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Acceleration of Orthodontic Tooth Movement : Myth or Fact. A Systematic Review of Humain Studies

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Abstract

Objective: This study aims to estimate the effectiveness of surgical and nonsurgical interventions in accelerating orthodontic tooth movement.

Methods: Electronic and manual searches were performed up to december 2022. Systematic reviews, controlled randomized and non-randomized studies investigating the impact of adjunctive techniques on the promotion of OTM were included.

Results: A 306 articles were retrieved initially, but only 25 articles were finally selected for this study.

This study is registered with PROSPERO, CRD42020177047.

Conclusions: Based on current information, low-quality evidence suggested that LLLT and alveolar decortication are effective in promoting tooth movement, at least in the short term.

Keywords: Orthodontic tooth movement; Acceleration; Biological agents; Surgical intervention; Human trials

Introduction

Traditionally, orthodontic treatments were perceived as a time-consuming process, often spanning several months or even years. Recently, and in response to the escalating demand for orthodontic care, acceleration of orthodontic movement has garnered significant attention. The field of orthodontics has witnessed remarkable advancements. With the advent of innovative techniques and technologies, orthodontists can now expedite tooth movement, reducing treatment times and enhancing patient satisfaction. This pursuit of accelerated orthodontic solutions has spurred intensive research and the development of various approaches aimed at achieving quicker and more efficient tooth alignment [1]. By adopting this approach, treatment speed is significantly improved, while the occurrence of adverse effects, such as gingival inflammation, decalcification, dental caries, gingival recessions, and external root resorption, is minimized [2]. These methods have been thoroughly tested in both laboratory settings (in vitro) and clinical situations (in vivo) to ascertain their effectiveness [3]. This article delves into the current state of accelerated orthodontics, examining the various methodologies and technologies that have emerged, as well as the evidence supporting their efficacy and safety. By understanding the landscape of accelerated orthodontic movement, dental professionals can provide their patients with cutting-edge treatment options that optimize both treatment outcomes and overall oral health.

Aim

The objective of the systematic review was to evaluate available evidence related to the effect of surgical and non-surgical procedures in accelerating orthodontic movement, and any reported posttreatment adverse effects.

Materials and Methods

Protocol and registration

This systematic review was conducted following the guidlines of PRISMA (Preferred Reporting Items for Systematic review and Meta-Analysis) [4]. The work protocol was registered in PROSPERO (CRD42022303079) on 2022.

Research question and eligibility criteria

The research question and the eligibility criteria for selection articles have been formed according to the PICOS framework, which for this systematic review were defined as follows.

Information Sources and Search Strategy

An electronic systematic search was conducted in the databases of PubMed, EBSCO, and ScienceDirect in November 2021 to gather all papers potentially relevant to the question addressed in our review. The search was restricted to articles published in English and French, and was limited to human studies.

We used the following search terms to search all trials registers and databases :

Pubmed: ("Acceleration"[Mesh]) AND ("orthodontics"[Mesh]).

Sciences Direct : (‘’Acceleration AND Orthodontic AND Movement’’)

Ebsco: ("Acceleration AND Orthodontic AND Tooth movement"). ("Surgical AND Acceleration AND Orthodontic").

The search was initially conducted from the inception of all databases on November 7, 2021, and was updated until May 1st, 2023.

Study selection

All stages were completed independently and in duplicate. Disagreements were resolved through consensus. Duplicate articles were removed using Zotero software, after which we screened the titles and abstracts of the remaining studies based on the eligibility criteria. Similarly, the full texts of potentially eligible articles were reviewed before final inclusion.

Data collection strategy

Data was extracted from the articles selected by means of a predefined standardized form developed by the two reviewers. The following items were considered relevant and thus collected.

Article identification

Author, Title, Journal, year, country, and study design.

Clinical data

Participant, Intervention, Primary outcome, secondary outcome and author conclusion. Along with it, the evidence level and the risk of bias were mentioned for each study. The extracted data were collected in summary tables, to be discussed and then analyzed to answer the main research questions.

