Systematic Review Article

Interventions for accelerating orthodontic tooth movement
A systematic review

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ABSTRACT

Objective: To evaluate the effectiveness of interventions on accelerating orthodontic tooth movement.

Materials and Methods: We searched the databases of PubMed, Embase, Science Citation Index, CENTRAL, and SIGLE from January 1990 to August 2011 for randomized or quasi-randomized controlled trials that assessed the effectiveness of interventions on accelerating orthodontic tooth movement. The processes of study search, selection, and quality assessment were conducted independently in duplicate by two review authors. Original outcome data, if possible, underwent statistical pooling by using Review Manager 5.

Results: Through a predefined search strategy, we finally included nine eligible studies. Among them, five interventions were studied (ie, low-level laser therapy, corticotomy, electrical current, pulsed electromagnetic fields, and dentoalveolar or periodontal distraction). Six outcomes were evaluated in these studies (ie, accumulative moved distance or movement rate, time required to move tooth to its destination, anchorage loss, periodontal health, pulp vitality, and root resorption).

Conclusion: Among the five interventions, corticotomy is effective and safe to accelerate orthodontic tooth movement, low-level laser therapy was unable to accelerate orthodontic tooth movement, current evidence does not reveal whether electrical current and pulsed electromagnetic fields are effective in accelerating orthodontic tooth movement, and dentoalveolar or periodontal distraction is promising in accelerating orthodontic tooth movement but lacks convincing evidence. (*Angle Orthod.* 2013;83:164–171.)

KEY WORDS: Accelerate; Corticotomy; Orthodontic tooth movement; Systematic review

INTRODUCTION

Currently, fixed orthodontic treatment requires a long duration of about 2–3 years,[1,2] which is a great concern and poses high risks of caries,[3,4] external root resorption,[5,6] and decreased patient compliance.[7] Thus, accelerating orthodontic tooth movement and the resulting shortening of the treatment duration would be quite beneficial. To date, several novel modalities have been reported to accelerate orthodontic tooth movement, including low-level laser therapy,[8,9] pulsed electromagnetic fields,[10] electrical currents,[11] corticotomy,[12,13] distraction osteogenesis,[14–16] and mechanical vibration.[17] However, pertinent results are inconclusive, and some are unreliable, which may bias clinicians' understandings and mislead clinical practice. Thus, a critical systematic review would be quite beneficial for clinicians. In this study, we conducted a critical systematic review on randomized or quasi-randomized controlled trials to assess the effectiveness of the interventions on accelerating orthodontic tooth movement.

MATERIALS AND METHODS

Inclusion Criteria for Included Studies

Types of studies. We included studies that evaluate or compare interventions for accelerating orthodontic

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Accepted: May 2012. Submitted: March 2012.
Published Online: June 21, 2012

Table 1. Search Strategies for Each Database[a]

Step	PubMed	Embase, SCI, CENTRAL & SIGLE
1	Orthodontics [Mesh] OR orthodontic*	Orthodontics OR orthodontic*
2	Tooth Movement [Mesh] OR mov* OR retract*	Tooth Movement OR mov* OR retract*
3	rapid OR accelerat* OR short* OR speed OR rate	rapid OR accelerat* OR short* OR speed OR rate
4	1 AND 2 AND 3	1 AND 2 AND 3

[a] Limits: publication date from January 1990 to August 2011.

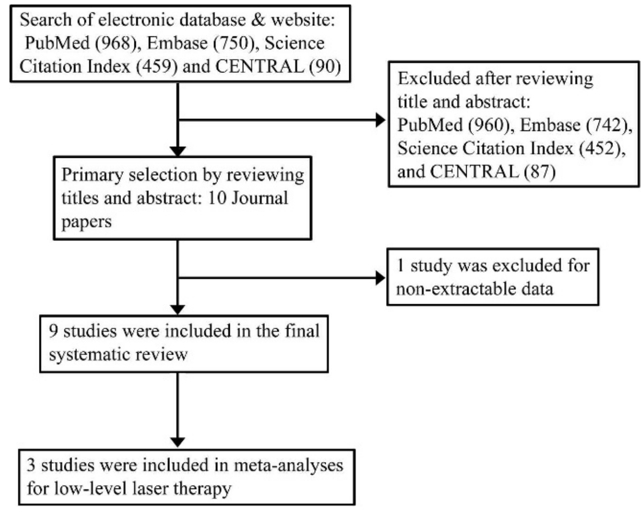

Figure 1. Systematic search and selection strategy (flow chart).

tooth movement. Only randomized or quasi-randomized controlled trials (where treatment assignment was based on nonrandom method) were eligible.

