# Dentoskeletal Effects of Two Orthodontic Intrusive Mechanisms; A Review and Quantitative Analysis

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**Abstract**

Introduction: Deep overbite correction with long term dentoskeletal stability is one of the challenging issues in everyday orthodontic practice. Segmented Arch Wires (SAW) and Continues Arch Wires (CAW) are the most popular techniques for deep overbite correction. In literature there is a lot of contradiction about the efficiency of both techniques in deep overbite correction. Objective of this review: was to answer this question 'In patients with deep overbite, will SAW be faster and achieve better long term dento-skeletal stability when compared to CAW?'. Methods: Randomized Clinical Trials (RCTs), Controlled Clinical Trials (CCTs) or cohort studies comparing between SAW and CAW in deep overbite correction were considered eligible. Review authors searched the following information sources; 5 electronic databases, 4 trial registers and 9 orthodontic journals in addition to Egyptian universities libraries consortium. No language or publication restrictions were attempted. Two review authors independently and in duplicates searched information sources as well as conducted primary and secondary screening for the identified articles. Two review authors independently and in duplicate extracted data of the included studies according to prespecified data extraction forms. Two review authors independently and in duplicate used Cochrane risk of bias assessment tools for RCTs', CCTs' and cohort studies' risk of bias assessment. Results: Nine studies met the inclusion criteria, 2 of them were excluded; one for over publication while the other was a case report. Seven studies (2 RCT, 2CCTs, 3 cohort studies) were included in the review and 5 of them were assigned into quantitative synthesis. Risk of bias assessment for RCTs was high risk and for both CCTs and cohort studies was serious risk of bias. Both SAW and CAW achieved similar amounts of deep overbite correction. Amounts of incisors intrusion and molars in SAW were respectively greater and lesser when compared to CAW. The increase in the total and lower anterior face heights as well as the increase of the mandibular backward rotation in CAW was greater than that observed in SAW. Quality of the evidence is very low. Conclusions: There is very low quality of evidence that both SAW and CAW achieves comparable amounts of deep overbite correction. In SAW deep overbite correction is achieved mainly via incisors intrusion and little amount of molars extrusion. While, in CAW deep overbite correction is achieved mainly via buccal segment extrusion and little amount of incisors intrusion and flaring.



**KeyWords:**Deep overbite, Segmented mechanics, Continuous mechanics, Meta-analysis.

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## Introduction.

Deep overbite is a common condition in adults[1, 2]. It can be seen with almost all malocclusions, regardless of the vertical growth pattern[3-6]. Deep overbite is defined as a condition of excessive vertical overlapping of mandibular incisors when the mandible is brought into habitual or centric occlusion[7]. It has detrimental effects on mandibular growth and function, temporomandibular joint function, periodontal health, as well as esthetics[8-10].

Many clinicians have reported that correction of deep overbite with subsequent achievement of long-term stability is still one of the most difficult problems faced by orthodontists[11-13]. Correction of dental deep overbite can be achieved mainly by intrusion of incisors, extrusion of molars or a combination of both movements [14,15]. The method used to treat deep overbite should be determined by proper treatment planning, with consideration given to etiology, esthetics, occlusal plane, lip competence, vertical skeletal dimension and skeletal convexity in addition to the stability of final result[16].

In certain cases, intrusion of incisors is absolutely indicated to reduce deep overbite[17]. Intrusion is defined as the apical movement of the geometric center of the root in respect to the occlusal plane[18]. Two of the most commonly used techniques for intrusion of anterior teeth are Continuous Arch Wire (CAW) containing reverse curve of Spee and segmented intrusive arches or Segmented Arch Wire (SAW) technique[19].

In CAW leveling is accomplished by extrusion of premolars and molars with as little intrusion and flaring of incisors as possible[20-22], while in SAW pure intrusion of incisors is achieved by bypassing premolars and preparing molars to provide anchorage[23,24].

There has been considerable disagreement in literature regarding which of the two philosophies is better in achieving overbite correction with long term stability. Proponents of CAW suggested that vertical extrusion of premolars and molars is a stable change[25-27] . On the other hand, advocates of SAW claimed that extrusion of molars and premolars in CAW tends to increase patient's face height, which in many deep overbite cases is opposed by strong elevator muscles of mastication that tend to cause relapse. Besides, impinging on freeway space leaves the prognosis for leveling with this technique in doubt[13,17]. So, a question still remains; which of the two philosophies is faster and provides long term dento-skeletal stability?

**Objectives:**

In patients with deep overbite, will SAW be faster and achieve better long term dento-skeletal stability when compared to CAW?

**PICOTS**

Population (P): patients with deep overbite.

Intervention (I): SAW.

Comparator (C): CAW.

Outcomes (O): these include primary and secondary outcomes. Prioritization of the outcomes was based on their patient's relevance.

The primary outcomes of this review were amount of overbite reduction, amount of upper incisors intrusion and amount of lower incisors intrusion. On the other hand, secondary outcomes included amount of upper molars extrusion, amount of lower molars extrusion, change of total and lower anterior face heights, backward rotation of mandible, change in the intercanine width, and the lower incisor irregularity.

Time (T): treatment and any post-treatment period.

Study design (S): Systematic review and meta-analysis.

**Material and Methods:**

**Eligibility criteria:**

Studies included in this systematic review are characterized by the following: participants', interventions', outcome and follow up periods' characteristics.

**Participants' characteristics:**

Studies including participants with full permanent dentition from first permanent molar of one side to that of the other side and deep overbite were considered eligible. Trials including participants who had received any surgery to correct deep overbite or those including individuals with deformities or craniofacial syndromes were excluded.

**Interventions' characteristics**

Studies comparing CAW and SAW to correct deep overbite were included.

**Outcomes' characteristics**

Trials that report linear and angular measurements of the previously mentioned dento-skeletal outcomes in mm and degrees, respectively, were considered eligible.

**Follow up periods.**

Studies reporting the aforementioned outcomes during and after deep bite correction were included.

**Study design**

Randomized Clinical Trials (RCTs), Controlled Clinical Trial (CCT) and cohort studies relevant to the PICO question were included.

**Reporting characteristics**

No publication, language and/or date restrictions were attempted.

**Information sources, search strategy, and study selection**

(MA[1]), (KT[2]),(IR[4]) and (AA[5]) sought five electronic databases; MEDLINE (April 2022), EMBASE (March 2022), LILACS (February 2022), Trip database (March 2022) and Graylit.org (April 2022),four trial registers; CENTRAL (January 2022), mRCT (March 2022), US National Institute of Health Register (April 2022) as well as ICTRP (January 2022) and hand searched nine journals. Two were searched till March 2022, namely; American Journal of Orthodontics and Dentofacial Orthopaedics, Angle orthodontist, three till January 2022 (European Journal of Orthodontics, Journal of Orofacial Orthopaedics, Progress in Orthodontics ), three till July 2022 (Journal of Orthodontic, Journal of Indian Orthodontic Society, Australian Orthodontic Journal ) and one till June 2022 (Journal of Clinical Orthodontics) in addition, to Egyptian Universities Libraries Consortium (May 2022). KT[2] received no additional articles via the activated RSS feed of the electronic databases till July 2022.