Risk of bias

Risk of bias of included studies was assessed in duplicate using the revised A MeaSurement Tool to Assess systematic Reviews (AMSTAR-2) tool for Systematic review [5]. We used the GRADE guidelines for randomized trials and ROBINS I for non-randomized trials [6].

Results

Study selection

The literature research initially yielded 306 references. After removing duplicates, 286 articles remained. The screening process of titles and abstracts resulted in the exclusion of 255 references, leaving only 28 that were deemed relevant and progressed to the next phase: reading the full texts when available and assessing their correspondence to the intended topic. Ultimately, 25 final papers were included in the review (Figure 1).

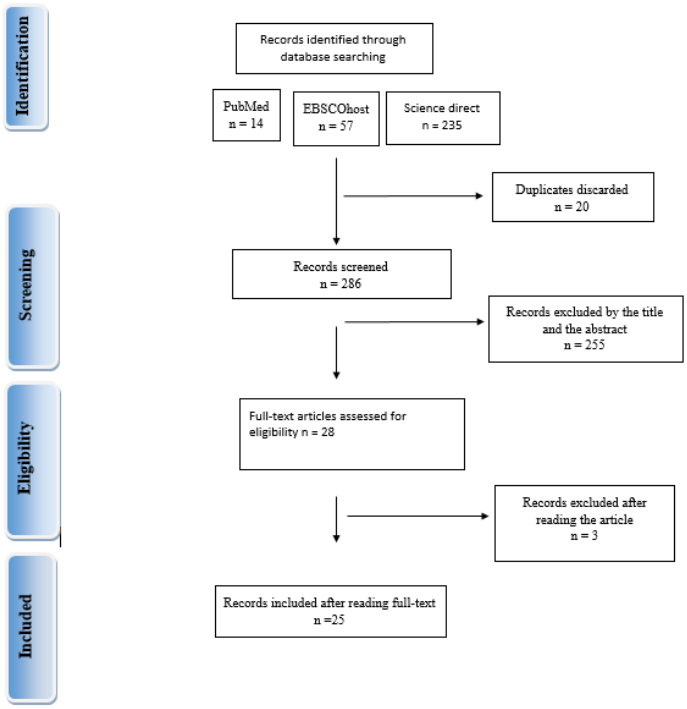

Figure 1: *Global outcome of the electronic and manual searcher.*

Discussion

Evidence summary

The purpose of this literature review is to identify potential methods or interventions that can influence the rate of orthodontic movement. Conducting a meta-analysis was not feasible due to significant heterogeneity in terms of study population, countries of origin, types of intervention, and follow-up durations. This review includes 16 articles that focus on surgical procedures. Several studies have investigated the effect of corticotomy on tooth movement and have reported a significant reduction in treatment time by increasing the rate of tooth movement [11,30]. While the evidence for corticotomy's effectiveness is promising,

further research is required to fully understand its long-term effects and potential risks. In the other hand, minimally invasive surgical procedures have gained popularity due to their potential to reduce pain, recovery time, and postoperative complications compared to traditional techniques. Three soft versions of alveolar decortication, known as "flapless corticotomy," have been developed: corticision, piezocision, and discision [13]. Several studies have examined the impact of these procedures on orthodontic treatment; however, the results have been conflicting. Controlled studies by Mustafa Cihan Yavuz and Julien Strippoli [21], showed a positive correlation between piezocision and tooth movement acceleration, while Maryam Omidkhoda's findings contradicted these results, showing no significant difference. In summary, while minimally invasive surgical procedures like corticision, piezocision, and discision show promise in reducing pain, recovery time, and postoperative complications, their effectiveness in accelerating orthodontic treatment remains controversial. Further studies are necessary to evaluate their long-term impact on orthodontic treatment.

