesthetic concerns<sup>1</sup> and time dependent adverse events such as discomfort, pain, external apical root resorption, suboptimal oral hygiene, white spot lesions and dental caries<sup>2</sup> are held to the minimum.

Empirical evidence has indicated that 2 years is a representative of average orthodontic treatment duration with a significant variation which can be influenced by several factors including case severity, extraction versus non-extraction therapy, need for orthognathic surgery, clinical expertise, and patient cooperation.<sup>3,4</sup>

Tooth movement induced by a physical stimulus/force consists of a series of phenomena involving biologic reactions of the alveolar bone, the periodontal ligament (PDL), the gingiva, and the vascular and neural networks.<sup>5</sup> Under applied force the stress-strain distribution in the PDL is altered and tension and compression sites develop. A series of events resembling inflammation are initiated and regional osteoclastic and osteoblastic activity is observed leading to bone resorption and apposition that results in tooth movement through modelling-remodelling of the alveolar bone.<sup>6</sup> Adjunct to the proper selection of brackets, wires, embiomechanic systems, force levels, and anchorage systems, an array of novel techniques has been introduced to accelerate orthodontic tooth movement. These techniques can be briefly categorized as surgical and non-surgical.

The surgical category includes alveolar decortication, corticotomy, distraction of the periodontal ligament, and distraction of the dento-alveolus.<sup>7</sup> The idea of surgically accelerated tooth movement although more than a century old<sup>8</sup> has only gained momentum and interest during the last 10 years.<sup>9,10</sup> Theoretically, selective surgical alveolar bone reduction induces a localized increase in turnover of alveolar cancellous bone, suggesting a possible mechanism underlying the observed acceleration of tooth movement.<sup>11</sup> Another possible mechanism could be attributed to the removal of the hyaline zone formed soon after force application, which allows earlier bone resorption required for tooth movement.<sup>12</sup>

Non-surgical techniques include low-intensity laser irradiation,<sup>7,13</sup> resonance vibration,<sup>14</sup> pulsed electromagnetic fields,<sup>15</sup> electrical currents,<sup>16</sup> and pharmacological approaches.<sup>17</sup> Low laser therapy is reported to stimulate osteoblast and osteoclast cell proliferation, and enhance the velocity of tooth movement due to accelerated bone remodelling mediated by the RANK/RANKL/OPG system.<sup>18</sup> Resonance vibration is also advocated to act through enhanced RANKL expression in the periodontal ligament.<sup>14</sup>

Over the years, several case reports, narrative reviews, and clinical research papers have discussed various aspects of techniques used for accelerated orthodontic tooth movement. The only systematic evaluation of all methods used on this rapidly moving field included a limited number of studies that were published until August 2011.<sup>19</sup> Thus, a thorough systematic evaluation of the most recent clinical evidence related to accelerated orthodontic treatment is missing from

the literature. The purpose of the present systematic review is to critically assess and systematically summarize the available evidence regarding clinical performance of surgical and non-surgical approaches for accelerated orthodontic tooth movement.

## 2. Materials and methods

The PRISMA (Preferred Reporting Items for Systematic reviews and Meta-Analyses) reporting guidelines are followed in the systematic review.<sup>20,21</sup> A pilot Pubmed search followed by systematic evaluation of five potentially eligible randomly selected studies was performed in order to prepare the study protocol. Data extraction forms were constructed after the initial results of the pilot search.

The interventions for accelerated orthodontic tooth movement are relatively unexplored. It was, therefore, decided to consider for inclusion eligibility also non-randomized studies.

### 2.1. Search strategy

Electronic search was conducted independently by two authors (T.K. and I.M.) in four major databases, Pubmed, EMBASE, Google scholar beta, and all Cochrane Databases, at the end of March 2014 with no time restrictions. A specific search was performed to identify any relevant study, based upon various combinations of key words. A detailed description of the electronic search strategy applied to all the electronic databases used for the study is provided in Appendix 1.

The references of all retrieved full text papers were searched for relevant papers that might have been missed through the electronic search.

Unpublished literature was not excluded from the present study, since it was searched through Cochrane Central Register of Controlled Trials and Google scholar beta. When additional or missing information on methods or results was needed, corresponding authors were contacted for clarifications.

Eligibility assessment was performed in a standardized manner and independently by two reviewers (T.K. and I.M.) who were not blinded to the identity of the authors, their institution, or the results of the research. Any disagreement was resolved by consensus and through discussion with a third reviewer (N.G.). Titles and abstracts were screened first and afterwards full text review of any relevant and potential for inclusion article was conducted. A positive exclusion method was used, whereby only those publications that did not meet one or more of the inclusion criteria were excluded. An independent reviewer (N.P.) checked a random selection (20%) of filtered articles for consistency. Inter-rater agreement on study eligibility was assessed by Cohen's kappa.

### 2.2. Eligibility criteria

The following inclusion criteria were applied:

1. Randomized controlled trials (RCTs) and controlled clinical trials (CCTs) reporting on results or treatment parameters related to accelerated orthodontic tooth movement.

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