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Original Research Paper

Lingual Orthodontics; A Systematic Review to Assess Clinical Success and Consequences

Malik Talal Almalki[1], Moaz Talal Almalki[2], Ahmed Abdullah Alzahrani[2], Fahad Abdullah Fallatah[2], and Saleh Atallah Albalawi[2]

[1]Orthodontics Post Graduate Student, United Kingdom
[2] Intern, Riyadh Elm University, Riyadh, Saudi Arabia

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Lingual orthodontics is a relatively recent treatment option that differs from the well-known labial orthodontic therapy in several ways, the most notable of which is the location of the appliances. This opinion was bolstered by a recent systematic evaluation of six studies that examined the negative effects of lingual and labial orthodontic treatment. The current systematic review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines for reporting studies that evaluate health care interventions to the Meta-analysis of Observational Studies in Epidemiology (MOOSE) guidelines for writing observational studies, and the Cochrane Non-Randomized Studies Methods Group guidelines for reporting observational studies. The first search on the Internet generated 3734 results. 87 full-text articles were analyzed after reading titles, abstracts, and applying inclusion and exclusion criteria. 16 papers qualified for inclusion in the review and descriptive synthesis from these. Lingual orthodontic treatment demonstrated promising outcomes in this systematic evaluation, particularly in achieving individual treatment objectives and reducing the danger of decalcifications on bonded tooth surfaces.

Keywords: Lingual orthodontics, systematic review, clinical success, orthodontists.

INTRODUCTION

Patients' aesthetic expectations have risen with time, not only in terms of treatment goals but also in terms of the impact of orthodontic equipment on a patient's aesthetic appearance (1). Traditional orthodontic treatment has been demonstrated to damage facial appearance, a prominent concern among orthodontic patients (2). As a result, aesthetic materials and procedures have been brought into therapeutic practice to circumvent these restrictions. Lingual orthodontics is one of the most basic manifestations of this need (3).

Several methods and approaches have been established since its launch in the 1980s, indicating a growing interest among patients and clinicians in this treatment approach (4). The fact that the appliances are not visible is a crucial benefit of lingual orthodontics. However, lingual orthodontics is a relatively recent treatment option that differs from the well-known labial orthodontic therapy in several ways, the most notable of which is the location of the appliances (5). This opinion was bolstered by a recent systematic evaluation of six studies that examined the negative effects of lingual and labial orthodontic treatment (6). Differences in many areas of treatment that can be linked to the patient, the practitioner, or the appliance itself could be the reason for the restricted but growing usage of lingual orthodontics in everyday practice (7). Several case reports, reviews, and clinical research studies have been published that highlight various elements of lingual orthodontic therapy (8).

On the other hand, the literature lacks a complete systematic examination of clinical research relating to clinical results of lingual orthodontic treatment (9). Such a review will allow doctors to acquire adequate evidence for this growing treatment strategy, assist clinicians in providing evidence-based treatment, and provide suggestions for future study in the field (10). Through a comprehensive evaluation of relevant research, this study aims to analyze the current information on the effectiveness of lingual orthodontic treatment and related clinical characteristics.

MATERIAL AND METHODS

The current systematic review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines for reporting studies that evaluate health care

Corresponding Email: moaath.t.almalki@student.riyadh.edu.sa

interventions to the Meta-analysis of Observational Studies in Epidemiology (MOOSE) guidelines for writing observational studies, and the Cochrane Non-Randomized Studies Methods Group guidelines for reporting observational studies (11). The quality of evidence was graded using the GRADE (Grades of Recommendation, Assessment, Development, and Evaluation) system (12). A preliminary PubMed search was conducted to construct the review methodology, followed by a systematic examination of 10 potentially suitable and randomly selected papers.

Based on the pilot research findings, the search and analysis methodologies, eligibility evaluation, data extraction forms, and all other procedures and instruments were designed in advance of the study (13). The most common kind of intervention, such as buccal or lingual-fixed orthodontic equipment, is difficult to be balanced since patients typically make decisions based on their requirements and preferences (14). Furthermore, this is a very new and uncharted treatment, especially in terms of systematic assessments. As a result, we decided to use a quality evaluation technique to examine non-randomized and retrospective studies for eligibility.