Types of participants. Subjects would be otherwise healthy patients who require orthodontic treatment. However, subjects with defects in oral and maxillofacial regions (eg, cleft lip), dental pathologies (eg, dental ankylosis), and medical conditions (eg, diabetes mellitus) would be excluded.

Types of interventions. Only interventions, adjunct to conventional orthodontic treatment, for accelerating orthodontic tooth movement would be considered (eg, laser irradiation, corticotomy, and pulsed electromagnetic fields). Interventions that are improvements of conventional orthodontic treatment modalities (eg, improvements in anchorage, brackets, and force magnitudes) would be excluded.

Search methods. We searched the electronic databases of PubMed, Embase, and Science Citation Index; websites of Cochrane Central Register of Controlled Trials (CENTRAL); and the grey literature database of SIGLE. The specific search strategies are presented in Table 1. The electronic search was from January 1, 1990 to August 20, 2011, with no language restriction. Two review authors conducted the electronic search independently, and disagreements were solved by discussion with a third review author.

Data Extraction and Analysis

Data extraction. The general data regarding study design, participant information, and intervention outcomes were extracted and recorded independently and in duplicate by two review authors.

Primary and secondary outcomes. Primary outcomes include accumulative moved distance or movement rate and time required to move the tooth to its destination. Secondary outcomes, including pain improvement, anchorage loss, periodontal health, orthodontic caries, pulp vitality, and root resorption, were extracted and collected.

Data Analysis

Original outcome data, if possible, underwent statistical pooling through fixed or random effects models by using Review Manager 5. The criteria for pooling of studies were determined a priori on the basis of comparability of patient type, treatments and outcomes measured, and risk of bias. For continuous data, the mean difference was employed for statistical pooling; for dichotomous data, the risk ratio was used for statistical pooling. Moreover, heterogeneity among studies in the meta-analysis was assessed through the I^2 statistic, publication bias was evaluated by Egger's and Begg's tests in Stata 11.2,[18,19] sensitivity analysis was done to test the robustness of the synthetic results in meta-analysis.

Moreover, the strengths and weaknesses of all the included studies were assessed according to *Cochrane Reviewers' Handbook*. The main items included sequence generation, allocation concealment, blinding, incomplete outcome data, selective outcome reporting, and other apparent risk of bias.

RESULTS

Description of Studies

The procedures of electronic searching are presented in Figure 1. Finally, we included nine studies. Among them, one was published in Chinese,[20] one was in Korean,[11] and the remaining seven were in English. One[11] included only females, while the other eight included both genders. The details of the included studies and their quality assessment are presented in Table 2 and Table 3, respectively. Moreover, the methods that the studies employed to measure tooth movement are summarized in Table 4.