In three controlled randomized studies, the authors investigated the effect of Micro-osteoperforations (MOPs) on canine retraction rate, yielding conflicting results. Two of the studies support the beneficial role of MOPs, while only one study refuted this hypothesis. The latter study showed no significant effect of the procedure at any time during the 3-month follow-up period. Several studies have examined the effects of repeated application of MOPs. Two of these studies, [12-25], found that the rate of dental movement is increased with repeated application. However, in a study [32] a significant difference was observed only after the first MOP was applied, with no further interest in performing a second intervention. Overall, surgical interventions can be an effective tool for enhancing orthodontic tooth movement, but they should be used judiciously and only after careful consideration of the potential risks and benefits. Apart from surgical interventions, nine articles examined non-surgical procedures, with four systematic reviews focusing on the use of recently introduced devices for accelerating Orthodontic Tooth Movement (OTM) through vibrating devices [8-16]. These reviews investigated the impact of vibration on canine retraction and incisor alignment. Surprisingly, the findings from all these studies indicate that vibratory stimuli do not lead to a reduction in dental alignment time nor do they accelerate canine retraction. For instance, Dobie's study serves as an example, where no significant differences in tooth movement were observed between the application of orthodontic force alone or in combination with vibrations at frequencies of 5-10 or 20 Hz) [30]. However, it is noteworthy that Dobie did observe a decrease in bone density, which could potentially reflect an increase in osteoclast activity.

In light of these results, it becomes evident that while vibrating devices are being explored as potential aids for accelerating OTM, their effectiveness in achieving this goal remains uncertain. Further research is needed to gain a deeper understanding of the mechanisms involved and to identify more reliable and efficient non-surgical methods for enhancing orthodontic treatment outcomes. The use of laser technology in accelerating tooth movement has garnered significant interest in recent research. Lasers, with their precise and controlled application, have shown potential in enhancing the orthodontic treatment process. By targeting specific areas of the periodontal ligament and bone, lasers can stimulate biological responses that expedite tooth repositioning. The role of Low-Level Laser Therapy (LLLT) in accelerating tooth movement has been prominently emphasized in numerous studies [33]. One notable research by Impellizzeni and colleagues [33] proposed an effective protocol for utilizing LLLT in four cycles: on days 0, 3, 7, and 14, each session lasting from 2 to 4 minutes. Their approach involved employing a dual gallium arsenide diode laser that emitted two wavelengths simultaneously, specifically 650 nm and 910 nm. These findings align with another study conducted by Junyi Zheng and Kai Yang, wherein they demonstrated the efficacy of Photobiomodulation Therapy (PBMT) in hastening tooth movement distal to the canines. In their investigation, they utilized a diode laser with a wavelength of 810 nm. Remarkably, they observed a substantial 35% difference in tooth movement between the irradiated group and the non-irradiated group, highlighting the positive impact of laser treatment on accelerating orthodontic tooth movement.

The evidence presented by these studies underscores the potential of LLLT and PBMT as valuable adjunctive tools in orthodontic treatment, offering a promising approach to expedite tooth repositioning effectively and efficiently. As research in this area continues to evolve, the integration of laser therapy in orthodontics is likely to gain even more significance, providing orthodontists with innovative options to enhance treatment outcomes and deliver improved patient experiences. Moreover, there have been numerous suggestions about the use of biological agents to expedite bone remodeling. Sarah Abu Arqub conducted a comprehensive evaluation to investigate the potential of locally administered biological substances, including PG, HRH, Vit D, Vit C, PRP, and its derivatives, to significantly enhance Orthodontic Tooth Movement (OTM) in humans. The findings of this review revealed that among these substances, Prostaglandins (PGs) displayed the most substantial impact on OTM acceleration, owing to their ability to stimulate both osteoclasts and osteoblasts in the remodeling process. Regarding the administration of PRC, extensive research has been dedicated to this subject. One notable study conducted by El-Timamy and his colleagues explored the impact of PRP injection on canine traction following premolar extraction [21]. Their findings revealed a notable acceleration in canine retraction on the intervention side during the first month by 15%, and during the

second month by 5%. However, upon discontinuing the injections, a surprising observation was made: the rate of canine retraction on the intervention side slowed down significantly, lagging behind the control side by 40%. This intriguing phenomenon could potentially be attributed to a negative feedback mechanism in the release of growth factors. Interestingly, these outcomes align with similar findings reported in Ke Yao's study [19]. Out of nine articles reviewed, seven supported a positive acceleration effect, while two other studies reported no discernible benefits of PRP. It is worth noting that the divergent results among these studies may be attributed to variations in manufacturing methods, activation of PRP, different concentrations of platelets used, as well as varying delivery modes (Tables 1-5).