Methods for locating research in the database

We did an electronic search in five significant databases, including Medline, EMBASE, Google Scholar beta, all Cochrane Databases, and Conference Paper Index, with the most recent update in 2022. A comprehensive Medline search (through PubMed) was conducted to find relevant studies using vital phrases such as 'lingual orthodontics, 'lingual patients,' and 'lingual brackets' in all domains (Limits: Humans, English, German, French, and Italian). All of the electronic databases utilized in the study were searched in the same way. All full-text articles that included papers and recognized reviews were subjected to a hand search of their references for relevant papers that may have been overlooked during the computerized search. The Cochrane Central Register of Controlled Trials, Conference Paper Index, and Google Scholar were used to find unpublished material.

Eligibility criteria

The following criteria were used to determine who was included in the study: 1. Randomized clinical trials (RCTs), prospective controlled clinical trials (CCTs), or retrospective studies with a control group reporting on orthodontic treatment results related to orthodontic treatment using fixed lingual brackets bonded to at least all teeth between the first molars in one or both arches. 2. Languages: English, German, French, and Italian. The following were the criteria for exclusion: 1. Studies that report on the results of questionnaires. 2. Animal and in vitro investigations 3. Case studies/case series (sample size: ten). 4. Articles with no reported sample, including editorials, comments, reviews, and technique descriptions. 5. Studies in which lingual therapy is conducted in a non-defined way in chosen teeth of an arch or in combination with other appliances, such as labial brackets, examine a specific hypothesis under a split-mouth design. 6. Studies published before January 2000 were eliminated to avoid confounding due to significant changes in bracket kinds and application methodologies at the time compared to current practice.

Quality assessment of individual studies

In places where there were conflicts, a common decision was reached following a debate among all writers to establish a consensus. (15) The Cochrane Risk of Bias tool was used to evaluate the quality of clinical studies. In the relevant fields, the same method was utilized for non-randomized prospective research. Investigators worked independently to assess the quality of retrospective studies using a modified quality assessment tool based on the Newcastle–Ottawa scale (16), relevant guidelines from the Cochrane Handbook for Systematic Reviews of Interventions Version 5.1.0 (17), and the GRADE approach (18). The total risk of bias in any included study was classified as follows. 1. If all important domains were judged as low risk of bias, there was a low risk of bias (possible bias unlikely to significantly change the findings). 2. If one or more important domains were rated as having an unknown risk of bias (possible bias that creates some question about the findings), 3. If one or more major categories were rated as having a high risk of bias (possible bias that severely undermines confidence in the findings), there was a high possibility of errors (19).

RESULTS

Literature flow

The first search on the Internet generated 3734 results. 87 full-text articles were analyzed after reading titles, abstracts, and applying inclusion and exclusion criteria. 16 papers qualified for inclusion in the review and descriptive synthesis from these. Figure 1 shows the study selection flow chart and the grounds for exclusion. To begin with, the kappa values were 0.86 for such initial data selection and 0.91 for the information gathering.

Characteristics of included studies

To categorize the research findings, we divided the 16 studies that were considered into three major categories: precision of treatment prediction, periodontal parameters, and other medical factors. Two pieces of research that were considered were split into two groups. Four trials were prospective CCTs, while one was a randomized controlled trial. Six retrospective investigations were conducted when comparing the setup of lingual therapy to the actual treatment result. It was also evaluated to see how well oral therapy performed compared to labial treatment. Study six was conducted to examine different clinical characteristics of therapy such as efficacy, bond failures; white spot lesions; anchoring loss; and treatment duration. The plaque and gingival indices were examined in two prospective CCTs, as with other periodontal markers.

Interventions' effects

Testing for precision

Lingual orthodontic therapy has been evaluated in six trials. The Incognito System (3M Unitek, Monrovia, California, USA) was used in all studies. Of the six, four showed a high and one an ambiguouslikelihood of bias. Using three-dimensional (3D) digital dental casts, researchers in two investigations (19 and 20) looked at the differences in tooth position between the intended (setup) and the actual treatment result. A majority of front teeth were positioned within a millimeter and four degrees of their targeted locations, but the second molars fared the worst. Using 3D digital dental casts, the research found a difference of 0.44 (SD: 0.29) mm in lower intercanine distance between the expected (setup) and the actual result evaluated using 3D digital dental castings (21).

