Comparative Evaluation of loss of anchorage and velocity of canine retraction during closure of extraction space by using conventional brackets and self-ligating brackets: A Systematic Review

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ABSTRACT

Background: One of the most difficult procedures in orthodontics is space closure, which necessitates a thorough understanding of biomechanics to prevent unfavourable side effects.Despite the wide range of appliance designs, space closure can be accomplished using friction or frictionless mechanics; each method has pros and cons.In this study, we aim to use the self- ligating brackets which is a cost - effective approach to evaluate the anchorage loss and velocity of canine retraction compared to conventional bracket.

Aim: This systematic review aimed to elucidate the question: Is there any difference between the anchorage loss and rate of canine retraction in self-ligating and conventional brackets.

Objective: To systematically review the literature in order to produce a database of outcome variables to distinguish the effect self-ligating and conventional brackets.

Design, data sources, and methods: The electronic databases such as MEDLINE (NCBI PubMed and PMC),Scopus, Cochrane Central Register of Controlled Trials (CCRCT), Web of science, Science Direct, Google Scholar, EMBASE, EBSCOwere systematically searched to obtain the articles related to anchorage loss and canine retraction from the year 1995. The reviewers assessed the risk of bias of individual studies with the Cochrane risk of bias tool, excluding RCTs with a high risk of bias in any domain.

Results: A sum of 311relevant titles was redeemed from various medical, dental and orthodontic journals. A total of 6 articles assessing the difference between the self-ligating and conventional bracketsin relation to anchorage loss and rate of canine retraction were shortlisted according to the inclusion and the exclusion criteria and were included in this systematic review after thorough scrutiny, meticulous screenings of abstracts and on duplicate removal. 80% of these studies had low risk of bias.

Conclusions: Traditional brackets tend to bind the tooth more elastically than self-ligating brackets; therefore, resistance to sliding is significantly more influenced by this than by friction, hence canine retraction by sliding the tooth over an undersized arch wire tends to be faster with traditional brackets.Maxillary canine retraction velocities, anchorage loss during maxillary canine retraction, and inclination changes on maxillary canines and molars were comparable between SLB and CB.

Keywords: canine retraction, anchorage loss, sliding mechanics. Self-ligating bracket, conventional brackets.

BACKGROUND

The methodical development of dental materials has prompted an ongoing search for technological advancements in orthodontics. The main challenges facing today's orthodontists are those related to appliance biocompatibility, orthodontic treatment effectiveness, and patient convenience.Retraction of the top anterior teeth is frequently required by the orthodontic diagnosis and treatment plan. Retraction of the canines using sliding mechanics before incisor retraction is one of the biomechanical alternatives to gap closure. [1]

In orthodontics, closing the extraction area is accomplished by using either high (sliding) or low (low) friction mechanisms.Self-ligating brackets were developed as a way to lessen friction and permit closure of the space utilising physiological forces that were of a very small magnitude, although this reduced friction may not always result in a shorter treatment period.[2]

So, comparing the "supremacy" of one bracket with the other in terms of friction would be fascinating.[3]

Anchorage this reaction, most of the times is an unwelcome and unwanted tooth motion.[4]

This undesired tooth movement of the dentition has to be underrated or expected self-indulgent by proper preparation of anchorage. anchorage, the, is the resistance to reaction forces that is to say provided by different teeth head or neck (extra oral force), or implants in bony process, an main objective of anchorage planning is maximizing the tooth movement that is asked while underrating offensive side effects.[5]

OBJECTIVE

The objective of this systematic review is to collect, compile and review the accessible evidence on anchorage loss and canine retraction to find difference in self- ligating and conventional brackets.

FOCUSED QUESTION

What is the difference between the self-ligating and conventional bracket with anchorage loss and rate of canine retraction?