IR[4], MA[1] and KT[2] developed detailed search strategies for each database which were based on synonyms of PIC elements. They used a combination of free text terms and controlled vocabularies [MeSH terms] which can be seen in *Appendix 1.* All identified records were imported to reference manager (Endnote X7 Reuters T. EndNote X7. Thomson Reuters: Philadelphia, PA, USA. 2016) to find and remove duplicates. IR[4], MA[1] and KT[2] screened titles and abstracts of all identified studies independently and in duplicate to exclude irrelevant studies. When titles and abstracts were unclear or controversial for the authors, inclusion rather than exclusion was the choice. Full text screening was then carried out by MA[1] and KT[2] to check for compliance of relevant studies with eligibility criteria. Disagreements were resolved by discussion, or the involvement of a third review author IR[4].

Inclusion in meta-analysis was based on a plan to assess clinical and methodological

heterogeneity of included studies. Going through participants' eligibility criteria (baseline characteristics), interventions and methodology of outcome assessment in each study was necessary for this procedure. Risk of bias assessment was not considered as a factor for inclusion in meta-analysis.

**Data items and collection:**

IR[4], MA[1] and KT[4] independently and in duplicate extracted data of included studies using paper and electronic based data extraction forms that suited all study designs (RCTs, CCT and cohort studies). This form included details about investigators, contact info, funding, study design, publications, setting, sample size calculation, participants, interventions, outcomes, outcome measures, time points and results in addition to follow up periods.

**Assumptions and simplifications**

**1-** Despite design differences most authors consider segmented and sectional intrusion arches as one intrusion system. Hence, both techniques are considered to be one treatment modality (segmented arch technique).[28-30]

**2-** Based on non-statistically significant findings between different classes of malocclusion (Angle class I and class II; both divisions), they could be considered as a single population of deep overbite regarding the treatment of deep overbite as long as they are treated with the same mechanics and reported by the same study.[31-33]

**Risk of bias/ quality assessment in individual studies:**

IR[4] and KT[2] assessed the risk of bias for the included studies independently and in duplicate based on the outcome level within and across the studies. Whenever disagreement arose between both authors, a third reviewer MA[1] was involved to resolve the issue. Tools used for risk of bias assessment were Cochrane tool for RCTs, A Cochrane Risk of Bias Assessment Tool for Non-Randomized Studies of Interventions (ACROBAT-NRSI) and Risk of Bias in Non-Randomized Studies of Interventions (ROBINS) for cohort studies. IR[4] and KT[2] used review manager software (RevMan 5.3, Cochrane collaboration, 2014) to generate risk of bias graphs and summaries.

**Summery measures and approach to synthesis:**

For continuous outcomes, IR[4] and KT[2] used Mean Difference (MD) as effect size measure. On the other hand, for dichotomous outcomes, the effect size was expressed as Relative Risk (RR). In studies with similar design reporting the same outcome, effect size measures were combined using both fixed and random-effects models. Whenever $\pi^2$ was zero, a fixed effect model was reported. $\pi^2$ greater than zero dictated using random effects model. Where meta-analysis could not be performed or when statistical data were missing and calculation of effect measures was impossible, IR[4] and KT[2] reported the results narratively.

**Risk of bias across studies**



Publication bias

IR[4], MA[1] and KT[2] planned to explore publication bias across studies by funnel plots if more than ten studies were included. Per contra, there was insufficient number of studies.

**Selective reporting within studies**

If the protocol was available, IR[4] and KT[2] compared outcomes in the protocol with those in the published report. If not, outcomes listed in the methods section were compared with those of the results.

**Confidence in cumulative evidence**

IR[4] and KT[2] assessed the body of evidence for each comparison and outcome using GRADE (gradepro.org), which takes into account the quality and quantity of included studies, study

designs, risk of bias of included studies, directness of evidence, inconsistency of results, precision of the estimates and risk of publication bias.

**Additional analyses**

The effect of study quality and including unpublished literature on review findings were planned to be explored. Therefore, IR[4], MA[1] and KT[2] plannedto carry out sensitivity and subgroup analyses, if there were more than ten studies included. However, an insufficient number of studies stood against undertaking these analyses.

**Results**

Study selection and characteristics:

By applying eligibility criteria on identified studies only six (2 RCT, 2 CCT and 3 cohort studies) were included in this review. Five of the included studies were assigned to quantitative synthesis (meta-analysis). Figure 1 shows the number of studies identified at the different stages of this review.