Table 2. General Information of the Nine Included Studies

Study	Study Design	Participants	Intervention	Start Time of Orthodontic Tooth Movement After Surgery	Anchorage Augmentation	Outcome
Cruz et al. 2004[8]	RCT	11 participants (12–18 y)	Low-level laser therapy[a]	Not specified	Modified Nance arch and transpalatal arch	Effective ($P < .001$)
Limpanichkul et al. 2006[21]	RCT	12 participants (20.11 ± 3.40 y)	Low-level laser therapy[a]	At least 3 mo after the extraction of first premolars	Vertical loops just mesial to molar tubes	Not effective ($P = .77 > .05$)
Fischer 2007[23]	RCT	6 participants (11.1–12.9 y)	Corticotomy[a]	2 wk after surgical exposure	Not specified	Effective ($P = .001$)
Gui and Qu 2008[20]	Quasi-RCT	20 participants (12–17 y)	Low-level laser therapy[a]	Not specified	Nance arch	Effective ($P < .01$)
Kim et al. 2008[11]	RCT	7 participants (mean: 20.25 y)	Electrical stimulation[a]	Not specified	Mini-screw	Effective ($P = .001$)
Kharkar et al. 2010[24]	Quasi-RCT	12 participants (17–22 y)	Dentoalveolar distraction vs periodontal distraction[b]	Dentoalveolar distraction: 2 d after first premolar extraction Periodontal distraction: immediately after first premolar extraction	Not specified	Dentoalveolar distraction is more effective than periodontal distraction ($P < .01$)
Showkatbakhsh et al. 2010[10]	RCT	10 participants (23.0 ± 3.3 y)	Pulsed electromagnetic fields[a]	Not specified	Tip back and molar stoppage	Effective ($P < .001$)
Aboul-Ela et al. 2011[13]	RCT	13 participants (mean: 19 y)	Corticotomy[a]	Immediately after corticotomy	Mini-screw	Effective ($P \leq .01$)
Sousa et al. 2011[22]	RCT	10 participants (10.5–20.2 y)	Low-level laser therapy[a]	3 mo after the extraction of first premolars	Not specified	Effective ($P < .001$)

[a] Interventions were assigned to either the left or right side in the same participant (comparison: intraparticipant).
[b] Interventions were assigned to both sides of different participants (comparison: interparticipant).

Description of Interventions

Low-level laser therapy. Low-level laser therapy was performed through a laser device from which the laser was emitted to the desired mucosa areas. Four studies investigated this intervention.[8,20–22]

Corticotomy. Corticotomy was performed by making small perforations on the alveolar bones along the way by which the tooth would be moved. Two studies evaluated this intervention.[13,23]

Electrical current. Electrical current was delivered to the mucosa of canines through a fixed electrical appliance assembly (20 μA, 5 hours per day) on canines. One study[11] assessed this intervention.

Pulsed electromagnetic fields. Pulsed electromagnetic fields are produced by an integrated circuit embedded in a removable denture (0.5 mT and 1 Hz, 8 hours per day overnight). One study[10] investigated this intervention.

Dentoalveolar distraction vs periodontal distraction. Dentoalveolar distraction was performed by making monocortical perforations on alveolar bones around canines, followed by distracting canines using distractors; periodontal distraction was performed by making

Table 3. Quality Assessment of the Included Studies

Study	Adequate Sequence Generation	Allocation Concealment[a]	Blinding	Incomplete Outcome Data Addressed	Free of Selective Reporting	Free of Other Apparent Bias	Score	Quality
Cruz et al. 2004[8]	Unclear	Yes	No	Unclear	Yes	No	6	Medium
Limpanichkul et al. 2006[21]	Unclear	Yes	Yes	Unclear	Yes	Yes	10	High
Fischer 2007[23]	Unclear	Yes	Yes	Yes	Yes	No	9	High
Gui and Qu 2008[20]	No	Yes	No	Unclear	Yes	No	5	Medium
Kim et al. 2008[11]	Unclear	Yes	No	Unclear	Yes	No	6	Medium
Kharkar et al. 2010[24]	Unclear	No	No	Unclear	No	No	2	Low
Showkatbakhsh et al. 2010[10]	Unclear	Yes	No	Unclear	No	No	4	Low
Aboul-Ela et al. 2011[13]	Yes	Yes	No	No	No	Yes	6	Medium
Sousa et al. 2011[22]	Unclear	Yes	Unclear	Unclear	Yes	No	7	Medium

[a] All studies except Kharkar et al. 2010[24] compared left and right sides of the same participant. When the experimental and control sides were assigned, since both experimental and control sides were in the same participant, the assignment would not change. Although the allocation was not concealed, it would not result in bias. Thus, we judged them to be "yes" in allocation concealment. Scoring rules: "Yes" for 2 score, "Unclear" for 1 score, and "No" for 0 score. Quality was categorized as low quality (1–4 scores), medium quality (5–8 scores), and high quality (9–12 scores).