MATERIAL AND METHODS

PROTOCOL

This systematic review is written and conducted according to the preferred reporting items for Systematic Reviews and meta-analysis (PRISMA Statement)checklist recommendations and was registered on PROSPERO (International prospective register of systematic reviews) (protocol number # CRD42023404240)

ELIGIBILITY CRITERIA

Articles related to ultrasonography and swallowing were collected from different databases. ThefollowingdatabaseswerethoroughlysearchedMEDLINE(NCBIPubMedandPMC),Scopus, CochraneCentralRegisterofControlledTrials(CCRCT),Web of science, ScienceDirect, GoogleScholar, EMBASE, EBSCO .

The review authors examined these journals following the guidance of the Cochrane Oral Health Group’s Journal Hand searchers’ Manual.

The reference lists of all the included studies were assessed to obtain additional eligible papers. The search strategy included the terms relating to or describing the study domain and

intervention. The terms were combined with the Cochrane MEDLINE filter for controlled trials of interventions.

INCLUSION CRITERIA

- Canine retraction and anchorage loss related articles were considered.
- Randomized controlled trial study articles were collected which were published from year 1995 to 2022.
- All articles that were in English language were included.

EXCLUSION CRITERIA

- Case reports, case series, uncontrolled studies, review articles, opinion articles, studies on animal teeth were considered "Non-eligible" for present systematic review.
- No control group/ control group not derived from the same patient.
- All articles published before 1995 and after year 2022.
- Articles that were not in English language were excluded.

SEARCH STRATEGY

- The studies to be included in present systematic review were searched by two independent reviewers and in case of discrepancy, a third examiner intervened to resolve the difference in opinion. The following combinations of title, abstract, Medical Subject Heading Terms (MeSH) and keywords were used to search through the above-mentioned databases. (canine retraction, OR incisor retraction) AND (anchorage loss OR space closure) AND (self-ligating brackets) And (conventional brackets OR MBT OR edgewise bracket) AND (orthodontics).(Table 1,2and)

Table 1- Primary and Secondary keywords

Primary Keywords	Secondary Keywords
Anchorage loss	Space closure
Canine retraction	Pre edgewise brackets
Self – ligating bracket	MBT brackets
Conventional bracket	

Keywords	No of articles searched	No of articles selected	Reason for exclusion
Canine retraction and anchorage loss	299	1	Case reports, Pathologic diagnosis, no relevant outcome
Canine retraction and self – ligating and conventional bracket	10	3	Case reports, Unclear about retraction rate
Anchorage loss and self - ligating and conventional brackets	5	2	-