Table 1: *Inclusion and exclusion criteria.*

	Inclusion criteria	Exclusion criteria
Participants	Patients undergoing fixed orthodontic	Patients with any systemic disease Animal studies
Intervention	Studies including various interventions surgical or nonsurgical.	
Comparator	Orthodontic treatment without any acceleration methods, or with a method different from the main intervention.	
Outcome	Primary outcome : Acceleration of tooth movement Secondary outcome : histological changes, pain, gingival indices…	Inadequate definition of outcomes
Study design	Randomised controlled trial Controlled trial systematic reviews or meta-analyses	Retrospective studies Case reports Comments Letters to the Editor Narrative reviews

Table 2: *Summary of risk of bias assessment for systematic reviews.*

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Grade
J. YI (7)	Y	N	Y	PY	Y	Y	PY	PY	Y	Y	NM	NM		Y	NM	Y	**B**
Jing (8)	Y	PY	Y	PY	Y	Y	PY	Y	Y	Y	NM	NM	Y	Y	NM	Y	**B**
Arqub (9)	Y	PY	Y	PY	Y	Y	PY	PY	Y	Y	NM	NM	Y	Y	NM	Y	**B**
Apalimova (10)	Y	PY	Y	PY	Y	N	N	Y	Y	Y	NM	NM	N	Y	NM	Y	**B**
NFAU (11)	Y	N	N	PY	Y	Y	PY	PY	Y	Y	NM	NM	N	N	NM	Y	**C**
Mohaghegh (12)	Y	N	Y	PY	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	**A**
T. Fu (13)	Y	N	Y	PY	Y	Y	N	Y	PY	Y	Y	N	N	Y	N	Y	**B**
Aljabaa (14)	Y	N	Y	PY	Y	Y	PY	PY	Y	Y	NM	NM	Y	Y	NM	Y	**B**
Bakdach (15)	Y	N	Y	PY	Y	Y	PY	Y	Y	Y	NM	NM	N	Y	NM	Y	**B**

Abd Elmotaleb (16)	Y	PY	Y	PY	Y	Y	Y	Y	Y	Y	N	N	N	N	N	Y	**B**
Sivarajan (17)	Y	Y	Y	PY	Y	Y	Y	PY	Y	N	Y	N	N	Y	N	N	**B**
Roberta Gasparro (18)	Y	PY	Y	PY	Y	Y	PY	PY	Y	Y	NM	N	N	Y	N	Y	**B**
Ke Yao (19)	Y	PY	N	PY	Y	Y	PY	Y	Y	Y	NM	NM	Y	Y	NM	Y	**B**

***Table 3**: Summary of risk of bias assessment for non-randomized studies-ROBINS-1 tool.*

Articles	Bias due to confounding	Bias in selection of participants for the study	Bias in classification of interventions	Bias in measurement of outcomes	Bias in selection of the reported result	Overall
Omidkhoda (20)	low	low	low	Pas d information	Pas d' information	moderate
Strippoli (21)	high	high	high	low	low	high
Yavuz (22)	low	low	low	Pas d'information	Pas d'information	moderate