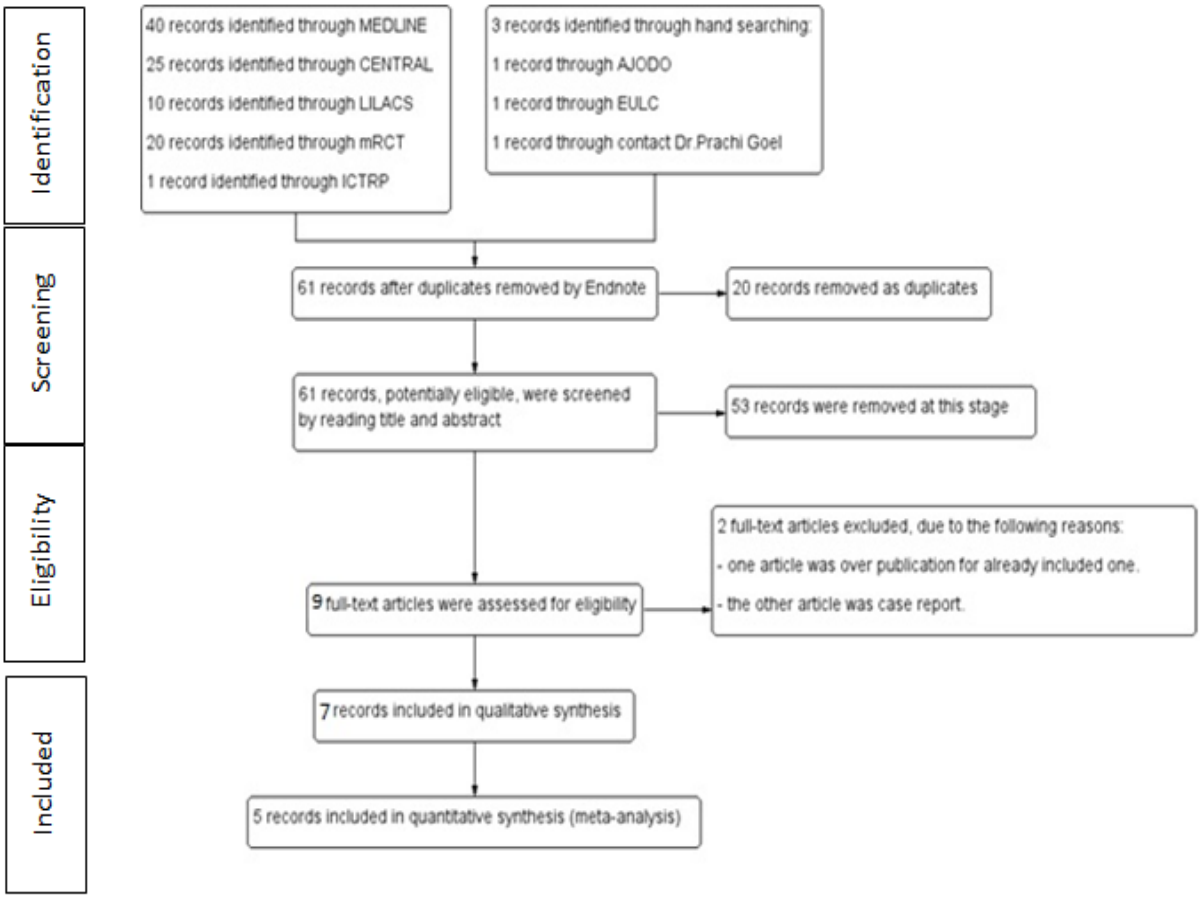


Fig 1. PRISMA flow chart showing number of studies at different stages of review.

Characteristics of included studies can be seen in table 1.

Table 1: Characteristic of included studies

| Study | Design | P | I | C | O |
|---|---|---|---|---|---|
| De Almeida et al. 2018[34] | RCT | -28 subjects<br>-Age:15.1 ± 1.6 Y | CIA | CAW | - Primary outcomes: external apical root resorption (EARR) of maxillary incisors<br>- Secondary outcomes: Amount of upper incisor intrusion |
| Goel et al. 2014[35] | RCT | -30 subjects<br>-Age:14-25Y<br>-Need incisor intrusion 2.0-4.0 mm | SAW Rickett's | K-SIR CAW | - Primary outcomes: Rate of intrusion, amount of upper incisors intrusion<br>- Secondary outcomes: root resorption, amount of upper molar extrusion, changes in overjet and overbite and skeletal changes associated with the three techniques. |
| Weiland et al.1996[36] | CCT | - 50 subjects<br>-Age:18-40Y<br>-Class II | SAW Burstone' | CAW | Primary outcomes: Total treatment time, amount of overbite reduction, amount of upper and lower incisors intrusion.<br>Secondary outcomes: amount of upper and lower molars extrusion, backward rotation of the mandible, change in inclination and protrusion of upper and lower incisors, change in angulation of upper and lower molars, intrusion force level, changes in total and lower anterior face heights. |
| Foda et al. 1998[37] | CCT | -28 subjects<br>-Age:15-22Y<br>-Class II | SAW Burstone | CAW | Primary outcomes: Total treatment time, amount of overbite reduction, amount of upper and lower incisors intrusion.<br>Secondary outcomes: amount of upper and lower molars extrusion, backward rotation of the mandible, change in protrusion of upper and lower incisors, incidence of root resorption, changes in total and lower anterior face heights. |
| Dake et al. 1989[38] | Cohort | - 60 subjects<br>-Age:11.1±1.7Y growing pateints<br>-class II | SAW Rickett's | CAW | Primary outcomes: total treatment time<br>Secondary outcomes: changes in lower incisors irregularity, overjet changes, changes in the curve of Spee and mandibular intercanine width.<br>Posttreatment changes: Changes in lower incisors irregularity, overjet, curve of Spee, and mandibular intercanine width. |
| Preston et al. 2008[39] | Cohort | -44 subjects<br>-Age: 13.1Y<br>growing pateints<br>-Class II | SAW Rickett's | CAW | Primary outcomes: total treatment time, amount of overbite reduction and amount of upper and lower incisors intrusion<br>Secondary outcomes: amount of upper and lower molars extrusion, backward rotation of the mandible, change in inclination and protrusion of upper and lower incisors, change in upper molars (mesiodistal) angulation, change in gonial angle, skeletal changes associated with the treatment and amount of intrusion force and changes in curve of Spee.<br>Posttreatment changes: for the aforementioned outcomes. |
| AlQabandi et al. 2002[40] | Cohort | 47 subjects<br>Age: 13.58±3.5<br>Total N: 249 | SAW Rickett's | CAW | Primary outcomes: amount of lower incisors intrusion, total intrusion time<br>Secondary outcomes: change in lower incisors irregularity, intercanine width lower incisors angulation and protrusion in addition to changes in lower molars angulation, change in curve of Spee and anteroposterior position. |

CAW: Continuous archwire SAW: Segmented archwire K-SIR: Kalra's simultaneous intrusion arch. P: population I: intervention

C: comparator O: outcomes CIA: Connecticut intrusion arch

Table 2: list of potential confounders in each study

| Study | Overjet. | Incisors inclination and interincisal relation. | Incisors alignment. | Pretreatment vertical incisors and molars position. | Age. | Sex. | Severity of deep overbite. | Angle classification. | Aetiology (dental, skeletal or combination). | Facial type. |
|---|---|---|---|---|---|---|---|---|---|---|
| De Almeida et al. 2018[34] | balanced | Balanced | Minimal or No crowding | Unclear | Balanced | Balanced | Balanced | Balanced Class I & II | Unclear | Unclear |
| Goel et al. 2014[35] | Balanced | Balanced | Unclear | Unclear | Balanced | Unclear | Unclear | Balanced | Unclear | Restricted " average" |
| Weiland et al. 1996[36] | Unclear | Balanced | Unclear | Balanced | Adults Balanced | Balanced Both | Balanced | Balanced Class I &II | Unclear | Restricted "low angle" |
| Foda et al. 1998[37] | Balanced | Unclear | Minimum crowding | Balanced | Adults Balanced | Restricted Females | Balanced | Restricted Class II | Unclear | Balanced |
| Dake et al. 1989 [38] | Unclear | Unclear | Unclear | Unclear | Growing Balanced | Balanced Both | Unclear | Restricted Class II | Unclear | Restricted "low angle" |
| Preston et al. 2008 [39] | Balanced | Unclear | Minimum crowding | Unclear | Growing Balanced | Unclear | Balanced | Restricted Class II | Unclear | Restricted "Average to low angle" |
| AlQabandi et al. 2002[40] | Unclear | Unclear | Minimum crowding | Unclear | Balanced Both | Balanced Both | Balanced | Balanced | Unclear | Balanced |





## Risk of bias within studies

**RCTs:**

Dentoskeletal outcomes, whether linear or angular, are subjective outcomes and considered at high risk of bias.Rate of incisors intrusion (objective) is considered at unclear risk of bias.