Table 2: Distribution of the journals in which the articles are published

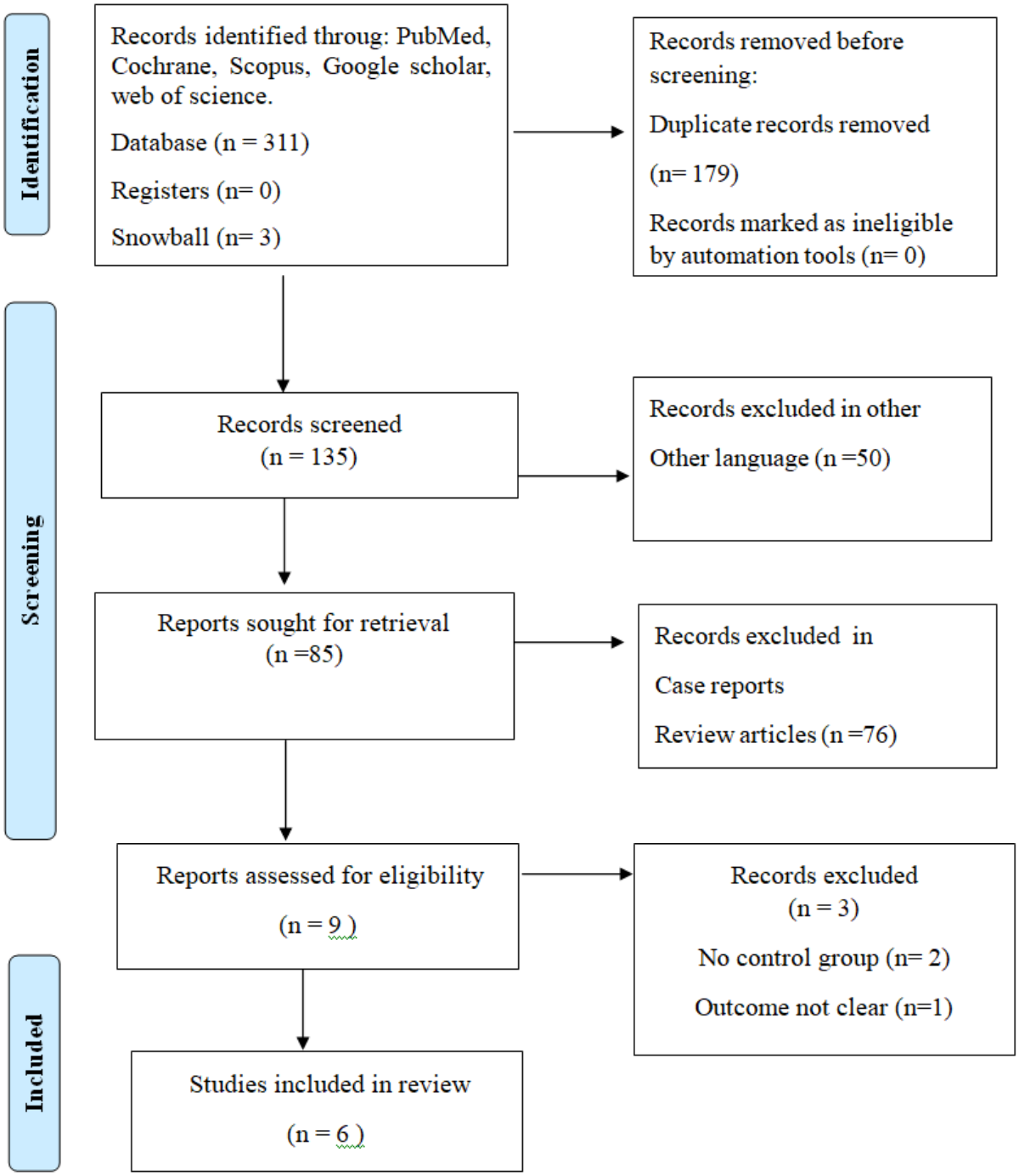
Table 3- Electronic Search approach for Each Database

STUDY SELECTION AND IDENTIFICATION

The articles evaluating the canine retraction and anchorage loss were first selected from the database by reading titles and abstracts. The duplicate records were identified and

removed.The titles and abstracts of the results of the search for desirable articles based on the PICO strategy were assessed by two review authors independently (Figure 1).

Figure 1-PRISMA flow diagram of the included and excluded records



DATA COLLECTION PROCESS

After a thorough electronic and manual search using the above-mentioned search strategy, studies obtained through duplicate searches were eliminated and the title and abstract of plausible eligible studies were noted. Furthermore, studies which do not fulfill the eligibility criteria were eliminated. In the next phase, full text detailed reading of the narrowed down studies was carried out, and studies that do not fulfill the systematic review criteria would be

excluded. The formal screening and data extraction were performed independently by two individual review team members. Any disagreement between them over the eligibility of particular studies will be resolved through discussion with a third reviewer.

RISK OF BIAS ASSESSMENT IN INDIVIDIAL STUDIES

All the eligible studies were subjected to a qualitative assessment, performed for every eligible study independently using risk of bias (quality) assessment. The Revised Cochrane Risk-of-Bias tool for Randomized trials, Version 2.0 (RoB 2) was used to perform the quality assessment of eligible studies.

An overall risk of bias was determined for each study considering individual risk of bias judgement for each domain and an overall risk of bias judgement and direction of the bias was concomitantly determined. Disagreements between the review authors over the risk of bias in particular studies were resolved by discussion, with the involvement of a third review author, wherever necessary.