Table 4: *Summary of risk of bias assessment for randomized studies.*

Etude	Sources de biais possibles								
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
El-Timamy (23)	Y	Y	I	Y	Y	Y	Y	Y	Y
Impellizzeri (24)	Y	I	Y	I	Y	Y	Y	I	Y
Babanour (25)	Y	Y	Y	Y	Y	Y	Y	Y	Y
Zheng (26)	Y	Y	N	I	I	Y	Y	I	Y
Feizbakhsh (27)	I	I	N	Y	I	N	N	N	Y
Alkebsi (28)	Y	Y	N	Y	Y	Y	Y	Y	Y
Hsu (29)	Y	I	N	I	I	Y	I	N	Y
Chandran (30)	N	N	N	I	Y	Y	Y	I	Y
Saurabh S. Simre(31)	Y	Y	Y	Y	I	Y	Y	Y	I

***Table 5**: Extraction of clinical data.*

Article identification	Study design	Participant articles	Intervention	Primary outcome	Secondary outcome	Main findings	Quality evidence
J. YI, 2017	SR	11 SR, 2670	LLLT, corticotomy, ISR, pulsed electomagnetic, electrical current, Vibration	Rate of tooth movement	Root resorption and pain perception, periodontal health, bone changes, pulp vitality	low-quality evidence suggested that LLLT and corticotomy are effective in promoting tooth movement, at least in the short term.	B
Dian Jing, 2017	SR	8 SR	Tooth masseuse n= 1 Acceledent n= 6 Vibrating tooth brush n=1	Canine retraction alignment	Root resorption and pain perception	Vibrational stimulus is effective for accelerating canine retraction but not for alignment.	B

Victor FAU, 2017	SR	11 with 155 subjects	alveolar decortication	Canine retraction alignment	Pain perception Periodontal health Root resorption Anchorage loss	Surgical decortications during the first three to four months after surgery is efficient.	C
Amal Alkebsi, 2018	RCT	32 subjects 24 F, 8 M	Micro-osteoperforations	Canine retraction	anchorage loss, periodontal index, pain perception	Three MOPs were not effective in accelerating tooth movement at any time point.	B
Mustafa Cihan Yavuz, 2018	CT	35 subjects	piezocision and discision methods	alignment	Pain and periodontal parameters	Discision is comparable to piezocision in terms of tooth movement acceleration.	B
Madhav Chandran, 2018	CT	20 subjects 10 M, 10 F	Alveolar corticotomy	Canine retraction	TNF-a and Alkaline phosphatase levels	alveolar corticotomy increased rate of canine retraction by approximately 40%.	B
Masood Feizbakhsh, 2018	RCT	20 subjects : 12M, 8 M	Micro-osteoperforations	Canine retraction	Patient discomfort	Micro-osteoperforations with two holes is an effective and time-preserving treatment modality.	B
Aljazi Aljabaa, 2018	SR	6 articles	vibrational devices	Canine retraction Teeth alignment	Pain perception, periodontal parameters	no advantage from the use of vibrational devices during orthodontic treatment is found.	B
Saritha Sivarajan, 2019	SR	8 articles	micro-osteoperforations	Canine retraction	anchorage loss, root resorption, gingival recession, and pain	One microosteoperforation does not speed up movement orthodontic and does not cause side effects	B
Julien Strippoli, 2019	CT		piezocorticision	alignment	periodontal parameters, root resorption	piezocorticision was effective at reducing the orthodontic treatment time	C
Ahmed El-Timamy, 2020	RCT	16 subjects F	injection of platelet-rich plasma	Canine retraction	Pain perception	PRP showed a positive potential to accelerate the rate of tooth movement when injected in the first 2 months.	B
T. Fu,	SR	19 articles	Corticotomy,	Canine	Root resorption,	Minimally Invasive	B