Table 4. Details of Methods on How to Measure Orthodontic Tooth Movement

Study	Methodology on Tooth Movement Measurement	Reliability of Each Methodology
Cruz et al. 2004[8]	To measure the decrease in the distance between the distal margin of canine bracket and the mesial margin of the first molar.	It is unreliable since the first molars would still move under orthodontic forces. Although the Nance arch was employed to reinforce anchorage, it cannot guarantee absolute nonmovement of molars. Moreover, anchorage loss had not been assessed.
Limpanichkul et al. 2006[21]	First, the initial mesial faces of canines were marked by palatal plug with reference wires. The moved distances were measured from the reference wires to the mesial faces of canines on progress models.	It is reliable since the absolute positions were recorded by reference wires.
Fischer 2007[23]	To measure the original incisal tips of canines to their final positions in the dental arch.	It is reliable since the absolute moved distances between original and final positions of canines were measured.
Gui and Qu 2008[20]	To measure the decrease in the distance between the mesial margin of the first molar tube and the distal margin of the canine bracket.	The same as Cruz et al. 2004[8]
Kim et al. 2008[11]	To measure the decrease in the distance between the distal margin of the mini-screw and the mesial margin of the canine bracket.	It is relatively reliable since absolute anchorage—mini-screws—was used.
Kharkar et al. 2010[24,a]	—	—
Showkatbakhsh et al. 2010[10]	To measure the decrease in the distance between the midpoint of the canine and the most mesial cervical point of the first molar.	It is unreliable since the first molars would still move under orthodontic forces. Although tip back and molar stoppage were employed to augment anchorage, they still cannot guarantee absolute no anchorage loss.
Aboul-Ela et al. 2011[13]	First, the medial points of the third rugae were used as reference points. The moved distance of canine was measured from the original position to the final position in reference to the third rugae.	It is reliable since the third rugae were stable during orthodontic treatment, which has been reported by Bailey et al.[30]
Sousa et al. 2011[22]	To measure the increase in the distance between canine tip and interincisal papilla (the gingival papilla between two central incisors).	It is unreliable since the measured distances cannot reflect the moved distances of canines; the direction from the interincisal papilla to canine tip was in angulation with the true movement of canine.

[a] Kharkar et al. 2010[24] did not measure tooth moved distances but the time required to move the tooth to its destination.

vertical grooves on the mesial side of the first premolar extraction sockets followed by the same distracting technique. The distractor was composed of an anterior segment fixed on the canine, a posterior segment fixed on the first molar, and a connecting sliding rod. Canine distraction (0.5 mm/d) was achieved by sliding the anterior segment toward the posterior segment. One study[24] compared the effectiveness of the two techniques.

Description of outcomes

Among the outcomes proposed above, six were evaluated in the included studies: accumulative moved distance or movement rate, time required to move tooth to its destination, anchorage loss, periodontal health, pulp vitality, and root resorption.

Effects of Interventions

1. Low-Level Laser Therapy vs No Intervention

Accumulative moved distance or movement rate. Four studies[8,20–22] investigated this outcome. Because of existing heterogeneity, a random-effect model was adopted. As presented in Figure 2, the pooled mean differences regarding accumulative moved distances were 0.32 (95% confidence interval [CI], -0.04, 0.68), 0.76 (95% CI, -0.14, 1.65), and 0.73 (95% CI, -0.68, 2.14) for 1 month, 2 months, and 3 months, respectively.

Periodontal health. Two studies[8,22] evaluated this outcome, and neither study reported any differences regarding periodontal health.

Root resorption. Two studies[8,22] investigated this outcome, and neither study found root resorption in either group.