**CCTs:**

Dentoskeletal outcomes, whether linear or angular, are subjective outcomes and considered at serious risk of bias (Fig. 2).

**Cohort studies:**

Dentoskeletal whether linear or angular outcomes (subjective) are considered at serious risk of bias (Fig. 3).

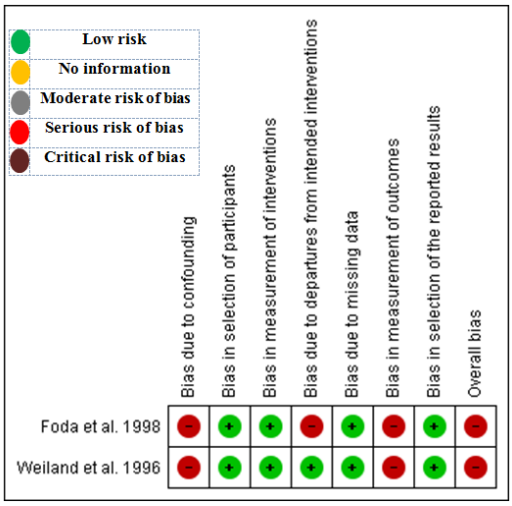


**Fig 1.** Risk of bias summary: review authors' judgement about each risk of bias item for each included CCT trials

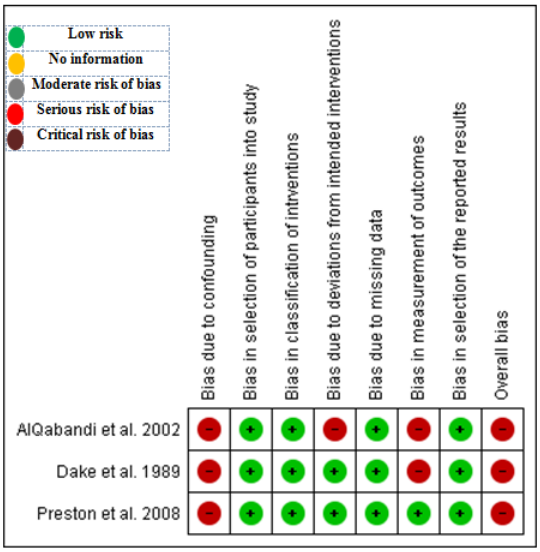


**Fig 2.** Risk of bias summary: review authors'judgements about each risk of bias item for each included cohort study.



## Results of individual studies, meta-analysis, and additional analyses

Forty outcomes were reported by the studies included in this review, 10 of them were sought in this review, the results of which are seen in table 3. Five studies with tin outcomes were assigned to meta-analysis.

## Table 3. Results of individual studies

| Outcome | Reported by | reported values | | | |
|---|---|---|---|---|---|
| Primary outcomes | | During treatment | | Post treatment | |
| 1- Amount of overbite reduction | Weiland et al. 1996[36] | CAW | -3.2±1.6 | ——— | |
| | | SAW | -3.6±1.8 | | |
| | Preston et al. 2008[39] | CAW | -2.8±0.8 | CAW | 0.75±0.8 |
| | | SAW | -3.5±1.1 | SAW | 0.52±0.8 |
| | Goel et al. 2014[35] | CAW | -1.5±0.8 | ——— | |
| | | SAW | -1.7±0.7 | | |
| | Foda et al. 1998[37] | CAW | -5.4±1.5 | ——— | |
| | | SAW | -5.1±1.4 | | |
| | Dake et al. 1989[38] | CAW | -5.0±1.6 | CAW | -0.4±2.4 |
| | | SAW | -4.7±1.5 | SAW | 0.2±4.3 |
| 2-Amount of upper incisor intrusion | De Almeida et al. 2018[34] | CAW | 0.30 | | |
| | | SAW | -2.23 | | |

| Outcome | Reported by | reported values | | | |
|---|---|---|---|---|---|
| | Goel et al. 2014[35] | CAW | -0.7±0.6 | ——— | |
| | | SAW | -1.6±0.5 | | |
| | Foda et al. 1998[37] | CAW | -0.95±3.4 | ——— | |
| | | SAW | -3.2±3.59 | | |
| | Dake et al. 1989[38] | CAW | 0.2±1.6 | CAW | 1.1±1.3 |
| | | SAW | 1.1±1.9 | SAW | 1.3±1.5 |
| | Weiland et al. 1996[36] | CAW | -0.26±1.6 | ——— | |
| | | SAW | -1.5±1.28 | | |
| 3-amount of lower incisor intrusion | Weiland et al. 1996[36] | CAW | -1.1±1.55 | ——— | |
| | | SAW | -1.7±1.91 | | |
| | Foda et al. 1998[37] | CAW | -1.9±3.2 | ——— | |
| | | SAW | -2.9±2.6 | | |
| | Dake et al. 1989[38] | CAW | 0.3±1.7 | CAW | 2.1±1.7 |
| | | SAW | -1.2±3.9 | SAW | 2.8±6.3 |
| | AlQabandi et al. 2002[40] | CAW | -0.26±1.6 | ——— | |
| | | SAW | -1.5±1.28 | | |
| | Weiland et al. 1996[36] | CAW | -1.1±1.55 | ——— | |
| | | SAW | -1.72±1.9 | | |
| Secondary outcomes | Goel et al. 2014[35] | CAW | -0.8±0.94 | ——— | |
| | | SAW | 0.00±0.94 | | |
| 4-Amount of upper molar extrusion | Foda et al. 1998[37] | CAW | 1.45±2.5 | ——— | |
| | | SAW | 0.65±3.2 | | |
| | Dake et al. 1989[38] | CAW | 2.5±2 | CAW | 1.2±1.4 |
| | | SAW | 2.5±2.3 | SAW | 2.9±2.1 |
| | Weiland et al. 1996[36] | CAW | 1.63±2.1 | ——— | |
| | | SAW | -0.1±1.5 | | |
| 5- Amount of lower molar extrusion | Weiland et al. 1996[36] | CAW | 1.3±1.43 | ——— | |
| | | SAW | 0.56±1.07 | | |
| | Foda et al. 1998[37] | CAW | 1.95±1.8 | ——— | |
| | | SAW | 0.8±1.73 | | |
| | Dake et al. 1989[38] | CAW | 3.7±2.3 | CAW | 1.7±2.0 |
| | | SAW | 2.6±2.2 | SAW | 0.5±6.0 |
| | AlQabandi et al. 2002[40] | CAW | -0.26±1.6 | ——— | |
| | | SAW | -1.5±1.28 | | |
| | Foda et al. 1998[36] | CAW | -0.95±2.6 | ——— | |
| | | SAW | -0.90±2.6 | | |
| 6- change of total anterior face height | Weiland et al. 1996[36] | CAW | 2.5±2.7 | ——— | |
| | | SAW | 0.8± | | |
| | Foda et al. 1998[37] | CAW | 4.4±5.0 | ——— | |
| | | SAW | 3.0±6.6 | | |
| | Dake et al. 1989[38] | CAW | 0.0±1.1 | CAW | 0.0±1.2 |
| | | SAW | 0.0±2.5 | SAW | 0.0±5.9 |
| 7 - change of lower anterior face height | Weiland et al. 1996[36] | CAW | 2.5±2.2 | ——— | |
| | | SAW | 0.4±1.9 | | |
| | Foda et al. 1998[37] | CAW | 3.3±5.8 | ——— | |
| | | SAW | 2.4±5.6 | | |
| | Dake et al. 1989[38] | CAW | 0.7±1.1 | CAW | -0.6±1.0 |
| | | SAW | -0.6±0.25 | SAW | -0.7±5.9 |
| 8 - backward rotation of the mandible | Goel et al. 2014[35] | CAW | -0.6˚±0.8˚ | ——— | |
| | | SAW | -0.5˚±2.2˚ | | |
| | Dake et al. 1989[38] | CAW | 0.8˚±3.2˚ | CAW | -2.1˚±3.8˚ |