2019	MA	538 subjects	piezocision, micro-osteoperforations	retraction Incisor retraction	Periodontal parameter, pain,	surgery has minimal effect on accelerating tooth movement.	
Alina Apalimova, 2020	SR	9 articles, 210 subjects	corticotomy	Alignment Canine retraction	Root resorption, periodontal level, pulpal vitality, Bone density	low quality evidence	B
Neda Babanouri,	RCT	28 subjects	microosteoperforation	Canine retraction	Pain perception	The MOP procedure was effective in accelerating orthodontic tooth movement.	B
Alessandra Impellizzeri, 2020	RCT	6 subjects	photobiomodulation	Canine retraction	Ancrage loss	LLLT was found to be a tool capable of statistically significantly accelerating the canine retraction.	B
Maryam Omidkhoda, 2020	CT	17 subjects, 7 M, 10 F	piezo-puncture	Canine retraction	Pain percetion	No significant difference between piezopuncture side and control side.	C
Samer Mheissen, 2020	SR MA	14 SR	Micro-osteoperforation, piezocision, corticotomy	canine retraction En masse retraction Upper incisor retraction	root resorption, periodontl health	SAPs can accelerate OTMs and reduce treatment duration, but the acceleration is minor and transient.	B
Wesam Mhd Mounir Bakdach, 2020	SR	22 articles, 730 subjects	Vibration	Canine retraction Alignment Incisor retraction	Pain perception Levels of cytokines in GCF	Vibrational parameters of 113 Hz for 10min/day, 120 Hz for 5min/day, and 125 Hz for 15 min/day seemed to be more effective than other used parameters in accelerating tooth movement	B
Junyi Zheng, 2021	RCT	12 subjects, 8 F, 4 M	LLLT	canine retraction	IL-1β, RANKL, and OPG levels.	LLLT, with the parameter settings used in this study could accelerate orthodontic^{3} tooth movement.	B
Sarah Abu Arqub,	SR	11 articles, 174 subjects	PG n= 3, Vit D n= 3, HRH n = 1,	Canine retraction	No secondary outcome was	local administration of biological agents	B

2021			LPRF n= 1 PRF n= 1 PRP n = 1, Vit C n= 1		studied	during treatment orthodontics may have different effects on speed of movement dental.	
Sadra Mohaghegh, 2021	SR MA	15 articles, 375 subjects	Single and multiple osteoperforations.	Canine retraction En masse retraction Maxillary Molar distalization	Pain level Root resorption Anchroage loss	No significant difference in the rate of tooth movement between MOP and control groups.	A
Mohamed Atfy Abd Elmotaleb, 2021	SR MA	6 articles, 353 subjects	Tooth masseuse n =1 Acceledent n =5	Canine retraction, alignment teeth	Root resorption	No significant difference between vibrating devices group and control group.	B
Roberta Gasparro, 2022	SR	28 articles	Corticotomy, piezocision, osteoperforation, PAOO	Canine retraction alignment	Periodontal health, root resorption, anchorage loss, pain perception	Favourable consistent findings regarding corticotomy can be found.	B
Saurabh S. Simre, 2022	RCT	24 subjects	Piezocision	Canine retraction	postoperative complications (periodontal index)	Piezo-guided corticotomy was effective in providing rapid OTM compared to surgical bur.	B
Ke Yao, 2022	SR	9	platelet-rich concentrates	space closure incisor retraction canine retraction	Not reported	Platelet-rich concentrates as PRP and PRF seem to be effective in accelerating OTM at early stages.	B

Strengths and Weaknesses

Our study's strength lies in its robust methodology, adhering to the PRISMA guidelines for systematic reviews and upholding the quality criteria of a systematic literature review. Out of the 27 items on the PRISMA 2009 checklist, 21 were diligently addressed in this review, ensuring a comprehensive and rigorous analysis. The results were derived from a critical examination of selected articles, comprising systematic reviews, meta-analyses, and both randomized and non-randomized controlled studies, which are considered ideal study patterns for obtaining reliable and conclusive findings. However, it is essential to acknowledge the limitations of this review, which merit emphasis. Firstly, the selection of articles was restricted to those available online and in non-paid paper formats, as well as those published or translated into French or English. This approach may introduce a potential selection bias, as it might exclude relevant scientific studies published in other languages. Nonetheless, it is worth noting that research in the medical sciences is more likely to be translated into English when it yields significant results, somewhat mitigating this limitation. Secondly, our review focused only on publications from the last five years, which may introduce another form of selection bias. Despite these limitations, our systematic review provides valuable insights into the current state of knowledge on the subject, contributing to the existing body of evidence and paving the way for future research endeavors in this field.