SYNTHESIS OF RESULTS

STUDY SELECTION

A comprehensive search from multiple database resulted in 314 articles. Articles of relevance pertaining to the current review were identified by two independent reviewers and 179 duplicates were removed. A total of 135 records remained for evaluation. After screening 50 records were removed because of their irrelevance. 85 articles were selected for full text evaluation after screening the tittle and abstracts. Eligibility of individual studies was determined by clearly set inclusion and exclusion criteria. 76 articles were excluded after through reading of material methodology section of each article, since they did not fulfil the criteria. 9 articles fulfilled the criteria for present systematic review; 6 articles were selected to assess the rate of canine retraction and anchorage loss in self-ligating brackets conventional brackets during orthodontic treatment.

The extracted data was analysed for the measured variables were recorded and compared. (Table 4 and 5)

RISK OF BIAS

Cochrane risk of Bias assessment was done. Risk of bias was evaluated for each question. For each question-based entry the judgment was: “Yes, for low risk of bias” and a point were allocated (*), and “No, for high risk of bias” and a point was not allocated. The questions evaluated in each study were based on the following criteria from the Newcastle Ottawa scale: representativeness of the sample (evaluated by the methods of generation of samples, allocation concealment and sample calculation); sample size, non-respondents, ascertainment of the exposure, the subjects in different outcome groups are comparable, assessment of the outcome, statistical test. The representativeness criteria were evaluated through the sampling methods. The presence of a random component in the sequence generation was judged as low risk of bias. Allocation concealment was also used as a criterion for assessing representativeness. Thus, any method that precluded participants and researchers from foreseeing assignment was judged as low risk of bias.

The evaluation was done on answering the questions, answers were yes towards the low risk bias. Evaluations were done and after estimation were found to be low risk articles.(Table 6 and 7)

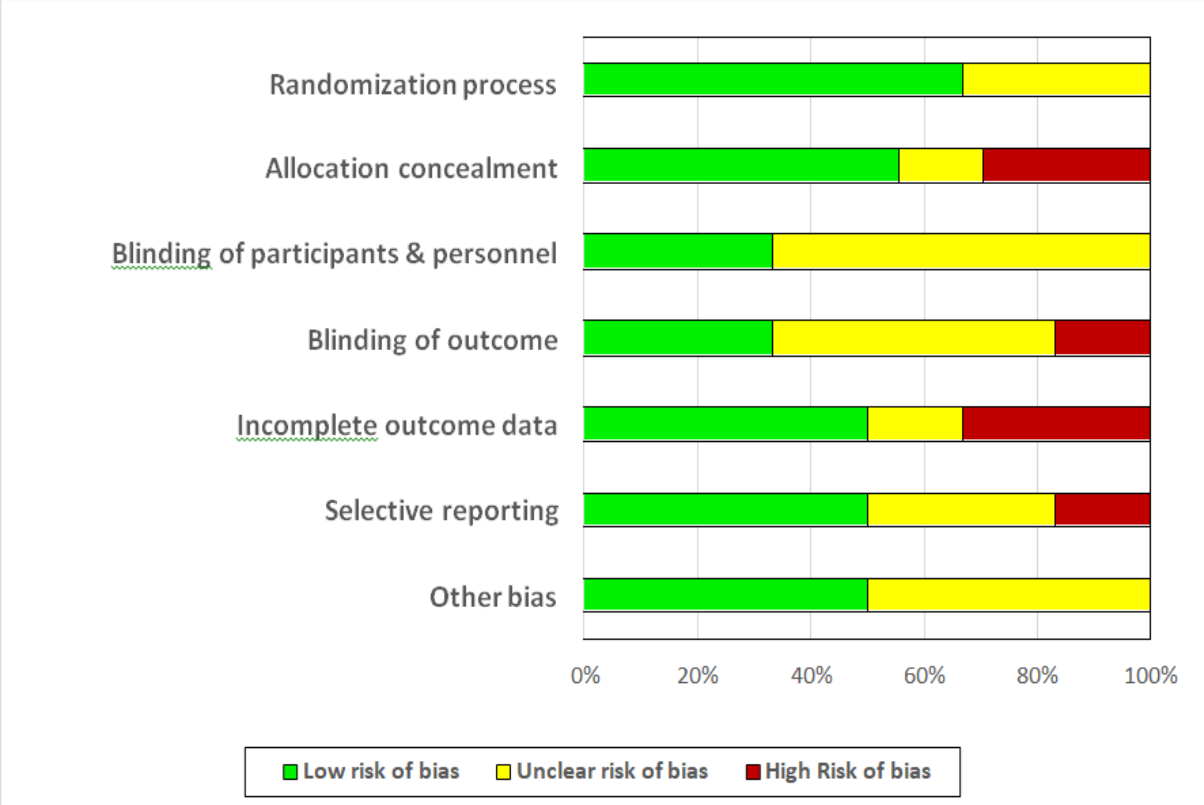
Cochrane Risk of Bias Assessment(RoB2)