| Outcome | Reported by | reported values | | | |
|---|---|---|---|---|---|
| | Weiland et al. 1996[36] | SAW | 0.8˚±3.0˚ | SAW | -1.9˚±5.5˚ |
| | | CAW | 1.9˚±1.3˚ | ——— | |
| | Foda et al. 1998[37] | SAW | 0.52˚±1.6˚ | | |
| | | CAW | 0.9˚±5.1˚ | ——— | |
| | | SAW | 0.9˚±5.2˚ | | |
| 9 - change in lower incisors irregularity | Preston et al. 2008[39] | CAW | -3.6±2.5 | CAW | 0.97±1.1 |
| | | SAW | -3.5±1.9 | SAW | 0.73±0.95 |
| | AlQabandi et al. 2002[40] | CAW | -1.03±1.4 | ——— | |
| | | SAW | -1.5±1.9 | | |
| 10 -Change in lower intercanine width | Preston et al. 2008[39] | CAW | 1.36±1.9 | CAW | 0.6±1.6 |
| | | SAW | 0.92±2.07 | SAW | 0.57±1.7 |
| | AlQabandi et al.2002[40] | CAW | 0.4±1.27 | ——— | |
| | | SAW | 2.37±1.1 | | |



**2. Quantitative synthesis: (fig 4-14)**

As a result of different study designs included in the quantitative synthesis, we carried out two comparisons; segmented versus continuous arch techniques for CCTs (comparison 1) and cohort studies (comparison 2).

**2.1 Segmented versus continuous arch techniques (CCTs)**:

IR[4], MA[1] and KT[2] combined two CCTs studies (Weiland et al. 1996[36] and Foda et al. 1998[37]) in 8 meta-analyses for eight different outcomes, thereby analyzing a total of 78 participants, all at serious risk of bias.

**2.2 Segmented versus continuous arch techniques (cohort studies):**

IR[4] and KT[2] combined Dake et al. 1989[38] and Preston et al. 2008[39] (analyzing 104 participants) regarding the outcome amount of overbite reduction and Preston et al. 2008[39]and AlQabandi et al. 2002[40] (analyzing 91 participants) for the following two outcomes: change in intercanine width and lower incisors irregularity. This resulted in three meta-analyses for three outcomes.

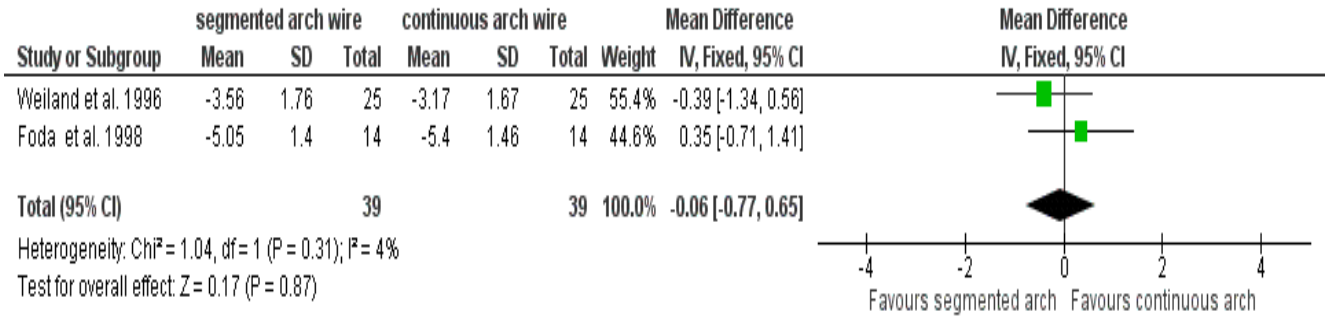


Figure (3): Comparison 1 segmented versus continuous archwire, outcome 1 Amount of overbite reduction.

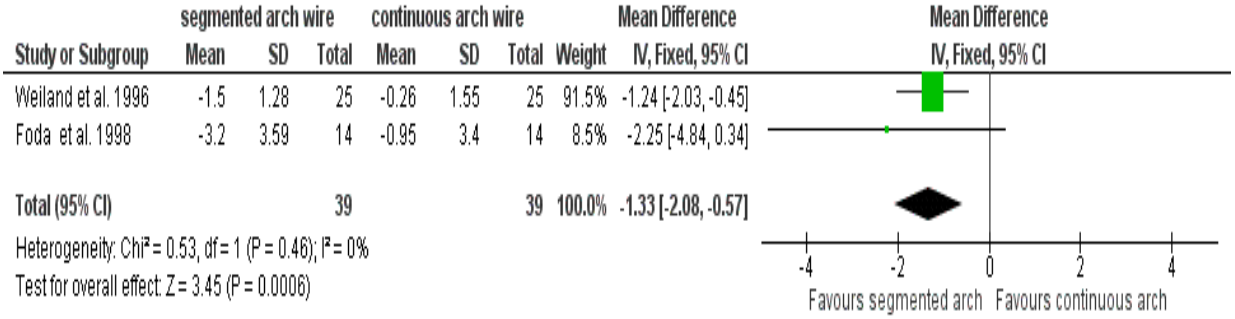


Figure (4): Comparison 1 segmented versus continuous archwire, outcome 2 Amount of upper incisors intrusion.