2. Corticotomy vs No Intervention

Accumulative moved distance or movement rate. Two studies[13,23] investigated this outcome. Because of no comparability of data, meta-analysis was not performed. Fischer[23] reported that the movement rate was significantly higher in the corticotomy group (0.265 $\pm$ 0.036 mm/wk vs 0.185 $\pm$ 0.014 mm/wk, $P = .001$); Aboul-Ela et al.[13] found that the accumulative moved distance was significantly larger in the corticotomy group for 1 month (1.89 vs 0.75 mm), 2 months (1.83 vs 0.86 mm), 3 months (1.07 vs 0.93 mm), and 4 months (0.89 vs 0.85 mm; $P < .01$ for all).

Study or Subgroup	Laser therapy Mean	SD	Total	Control Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
1 month								
Gui 2008	1.67	0.05	20	1.30	0.06	20	36.1%	0.37 [0.34, 0.40]
Limpanichkul 2006	0.32	0.08	12	0.38	0.08	12	35.8%	-0.06 [-0.12, 0.00]
Sousa 2011	1.16	0.51	13	0.42	0.29	13	28.2%	0.74 [0.42, 1.06]
Total (95% CI)			**45**			**45**	**100%**	**0.32 [-0.04, 0.68]**
Heterogeneity: Tau^2=0.09; Chi^2=142.91, df=2 (p<0.00001), I^2=99%								
Test for overall effect: Z=1.75 (p=0.08)								
2 month								
Cruz 2004	4.39	0.27	11	3.30	0.24	11	34.4%	1.09 [0.88, 1.30]
Limpanichkul 2006	0.73	0.13	12	0.74	0.13	12	34.9%	-0.01 [-0.11, 0.09]
Sousa 2011	2.05	0.93	13	0.80	0.49	13	30.7%	1.25 [0.68, 1.82]
Total (95% CI)			**36**			**36**	**100%**	**0.76 [-0.14, 1.65]**
Heterogeneity: Tau^2=0.60; Chi^2=95.03, df=2 (p<0.00001); I^2=98%								
Test for overall effect: Z=1.65 (p=0.10)								
3 month								
Limpanichkul 2006	1.29	0.21	12	1.24	0.21	12	52.6%	0.05 [-0.12, 0.22]
Sousa 2011	3.09	1.06	13	1.60	0.63	13	47.4%	1.49 [0.82, 2.16]
Total (95% CI)			**25**			**25**	**100%**	**0.73 [-0.68, 2.14]**
Heterogeneity: Tau^2=0.97; Chi^2=16.68, df=1 (p<0.00001); I^2=94%								
Test for overall effect: Z=1.02 (p=0.31)								

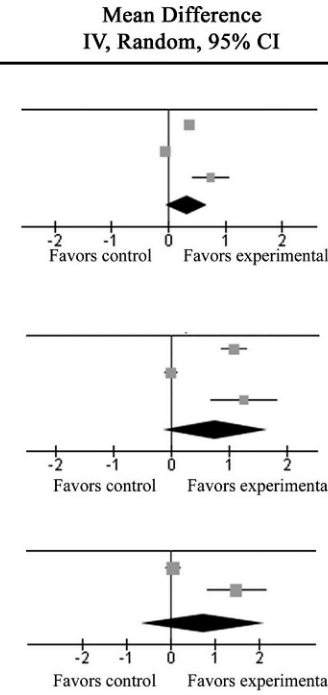

Figure 2. Forest plot of pooled mean difference for low-level laser therapy vs no intervention.

Anchorage loss. One study[13] reported that no significant anchorage loss occurred in either group (pretreatment vs posttreatment: 13.79 ± 1.16 mm vs 13.73 ± 1.16 mm or 13.62 ± 1.06 mm vs 13.50 ± 1.10 mm, respectively). Although this author did not compare anchorage loss between the two groups, we can deduce from the data presented above that anchorage loss did not differ between two groups.

Periodontal health. Both studies[13,23] revealed no difference regarding periodontal health between the two groups, except that gingival index scores were significantly higher in the corticotomy group in the latter.

3. Electrical Current vs No Intervention

Accumulative moved distance or movement rate. Kim et al.[11] reported that the accumulative moved distance was significantly larger in the experimental group for 1 month (2.42 ± 0.26 vs 1.89 ± 0.27 mm, $P = .001$).