Conclusion

There is an undeniable relationship between surgical interventions and the reduction of orthodontic treatment time. Traditionally established surgical techniques are more invasive than more recent ones, but they are much faster, leading us to say that the gentleness of the technique and its speed are empirically inversely proportional. Regarding physical procedures, vibrations show no acceleration advantage, while photobiomodulation, with well-defined parameters, showed an acceptable acceleration potential. Nevertheless, the majority of studies leading to these conclusions are not highly robust.

Consent

It is not applicable.

Ethical Approval

It is not applicable.

Competing Interests

Authors have declared that no competing interests exist.

References

1. Aboaf Y, Strub M, Wagner D. Surgical acceleration of tooth movement: systematic review to optimize exchanges between the orthodontist, the oral surgeon and the patient. Orthod Fr. 2021; 92: 303-34.
2. Alikhani M. Clinical guide to accelerated orthodontics: with a focus on microosteoperforations. Cham : Springer. 2017.
3. Agrawal AA. Evolution, current status and advances in application of platelet concentrate in periodontics and implantology. World J Clin Cases. 2017; 5: 159-171.
4. Gedda M. Traduction française des lignes directrices PRISMA pour l'écriture et la lecture des revues systématiques et des méta-analyses. Kinésithérapie. 2015;15:39-44.
5. Shea BJ, Reeves BC, Wells G et al. AMSTAR 2: a critical appraisal tool for systematic reviews that include randomised or non-randomised studies of healthcare interventions, or both. BMJ. 2017; 358.
6. Sterne JA, Hernan MA, Reeves BC et al. ROBINS-I: a tool for assessing risk of bias in non-randomised studies of interventions. BMJ. 2016; 355.
7. Yi J, Xiao J, Li H, Li Y, Li X, Zhao Z. Effectiveness of adjunctive interventions for accelerating orthodontic tooth movement: a systematic review of systematic reviews. J Oral Rehabil. 2017;44:636-54. 77.
8. Jing D, Xiao J, Li X, Li Y, Zhao Z. The effectiveness of vibrational stimulus to accelerate orthodontic tooth movement: a systematic review. BMC Oral Health. 2017; 17: 143.
9. Arqub SA, Gandhi V, Iverson MG et al. The effect of the local administration of biological substances on the rate of orthodontic tooth movement: a systematic review of human studies. ProgOrthod. 2021; 22: 5.
10. Apalimova A, Rosello À, Jane-Salas E, Arranz-Obispo C, Mari-Roig A, Lopez-Lopez J. Corticotomy in orthodontic treatment: Systematic review. Heliyon. 2020; 6: 4013.
11. Fau V, Diep D, Bader G, Brézulier D, Sorel O. Effectiveness of selective alveolar decortication techniques in accelerating orthodontic treatment: a systematic review of the literature. Orthod Fr. 2017; 88: 165-178.
12. Mohaghegh S, Soleimani M, Kouhestani F, Motamedian SR. The effect of single/multiple micro-osteoperforation on the rate of orthodontic tooth movement and its possible complications: A systematic review and meta-analysis. Int Orthod. 2021; 19: 183-196.
13. Fu T, Liu S, Zhao H, Cao M, Zhang R. Effectiveness and safety of minimally invasive orthodontic tooth movement acceleration: a systematic review and meta-analysis. J Dent Res. 2019; 98: 1469-1479.
14. Aljabaa A, Almoammar K, Aldrees A, Huang G. Effects of vibrational devices on orthodontic tooth movement: A systematic review. Am J Orthod Dentofacial Orthop 2018; 154: 768-779.
15. Bakdach WM, Hadad R. Is there any differential efficacy among different vibrational frequencies and duration of sessions on tooth movement acceleration? A systematic review. J Int Oral Health. 2020;12:289.
16. Elmotaleb MA, Elnamrawy MM, Sharaby F, Elbeialy AR, ElDakroury A. Effectiveness of using a vibrating device in accelerating orthodontic tooth movement: A systematic review and meta-analysis. J IntSocPrev Community Dent. 2019; 9: 5-12.
17. Sivarajan S, Ringgingon LP, Fayed MMS, Wey MC. The effect of micro-osteoperforations on the rate of orthodontic tooth movement: A systematic review and meta-analysis. Am J OrthodDentofacialOrthop. 2020; 157: 290-304.
18. Gasparro R, Effectiveness of surgical procedures in the acceleration of orthodontic tooth movement: Findings from systematic reviews and meta-analyses Jap Dental Sci Rev. 2022;58 :137–154
19. Ke Yao et al. The effect of platelet-rich concentrates on orthodontic tooth movement: A review of randomized controlled trials. Heliyon. 2022; 8.
20. Omidkhoda M, Radvar M, Azizi M, Dehghani M. Evaluating the efficacy of a modified piezo-puncture method on the rate of tooth movement in orthodontic patients: a clinical study. Turk J Orthod. 2020; 33: 13-20.
21. Strippoli J, Aknin JJ. The concept of accelerated tooth movement by corticotomy or piezocisionOrthod Fr. 2012; 83: 155-164.
22. Zheng J, Yang K. Clinical research: low-level laser therapy in accelerating orthodontic tooth movement. BMC Oral Health. 2021; 21: 324.
23. El-Timamy A, El Sharaby F, Eid F, El Dakroury A, Mostafa Y, Shaker O. Effect of platelet-rich plasma on the rate of orthodontic tooth movement. Angle Orthod. 2020; 90: 354-61.
24. Impellizzeri A, Horodynski M, Fusco R et al.Photobiomodulation therapy on orthodontic movement: analysis of preliminary studies with a new protocol. Int J Environ Res Public Health. 2020; 19; 17.
25. Babanouri N, Ajami S, Salehi P. Effect of mini-screw-facilitated micro-osteoperforation on the rate of orthodontic tooth movement: a