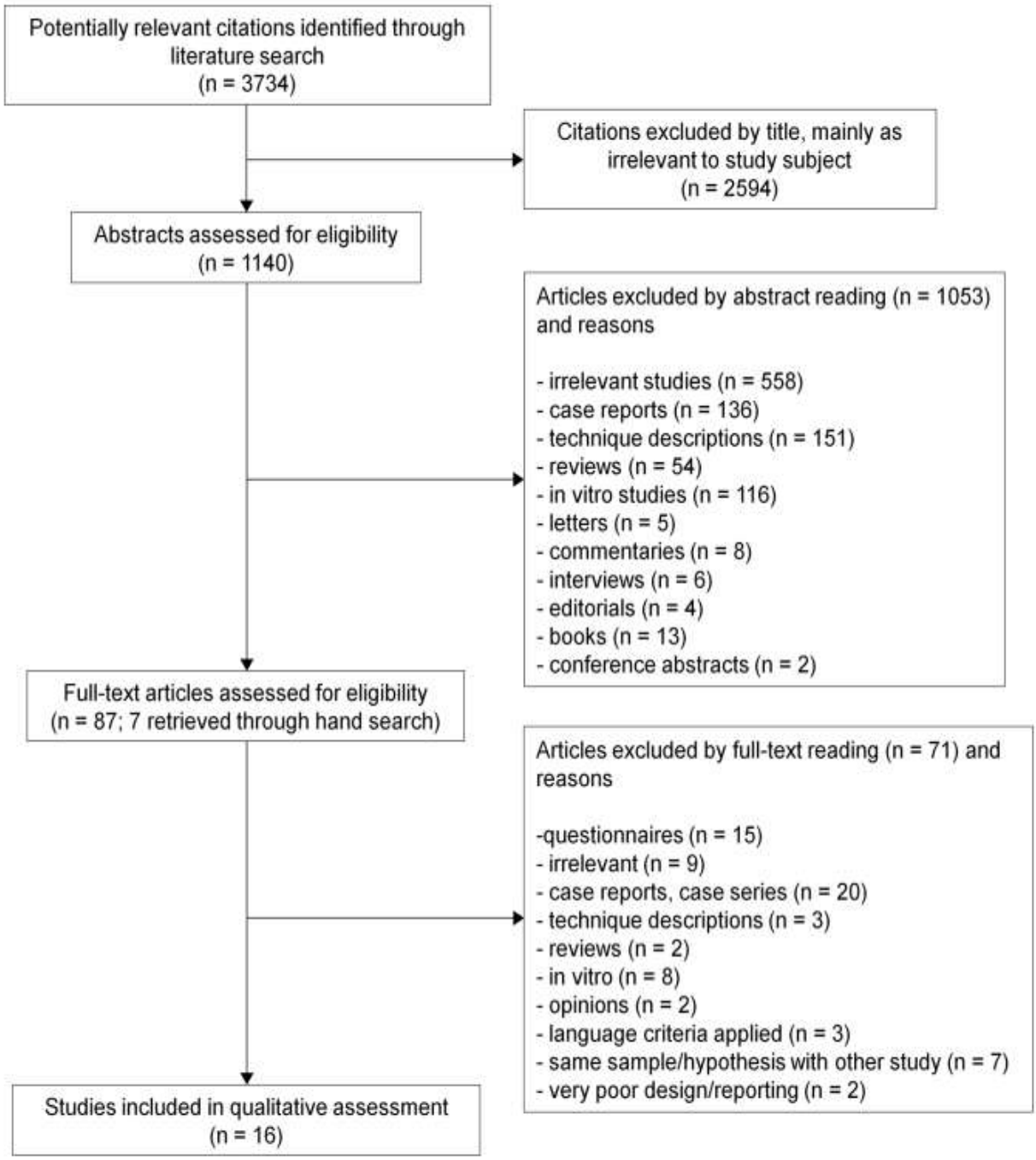

Figure 1. Flow chart of study selection.