4. Pulsed Electromagnetic Field vs No Intervention

Accumulative moved distance or movement rate. Showkatbakhsh et al.[10] reported that the accumulative moved distance was significantly larger in the experimental group (5.0 ± 1.3 vs 3.5 ± 1.6 mm, $P < .001$) for 5 ± 0.6 months.

5. Dentoalveolar Distraction vs Periodontal Distraction

Time required to move tooth to its destination. Kharkar et al.[24] revealed that the required time was significantly shorter in the dentoalveolar distraction group than in the periodontal distraction group (12.5 ± 0.50 vs 19.5 ± 1.70 days, $P < .01$).

Anchorage loss. Kharkar et al.[24] showed that the dentoalveolar distraction group presented significantly less anchorage loss in the sagittal plane but significantly more in the vertical plane than in the periodontal distraction group ($P < .01$ for both).

Pulp vitality. Kharkar et al.[24] revealed that the moved teeth in both groups were vital after 1 year.

Root resorption. Kharkar et al.[24] reported that no root resorption was found in the dentoalveolar distraction group, but 1 of 6 cases presented root resorption in the periodontal distraction group.

Assessment of Publication Bias

Because of a limited number of studies in the meta-analysis, we employed Egger's test and Begg's test rather than funnel plot to detect publication bias. Begg's test revealed no evidence of publication bias regarding accumulative moved distance at 1 month ($P = 1.000 > .05$), 2 months ($P = 1.000 > .05$), and 3 months ($P = 1.000 > .05$). Likewise, Egger's test found similar results at 1 month ($P = .872 > .05$), 2 months ($P = .420 > .05$), and 3 months (P value was inapplicable because there were only two studies for this item).

Sensitivity Analysis

Among the three studies in the meta-analysis, Gui and Qu[20] and Sousa et al.[22] were of medium quality, and Limpanichkul et al.[21] was of high quality. The exclusion of the two studies of medium quality in the meta-analysis resulted in no significant changes in the pooled results: 1 month (95% CI: −0.04, 0.68 vs −0.12, 0.00), 2 months (95% CI: −0.14, 1.65 vs −0.11, 0.09), and 3 months (95% CI: −0.68, 2.14 vs −0.12, 0.22), which was indicative of the robustness of the results in the meta-analysis.

DISCUSSION

In this systematic review, we analyzed nine eligible studies of five types of interventions, within which six outcomes were evaluated. Among the nine included studies, Kim et al.[11] and Aboul-Ela et al.[13] used mini-screws as anchorage to retract canines, while the remaining seven studies used first molars. For the seven studies, measurements of the moved distances of canines may be influenced by mesial movements of the first molars. However, in consideration of the methods for the measurements (Table 4), we suggest that Limpanichkul et al.,[21] Fischer,[23] Kim et al.,[11] and Aboul-Ela et al.[13] employed reliable methods and were not influenced by the mesial movement of first molars.

Low-Level Laser Therapy

For this intervention, accumulative moved distance, periodontal health, and root resorption were evaluated, but a meta-analysis was conducted only for accumulative moved distance. The pooled mean differences between the two groups regarding accumulative moved distance were 0.32 (95% CI: −0.04, 0.68), 0.76 (95% CI: −0.14, 1.65), and 0.73 (95% CI: −0.68, 2.14) for 1 month, 2 months, and 3 months, respectively, indicating that low-level laser therapy was unable to accelerate orthodontic tooth movement. Begg's test and Egger's test revealed no publication bias, and the sensitivity analysis indicated the robustness of the results analyzed through meta-analysis. Moreover, two studies[8,22] showed consistent results that laser therapy was safe in terms of periodontal and root health.

Therefore, we suggest that low-level laser therapy is safe regarding periodontal and root health and that it is unable to accelerate orthodontic tooth movement.