single-center, split-mouth, randomized, controlled trial. ProgOrthod. 2020; 21: 7.

26. Zheng J, Yang K. Clinical research: low-level laser therapy in accelerating orthodontic tooth movement. BMC Oral Health. 2021; 21: 324.
27. Feizbakhsh M, Zandian D, Heidarpour M, Farhad SZ, Fallahi HR. The use of micro-osteoperforation concept for accelerating differential tooth movement. J World Fed Orthod. 2018; 7: 56-60.
28. Alkebsi A, Al-Maaitah E, Al-Shorman H, Abu Alhaija E. Three-dimensional assessment of the effect of micro-osteoperforations on the rate of tooth movement during canine retraction in adults with Class II malocclusion: A randomized controlled clinical trial. Am J Orthod Dentofacial Orthop. 2018; 153: 771-85.
29. Hsu LF, Tsai MH, Shih AH et al. 970 nm low-level laser affects bone metabolism in orthodontic tooth movement. J PhotochemPhotobiol B. 2018;186:41-50.
30. Chandran et al. Clinical and molecular-level comparison between conventionaland corticotomy-assisted canine retraction techniques.J Wor Fed Ort. 2018; 7: 128-133
31. Saurabh S. Simre K. Rajanikanth Nitin Bhola, Anendd Jadhav, Chirag Patil, Apoorva Mishra Comparative assessment of corticotomy facilitated rapid canine retraction using piezo versus bur: A randomized clinical study. J Ora Bio Cra Res. 2022 ; 182-186
32. Haliloglu-Ozkan T, Arici N, Arici S. In-vivo effects of flapless osteopuncture-facilitated tooth movement in the maxilla and the mandible. J ClinExp Dent. 2018; 10: 761-767.
33. deFreitas LF, Hamblin MR. Proposed mechanisms of photobiomodulation or low-level light therapy. IEEE J Sel Top Quantum Electron. 2016; 22.