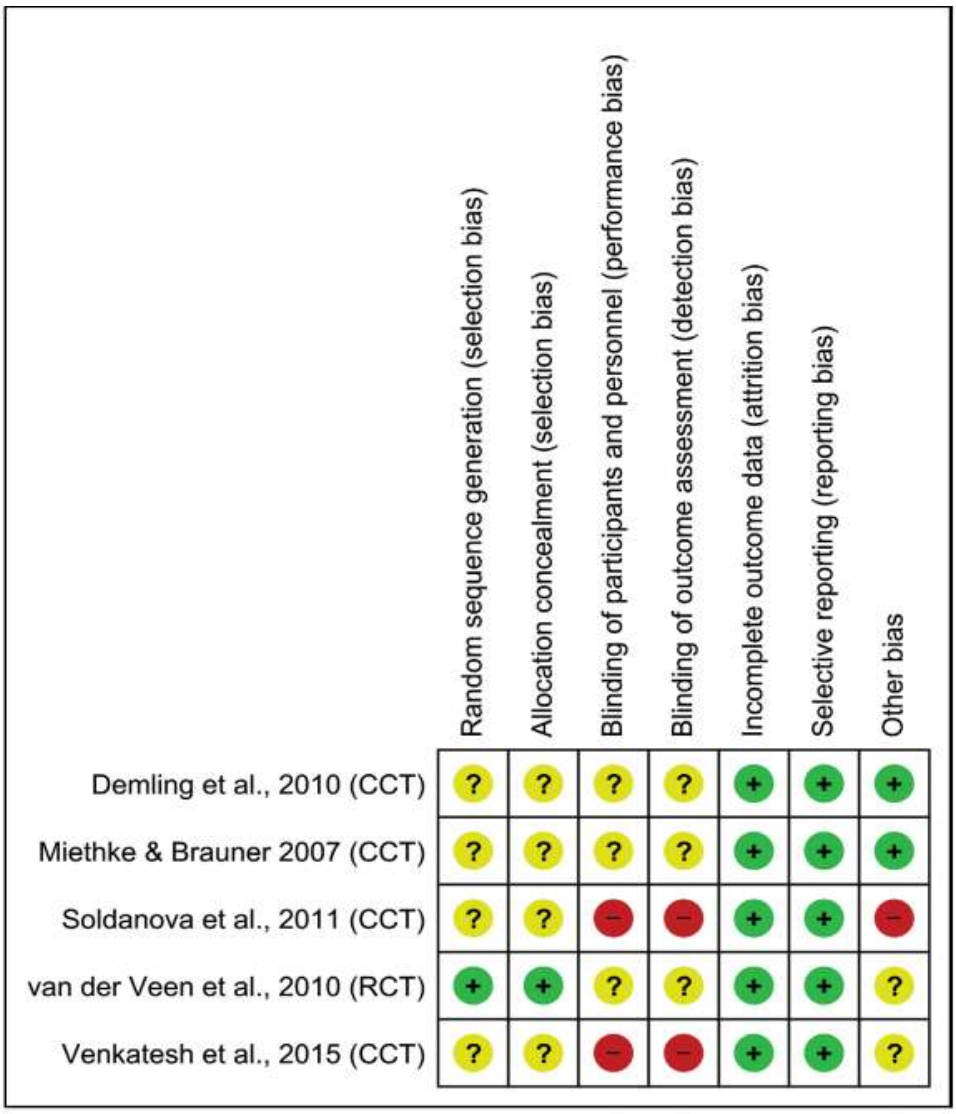

Figure 2. Risk of bias summary for included RCT and prospective CCT studies. The plus sign indicates low risk of bias; the circle with question mark indicates unclear risk of bias; the minus sign indicates high risk of bias. Overall, studies with at least one high are considered high risk of bias, studies with at least one question mark unclear risk of bias, while studies with plus signs only low risk of bias. For CCTs, the first two items are not applicable (default: unclear).

For Class III patients, the actual result differed by 3.75 degrees (standard deviation: 3.06 degrees) from the anticipated (setup) outcome for lower incisor inclination (29). Undersized finishing wires and extraction casings exacerbated this discrepancy. Central incisor apices also tended to move at the lingual side of the symphysis during incisor decompensation. According to one research, the Incognito lingual method with the Herbst had an accuracy rate of 2.2% (SD: 1.0%) on mandibular incisor proclination ($P > 0.05$). (22). Finally, one research examined the differences between the setup and the real lingual treatment result in peer evaluation rating (PAR) ratings recorded on dental casts and found a difference of 4.1 in total weighted PAR score (P 0.05).

The evaluation of clinical parameters

Some ten clinical trials evaluated different elements of therapy, such as efficacy, bond failures, and white spot lesions. Anchorage loss and treatment length were also studied. Nine of them exhibited a significant risk of bias (18, 22–25, 28, 30–32), and one was ambiguous (6). Retrospectively, an Incognito lingual method and Herbst's research indicated an increase of

16.5 degrees to 5.8 degrees in the mandibular incisor angle in each patient (22). There was no significant difference in the occlusal result and treatment time between lingual (Incognito) and labial appliances (P > 0.05).