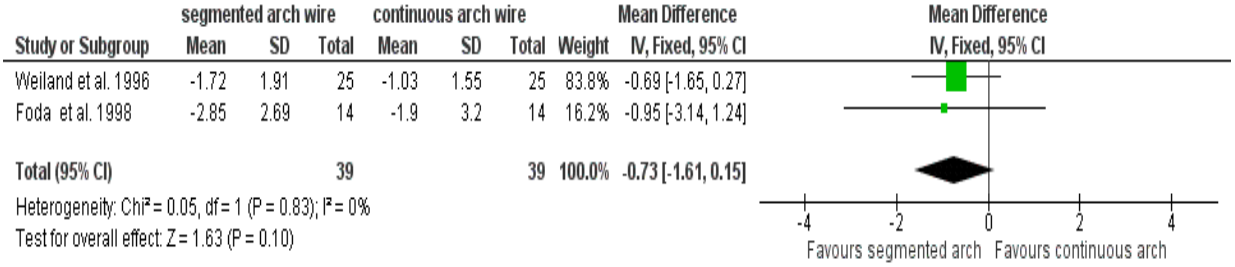


Figure (5): Comparison 1 segmented versus continuous archwire, outcome 3 Amount of lower incisors intrusion

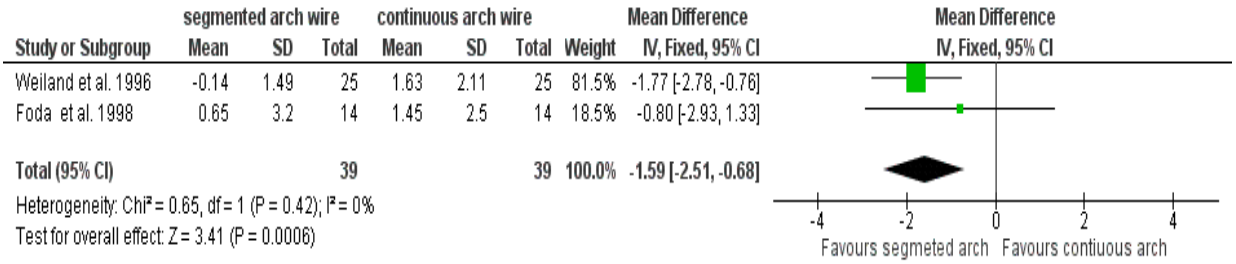


**Figure (6): Comparison 1 segmented versus continuous archwire, outcome 4 Amount of upper molars extrusion**

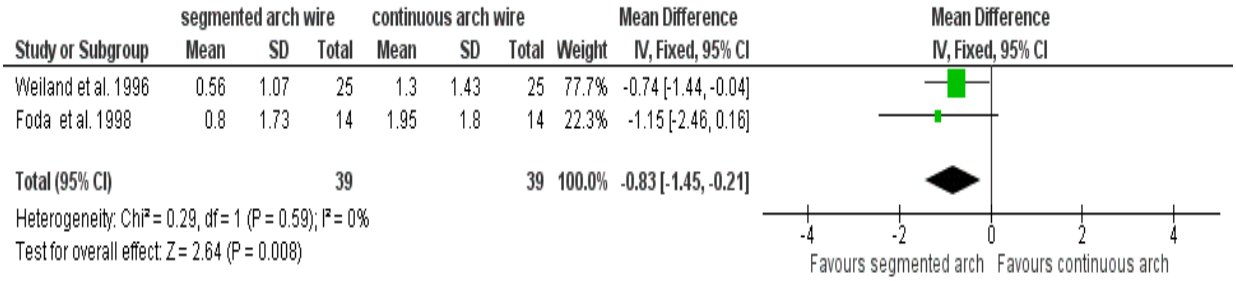


Figure (7): Comparison 1 segmented versus continuous archwire, outcome 5 Amount of lower molars extrusion

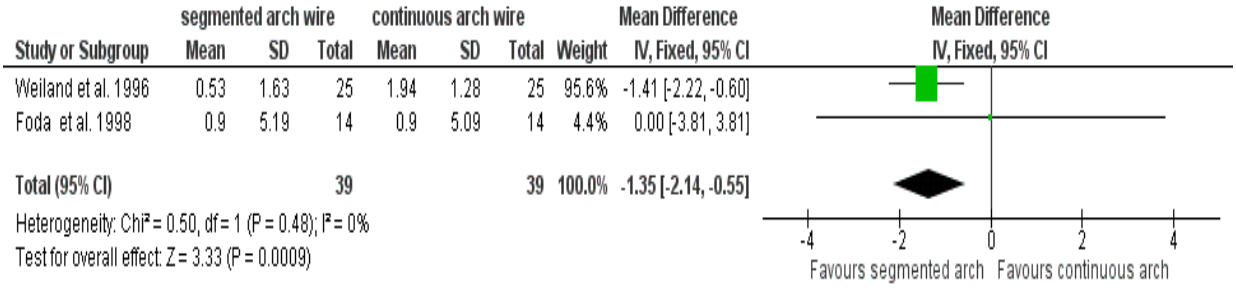


Figure (8): Comparison 1 segmented versus continuous archwire, outcome 6 Backward mandibular rotation

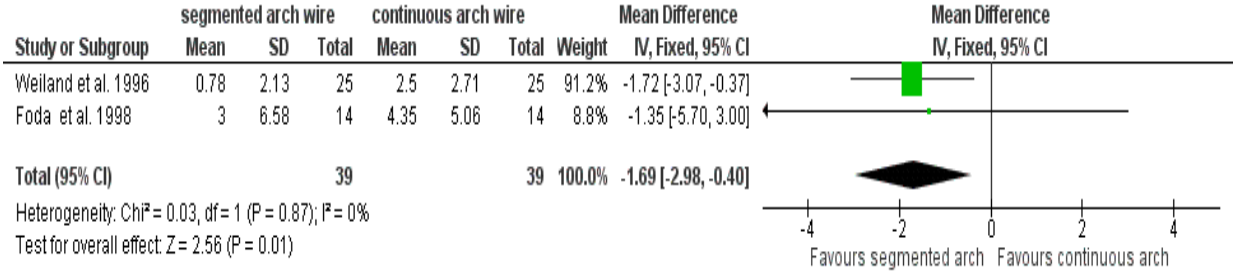


Figure (9): Comparison 1 segmented versus continuous archwire, outcome 7 Change in total anterior face height



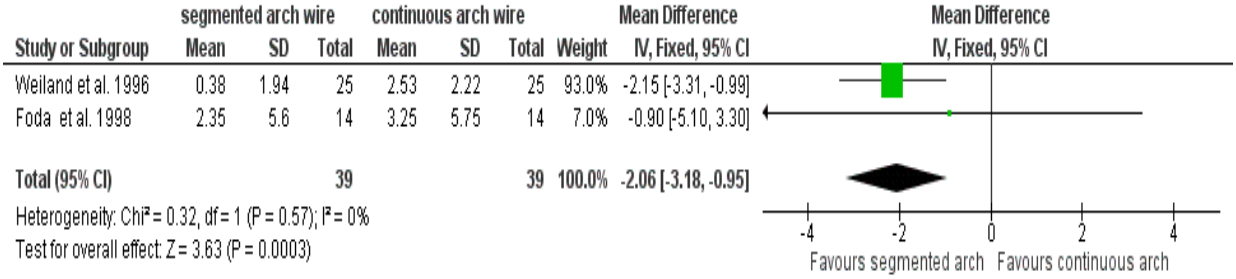


Figure (10): Comparison 1 segmented versus continuous archwire, outcome 8 Change in lower anterior face height