Table 6-Individual risk of Bias

Studies(year)	ndomizationprocess	Allocationconcealment	Blinding ofparticipants&personnel	Blinding ofoutcome	Incompleteoutcomedata	Selectivereporting	OtherBias
SJackBurrowetal 2010	+	−	?	?	+	+	?
MauricioMezomoet al2011	?	?	?	?	−	?	?
FerdinandMachibya etal2013	+	−	?	+	−	+	+
MajPankaj Juneja et al2014	+	+	+	−	?	−	?
AndredaCosta Moninietal2014	+	+	+	+	+	?	+
AndredaCosta Moninietal2016	?	+	?	?	+	+	?

+/greencolor:lowriskofbias;?/yellowcolor:someconcerns;−/redcolor:highriskofbias (AssessmentdoneusingCrombie'sitemusingAHRQMethodologyChecklistforCrossSectionalStudy)

Table 7- Overall risk of bias



DISCUSSION

Paulson et al. 1970. [34]The following research looked at sliding mechanics. They used sliding mechanics to determine the canine retraction of a 0.016-inch wire. 50 to 100 g to 100 g was the retraction force. His sample had an average monthly growth rate of 1.08 mm, but individual rates varied from 0.7 mm to 2.4 mm. Using sliding mechanics, Huffman and Way18 conducted an in-vivo investigation to measure the amount of movement, velocity of movement, and degree of tilting when retracting a canine down a 0.016-inch and 0.020-inch wire. They retracted the dog with 200 g of force. The speeds were 1.20 mm/month using the 0.020-inch wire and 1.37 mm/month while retracting down the 0.016-inch wire. The variation was insignificant. Energy chains and latex thread were employed by Sonis et al.19 to retract canines down a archwire, 0.016 x 0.022 inches. There were initially 250–400 g of forces. For elastic threads and chains, the mean tooth movement velocity determined during a 3-week period was 1.28 mm and 1.51 mm, respectively. They came to the conclusion that "all the tested materials produced roughly equal amounts of tooth movement."

Aronsen et al. 1990 [37] Anchorage losses of 2.4 mm in 1 monkey and 1.4 mm in another were seen, according The outcomes of these earlier studies were consistent with the outcomes of our human study, which found anchorage losses of 2.08 0.43 mm in the maxilla and 1.95 0.44 mm in the mandible using the M.B.T. bracket system and 1.90 0.68 mm in the maxilla and 1.90 0.43 mm in the mandible using the passive SLB method.

(Smart Clip). The mean anchoring loss between the self-ligating and conventional (M.B.T.) brackets in the maxillary arch was 0.18 mm (sagittal) and 0.02 mm (vertical), respectively. The mean anchorage loss between the self-ligating and conventional (M.B.T.) brackets in the mandibular arch was 0.05 mm (sagittal) and 0.02 mm (vertical), respectively. However, a slight clinical difference that appears to exist when comparing the data was not statistically significant.