However, there was a trend for larger improvement in the weighted PAR index after labial treatment (23). Lingual bidimensionalpreadjusted brackets were compared to labial appliances in one retrospective investigation, and the results showed that anchorage loss was more than twice as great with the labial treatment (Ormco Corp., Glendora, California, USA) (24). A prospective CCT research conducted with a different bracket system (STb, Ormco, Orange, California, USA) looked at the same problem and came to identical conclusions (30). The lower dental arch of Class I patients with crowding was examined in prospective research using either a labial or lingual two-dimensional (2D) orthodontic approach (Forestadent, St Louis, Missouri, USA). The incisors' location with A–Po was the only significant variation.

Periodontal parameters testing

The effects of therapy on numerous periodontal markers were evaluated in two prospective CCTs with an unknown risk of bias (26, 27). Clinical periodontal and microbiological indicators were measured before and after the bonding of Incognito lingual appliances in split-mouth research. Plaque index and bleeding on probing rose dramatically in the bonded sites throughout this time, although probing depth did not change. The Periodontopathogenic bacteria that cause periodontal disease have not changed considerably over time (26).

Other studies looked at long-term clinical periodontal characteristics in patients who had either had Ormco seventh-generation lingual (Ormco Europe, Amersfoort, The Netherlands) or Invisalign therapy and did so throughout three consultations spaced three to four weeks apart. Aside from probing depth, all indicators save probing depth in Invisalign patients improved considerably between the first and third examinations however they were significantly worse in lingual treatment at all time points.

DISCUSSION

Lingual orthodontics has attracted the scientific community's attention in recent years, as shown by the rise in the number of relevant papers in the literature. Over a 15-year search interval (2000–2015), 13 of the 16 articles considered in this systematic review were published within the previous five years. This highlights the importance of orthodontics in meeting the ever-increasing aesthetic expectations of patients (33). On the other hand, Lingual orthodontics isn't widely used in modern orthodontic practice and isn't regarded as a standard alternative. This may be because lingual orthodontics is not taught in most postgraduate programs to the same degree as standard buccal procedures, the extra knowledge necessary to be used, and the greater expenditures normally involved.We applied a temporal constraint to our search approach in order to ensure that our findings were in line with current clinical practice.

Consequently, if older studies were included, the development of lingual appliances and procedures throughout the years (34) might result in findings not relevant to the current clinical practice. It was published in 2003, and the following investigations were released after 2007. 16 researches were grouped into three main categories based on the study topic. The first one dealt with accuracy, the second with clinical parameters, and the third dealt with periodontal parameters. When comparing the anticipated treatment aim to the actual result, six retrospective studies examined lingual orthodontic treatment's accuracy (19–23, 29). There were positive findings from these trials that indicated that current lingual orthodontic systems might reach to a great degree the treatment objectives stated by the setup. It's impossible to discern the factors that impact an individual patient's treatment results from this research since they are all retrospective. That's why well-thought-out clinical studies are required. Ten researches were included in the second group, which focused on different clinical aspects of lingual orthodontics. The frequency of new or worsening buccal caries lesions was five times more than that of lingual caries lesions following buccal fixed appliance therapy, according to the single RCT that was conducted (6).

However, owing to the split-mouth research design, the possibility of performance bias cannot be ruled out. Further RCTs with large sample sizes are required for oral health to establish this benefit of lingual appliance therapy. "The inclusion of hydrophilic resin during the bonding operation was observed to lower the incidence of demineralization beneath the lingual bracket base in children and adolescents in another retrospective investigation (28). The second subject group's other trials examined the effectiveness, treatment duration, anchoring loss, and binding failures.

Mandibular incisor proclination was studied retrospectively in a small sample of patients using the lingual and Herbst braces. It was found to be following the intended movement (22). For the same dental result, the same treatment time was reported for lingual (Incognito) and labial appliances in another retrospective research (23).Labial appliances were shown to have nearly twice as much anchoring loss as lingual (STb or bidimensional, Ormco) appliances in premolar extraction patients.

CONCLUSIONS

Lingual orthodontic treatment demonstrated promising outcomes in this systematic evaluation, particularly in achieving individual treatment objectives and reducing the danger of decalcifications on bonded tooth surfaces. Those results must be confirmed in larger prospective clinical studies with well-designed study designs and big samples. Due to the research design, heterogeneity, small sample sizes, and significant risk of bias in most included studies, certain lingual orthodontic treatment elements could not be definitively assessed.

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ETHICS STATEMENT

Data from the participants will be kept confidential.

CONFLICT OF INTEREST

There was no conflict of interest among the study authors.

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