## 2.2 Segmented versus continuous arch techniques (Cohort studies):

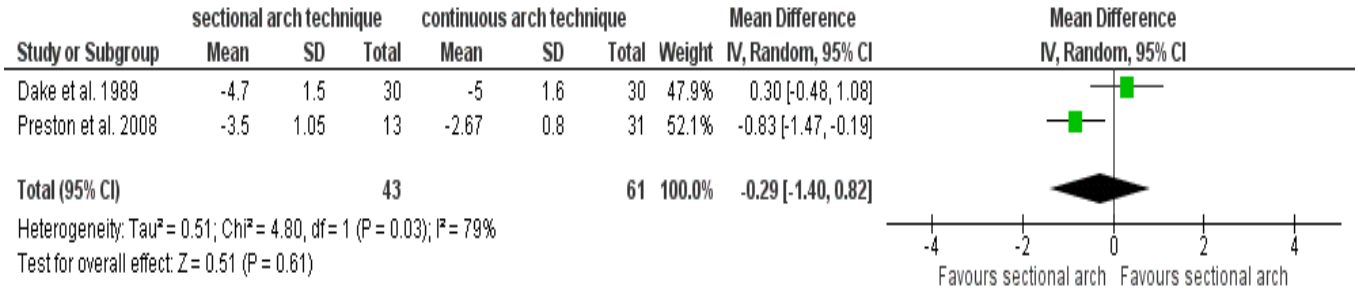


**Figure (12):** Comparison 2 segmented versus continuous archwire, outcome 1 Amount of overbite reduction (random effects model)

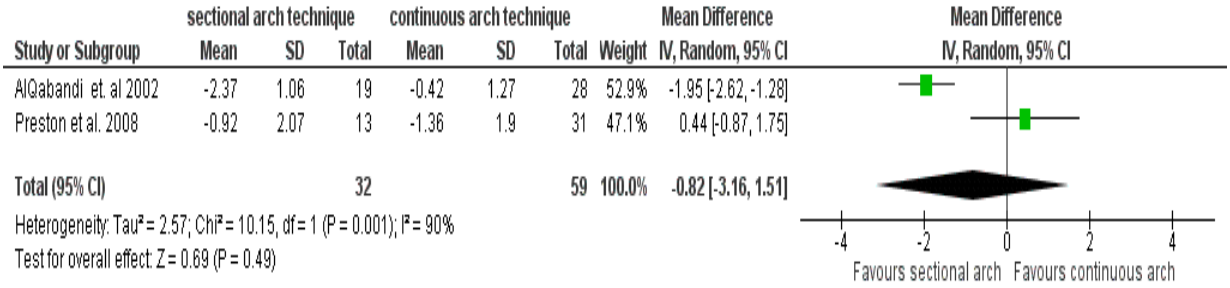


Figure (13) Comparison 2 segmented versus continuous archwire, outcome 2 Change in intercanine width (random effects model).

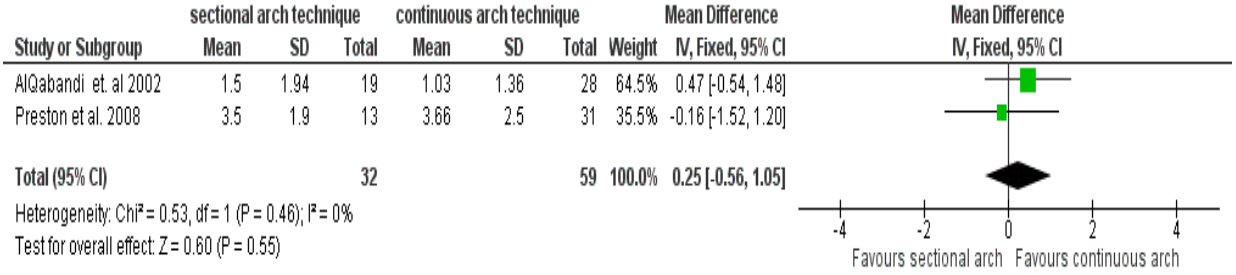


Figure (114) Comparison 2 segmented versus continuous archwire, outcome 3 Change in lower incisor irregularity.

## Risk of bias across the studies

Risk of bias assessment across CCTs and cohort studies included 7 domains. Four domains were at low risk of bias; these were bias in selection of participants, bias in measurement of interventions, bias due to missing data and bias in selection of reported results. Three domains were at serious risk of bias; these were bias due to confounding, departures from intended interventions and in measurement of outcomes. The overall risk of bias assessment across included CCTs was at serious risk of bias. (Figures 15 &16)

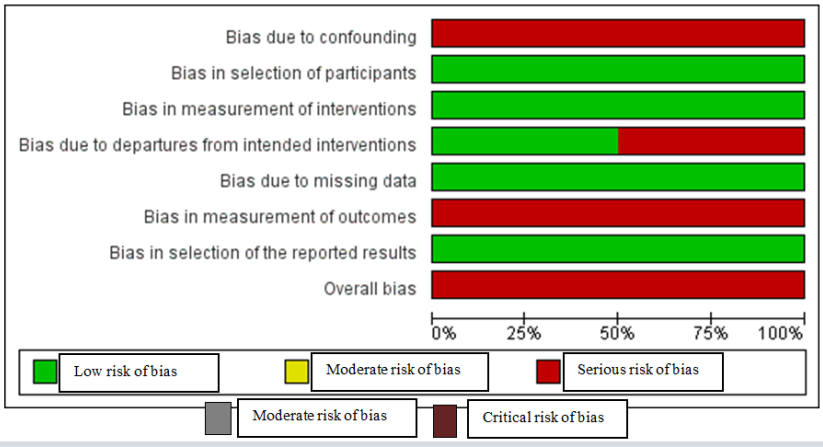


Fig 15.Risk of bias graph: review authors judgements about each risk of bias item presented as percentage across all included CCT studies



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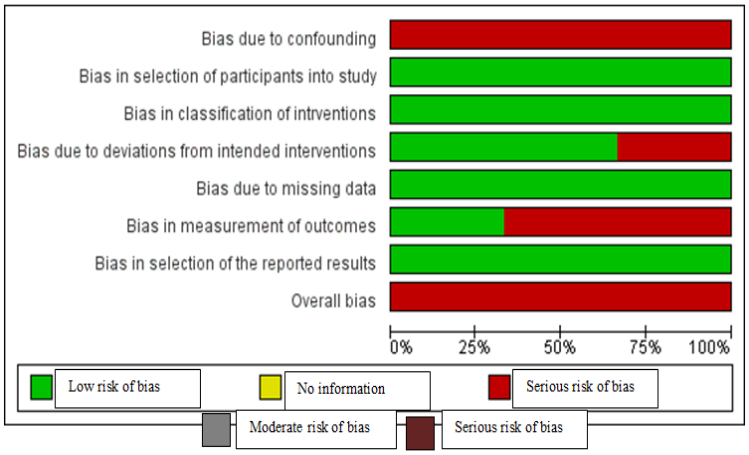


Fig 16. Risk of bias graph: review authors judgements about each risk of bias item presented as percentage across all included cohort studies.