Sirinivas S 2003. [35] In comparison to traditional brackets, this study discovered that self-ligating brackets resulted in greater rates of canine distal displacement. However, measurements were only made at the canine cusps, thus tooth inclination may have overstated how well the self-ligating brackets worked.

found similar results, with a better rotational control for self-ligating brackets during canine retraction. The author used an archwire with a larger diameter (0.018 3 0.025 in.), with less slack between the wire and the cover of the self-ligating brackets. However, rotation values were not affected. Other procedures, such as tying the distal tie-wings of the brackets with SS ligature or applying additional lingual forces, are routinely used in orthodontic practice. The latter, although effective in most cases, may increase patient discomfort.

larger loss of anchoring than that observed in this investigation utilising nickel-titanium springs loaded with 150 g of force and SS 0.018- 3 0.025-inch wires. With self-ligating brackets, molars moved 0.43 mm/mo in the mesial direction every month, compared to 0.53 mm/mo with traditional brackets.

Badri et al. 2006[36] shown that an anchor unit composed of the first molar and second premolar can occupy between 5% and 50% of the overall extraction space.

Burrow S J 2010.[4]In this study, the side being treated with the traditional bracket moved more frequently on average every 28 days than the side being treated with the self-ligating bracket. Despite the fact that this difference is statistically significant, it probably has little impact on patients. Although bracket geometry, in particular bracket width, increases resistance to sliding, it is still vital to remember that the biological reaction to force, rather than mechanical features of the orthodontic appliance, appears to be the limiting element in the pace of tooth movement.

Mezomo M. 2011. [1]In recent years, interest in self-ligating brackets has increased. Self-ligating brackets have a significantly lower coefficient of friction than traditional brackets, according to in vitro research, which may have a therapeutic advantage in sliding mechanics.

In certain instances, the canines on either side of the maxillary arches were retracted.To lessen the bias in clinical research, other people randomly assigned which side of each system will be used. Because bracket positioning accuracy might differ depending on the patient's side, randomization was selected for the current investigation. Such bias could affect the outcomes, particularly when assessing canine rotation.[1]

Canine rotation was more pronounced with traditional brackets, but the amount of gap closure brought on by canine retraction was similar across the two bracket ligation methods. It was discovered through clinical research and stone model analysis that rotations higher than 10u could be crucial for the order of therapy. Retraction must be stopped if the archwire separates from the bracket slot distally until canine rotation is fixed. Such a pause would lengthen the healing process and eventually degrade the quality of the finish.

Machibya F M 2013.[28]One of the claimed benefits of self-ligating over traditional brackets is anchorage conservation. By reducing friction during sliding mechanics, teeth are anticipated to be moved more easily during orthodontic treatment, which in turn lessens the force acting on the anchor tooth or unit. This process is predicted to strengthen the anchoring and encourage natural tooth movement, which might lead to a more stable treatment outcome.

For both the SLB and CB groups, the loss of anchorage in this study is greater in the maxilla than the mandible; this may be explained by the well-known fact that the maxilla has lesser bone mass than the mandible. Clinicians should anticipate higher anchorage loss in the maxilla than in the mandible; hence, more effort is needed compared to the mandible to impose anchoring in the maxilla during orthodontic treatment.

CONCLUSION

In conclusion, it can be said with traditional brackets as opposed to self-ligating ones, canines tend to retract more quickly over an undersized archwire. This is likely because self-ligating brackets' smaller design causes more elastic binding, which affects sliding resistance more so than friction.

Both conventional and self-ligating brackets caused the upper canines to migrate distally at about the same rates. Self-ligating brackets helped to reduce rotation of the upper canines during retraction. The upper molar anchorage loss was comparable with conventional and self-ligating brackets.

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