Corticotomy

The results from two included studies showed consistent results that corticotomy can accelerate orthodontic tooth movement. Moreover, both employed reliable methods to measure tooth movement (Table 4) and specified and used a similar start time of force applications between two groups (Table 2), which would lend more credence to their results since the rates of tooth movement into healed and recent extraction sites are significantly different.[25] Moreover, the results showed that corticotomy in conjunction with mini-screws can dramatically augment posterior anchorage, which is of prime importance since effective anchorage would greatly improve orthodontic treatment results.[26]

Since corticotomy is per se a surgical intervention on alveolar bones, it may have adverse effects on periodontal tissues, which was addressed in Gantes et al.[27] but not in Iino et al.[28] However, in this systematic review, neither study indicated that corticotomy would damage periodontal health, except that gingival index scores increased in the experimental group in Aboul-Ela et al.[13] We suggest this may be simply a response of gingiva to alveolar healing, since alveolar healing following surgery takes at least 4 months.[29] Thus, dental hygiene should be paid special attention during the healing stage after corticotomy.

Therefore, we suggest that corticotomy is relatively safe and is an effective intervention to accelerate orthodontic tooth movement.

Electrical Current

In this systematic review, only accumulative moved distance was evaluated. Kim et al.[11] revealed that electrical current was capable of accelerating orthodontic tooth movement. This study employed a reliable method to measure tooth movement (Table 4). However, it did not specify the start time of canine retraction after first premolar extraction, which decreases the reliability of the results since canine retraction speed into healed and recent extraction sites differ.[25] Moreover, since only females were included in this study, we do not know the intervention effects in males.

Therefore, regarding unreliable methodology and results, we cannot determine whether electrical current would accelerate orthodontic tooth movement.

Pulsed Electromagnetic Fields

In this systematic review, only accumulative moved distance was assessed. Showkatbakhsh et al.[10] showed that a pulsed electromagnetic field was capable of accelerating orthodontic tooth movement. However, this study suffered from several drawbacks.

First, the study measured moved distance using an unreliable method (Table 4). Second, this study did not specify the start time of canine retractions after extractions of the first premolars. Furthermore, the quality assessment indicates that this study is of low quality, which further limits the reliability of this study.

Therefore, with regard to unreliable methodology and results, we cannot determine the effectiveness of pulsed electromagnetic fields on accelerating orthodontic tooth movement.

Dentoalveolar Distraction vs Periodontal Distraction

Kharkar et al.[24] showed that dentoalveolar distraction can accelerate orthodontic tooth movement compared with periodontal distraction. However, this study suffered from a significant drawback: the distractors were activated 2 days after first premolar extractions for dentoalveolar distraction, while they were activated immediately after first premolar extractions for periodontal distraction, rendering the two modalities incomparable. In addition, this study was of low quality (Table 3). Thus, we cannot determine which modality would be more effective in accelerating orthodontic tooth movement. But with regard to the great differences in treatment duration between dentoalveolar or periodontal distraction and conventional treatment (10–20 days vs 6–9 months), we suggest that dentoalveolar or periodontal distraction is promising in clinical practice.

Moreover, both techniques cause negligible anchorage loss, and all the moved teeth were vital after 1 year for both techniques. Dentoalveolar distraction did not cause root resorption, while periodontal distraction did (incidence: 1/6), which may be attributed to extended duration of applied force required for periodontal distraction.

Thus, we suggest that dentoalveolar or periodontal distraction is safe and that the unreliable methodology and results limited the interpretation that these techniques are effective in accelerating orthodontic tooth movement.

The results of this systematic review must be interpreted with caution because of several limitations, including the small number of high-quality studies and limitation of statistical pooling due to clinical or methodological heterogeneity and noncomparability of outcome data.

CONCLUSIONS

- Low-level laser therapy is safe but unable to accelerate orthodontic tooth movement; corticotomy is safe and able to accelerate orthodontic tooth movement.
- Current evidence does not reveal whether electrical current and pulsed electromagnetic fields are effective in accelerating orthodontic tooth movement; dentoalveolar or periodontal distraction is promising in accelerating orthodontic tooth movement but lacks convincing evidence.

ACKNOWLEDGMENT

This work was supported by the National Natural Science Foundation of China, No. 81070858. We sincerely thank Dr Lee Kyungmo for translating the Korean article.

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