Additional analysis: no additional analyses were attempted.

Summary of main results and body of evidence assessment: IR and KT used online GRADEpro/GDT (https://gradepro.org) which revealed very low (level D) quality of evidence for all outcomes.

## Discussion

Among the studies identified, only six studies met the inclusion criteria for this review (one randomized clinical trial, two non-randomized clinical trials and three cohort studies), investigating 249 participants. The small number of randomized clinical trials addressing the question of this review (only one study) may be due to two reasons: difficulties inherent to conducting randomized clinical trials; or lack of knowledge about the importance of conducting these types of studies in evaluating the effectiveness of a type of treatment.

All included studies were at high (RCTs) and serious (CCTs, cohort) risks of bias. Therefore, the body of evidence assessment using GRADE revealed very low (level D) quality of evidence.

The results of quantitative synthesis denoted that both techniques achieved similar amounts of overbite reduction. Deep overbite correction was obtained via intrusion of incisors and to a lesser extent extrusion of the posterior segments in SAW. On the other hand extrusion of the buccal segments concomitant with slight intrusion and flaring of incisors was observed in CAW. Hence, the increase in total facial height, lower anterior facial height and backward rotation of the mandible was greater in CAW when compared to SAW.



Combination of the results regarding posttreatment changes was impossible since not all outcomes were reported by similar studies and even those similar outcomes reported by similar studies were at different observation times (5 years interval).

Dake et al. 1989[38] reported that in growing patients, no difference between both techniques in deep overbite correction. They reported minimal increase in mandibular plane angle and anterior face height. This could be attributed to the vertical ramal growth that compensated for the extrusion of the buccal segments. They also reported that in growing patients Relative intrusion of incisors is achieved, holding them in place while other teeth and faces are developing.

With the limitations of design and being judged at serious risk of bias, Dake et al. 1989[38] and Preston et al. 2008[39] reported that post

treatment changes were similar in both techniques. However, their conclusions might be questionable since they included only growing patients in their samples therefore, the effect of growth cannot be neglected.

Dake et al. 1989[38]and AlQabandi et al. 2002[40]reported incisors flaring in sectional arches although they applied labial root torque as Rickett's recommendations. They attributed this flaring to the large angle of play between the archwire and bracket slot. However, this could also be explained as a result of the constructed step bend geometry (two counterclockwise moments one at incisors and the other at molars) that is associated with vertical equilibrating forces that increase both incisors flaring and molars extrusion.

Although wire cinch back (tieback) is reported by Dake et al. 1989[38]and AlQabandi et al. 2002[40]to effective in limiting the amount of incisors flaring, it exerts a great burden on the anchorage unit.

**Limitations**

Regarding the only RCT (Goel et al. 2014)[34] included in this review the risk of bias for this study is at high risk; the report of this trial did not mention the method of randomization, allocation concealment or blinding of outcome assessment. Review authors acquired clarifications for these points, but they did not respond.

Weiland et al. 1996[36] and Foda et al. 1998[37] are non-randomized clinical trials included in this review; both are at serious risk of bias. Dake et al. 1989[38], Preston et al. 2008[39] and AlQabandi et al. 2002[40] are cohort studies included in this review; all are at serious risk of bias.

Studies identified in this review are insufficient to address the question of what the best treatment for deep overbite by intrusion of incisors is confidently. We were able to include 6 studies only, and, therefore, there was minimal pooling of data. This is unfortunate as one of the advantages of a systematic review is the ability to pool multiple studies in order to increase the power to detect a difference confidently, and thus to inform clinical practice about better interventions. Furthermore, this limited number of studies did not enable us to perform subgroup analyses to detect confounders and effect modifiers that might be of clinical importance. Due to lake of randomized clinical trials to address the question of this review we had to include low quality trials (CCTs and Cohort studies) in comparison to the target randomized clinical trials.

We made every attempt to limit bias in the review process by ensuring a comprehensive search for potentially eligible studies. The authors' independent and then in duplicate assessments of study eligibility and subsequent data extraction and risk of bias assessment minimized the Potential for additional bias beyond that detailed in the 'Risk of Bias' tables for each study. The incompleteness of some of the reports and our inability to obtain clarification of certain trial details or to resolve ambiguities in the reports may have contributed to some bias in their assessment.



**Conclusions**

Based on quantitative synthesis the following conclusions are drawn:

1- No significant difference between SAW and CAW regarding the amount of overbite reduction and the amount of lower incisors intrusion.
2- The SAW shows greater amount of upper incisors intrusion in comparison with that achieved by CAW.
3- CAW shows a greater amount of upper and lower molars extrusion in comparison with that caused by SAW.
4- The increase in total and lower anterior face height with the backward rotation caused by CAW is greater than that caused by SAW.

5- Both techniques achieve comparable amounts of increase in the lower anterior arch length and lower intercanine width.

The quality of evidence according to GRADE is very low (level D), hence further well conducted RCTs with calculated sample sizes are likely to change this conclusion.

## Recommendations

1- Well conducted randomized controlled trials are urgently required to reveal the best method for deep overbite correction either segmented or continuous arch mechanics. These studies should conform to the Consolidated Standards of Reporting Trials (CONSORT) statement (www.consortstatement.org), which will enable appraisal and interpretation of results, and accurate judgements to be made about the risk of bias and the overall quality of the evidence

2- Core outcome should be set in association with the COMET (Core Outcome Measures in Effectiveness trials) Initiative (www.comet-initiative.org). Accordingly, outcomes included in this systematic review will be prioritized, and this will help to avoid selective reporting bias.

## APPENDIX

### MEDLINE search strategy

#1 deep bite or bite, deep or deep-bite or incisor intrusion or over-bite or deep overbite or malocclusion

#2 Segmented arch or Intrusion arch or Sectional arch or Burstone intrusion arch or Ricketts' utility archor Connecticut intrusion arch or Segmented leveling arch or Segmented arch mechanics

#3 continuous arch or Reverse curve of Spee or Continuous intrusive arch or Tweed's technique or Continuous arch mechanics or Intrusion arch or Straight wire technique or Alexander's discipline

#1 and #2 and #3

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