Al-Rafidain Dental Journal

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Maxillary molars in class II, derotate or distalize: A Systematic review

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Article information

Received: January 23, 2023
Accepted: February 25, 2023
Available online: March 10, 2023

Keywords
Systematic review
Class I
De-rotation
Distalisation

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Abstract

Aims: This review aims to prove whether derotation can correct minimal class II. **Materials and Methods**: The systematic search included Medline (PubMed, Ovid MEDLINE and EBSCO, Science Direct, and Cochrane Library (Cochrane Review, Trails), and additional studies were searched in the reference lists of all articles. The date of the last search was December 13th, 2022. The methodological quality of the retrospective studies was graded by means of the Quality Assessment Tool for Quantitative Studies, developed for the Effective Public Health Practice Project (EPHPP), and prospective studies by means of the Newcastle–Ottawa Scale. **Results**: Totally, 1342 studies were identified for screening, and 5 studies were eligible. The Quality Assessment Tool for Quantitative Studies rated 2, of the included retrospective clinical studies as high risk and 1 as moderate risk. The Newcastle–Ottawa Scale rated all 2 included studies as high risk. The mean molar derotation values varied from 1 mm to 2 mm. **Conclusion**: Through this systematic review, we have highlighted that; the derotation can correct the minimal class II. It is possible thanks to several devices like traspalatin arch, clear aligner, headgear, and some distalizers especially those with vestibular action. The mean molar derotation values varied from 1 mm to 2 mm, conditionally to not lose the space obtained by the effect of mezialization.

الخلاصة

الاهداف: تهدف هذه المراجعة الى إثبات ما إذا كان تصحيح الدوران المولي يمكنه تصحيح سوء الإطباق البسيط من الصنف الثاني. **المواد وطرائق العمل**: تضمن البحث المنهجي Medline (PubMed و Ovid MEDLINE و EBSCO و Science Direct ومكتبة Cochrane (مراجعة Cochrane، Trails) ، وتم البحث عن دراسات إضافية في قوائم المراجع لجميع المقالات.كان تاريخ آخر بحث في 13 ديسمبر ، 2022. تم تصنيف الجودة المنهجية للدراسات بأثر رجعي عن طريق أداة تقييم الجودة للدراسات الكمية ، التي تم تطويرها من أجل مشروع الممارسات الفعالة للصحة العامة (EPHPP) والدراسات المستقبلية عن طريق مقياس نيوكاسل - أوتاوا. **النتائج**: إجمالاً ، تم إجراء 1342 دراسة تم تحديدها للفحص ، وكانت خمسة دراسات مؤهلة.صنفت أداة تقييم الجودة للدراسات الكمية لدراستين ، من الدراسات السريرية بأثر رجعي المشمولة على أنها ذات درجة تحيز علمي عاليه و دراسه واحدة على أنها ذات درجة تحيز العلمي متوسطه. اختلفت قيم الانحراف المولي المتوسط من واحد مم إلى اثنان مم.**الاستنتاجات**: من خلال هذه المراجعة المنهجية ، قمنا بتسليط الضوء على ذلك ؛ يمكن أن تصحيح الدوران المولي يمكنه تصحيح سوء الإطباق البسيط من الصنف الثاني و ذلك بفضل العديد من الاجهزه على غرار جهاز تقويم الأسنان الشفاف ، اغطية الرأس بعض أجهزة distazers ذات تاثيرموجه من جهة الخد الانحراف الحد الأدنى من الدرجة الثانية. من الممكن بفضل العديد من الأجهزة مثل قوس traspalatin ، والصفائح الشفافة ، وأغطية الرأس ، وبعض المواد البعيدة خاصة تلك ذات الحركة الدهليزية. تفاوتت قيم الدوران المولي المتوسطة من واحد مم إلى اثنان مم ، تحت شرط عدم ضياع هذه المساحة بتحرك الاسنان نحو الامام حتى لا تفقد المساحة التي تم الحصول عليها عن طريق تأثير الانقسام.

DOI:10.33899/rdenj.2023.137944.1191,

INTRODUCTION

The position of the first permanent maxillary molars were deemed to be decisive in describing occlusal relationships since Angle in 1899 defined it as a "key to occlusion" [1]. According to the angle classification; Class II: is "characterized by a distal occlusion of more than a half cuspid of the mandibular first molar relative to the maxilla, on each side, forcing the other teeth into the same distal relationship".[2]

One of the causes of maxillary molars' displacement is the mesial movement into the leeway space left during the transition from mixed to permanent dentition [3]. The displacement in mesial direction is not the product of the pure translation, but quite often, it results in a rotation around the axis of the tooth. Due to its trapezoidal shape with a wider buccolingual diameter than mesiodistal, a rotated upper first molar occupies more space, creating an unfavorable situation for the achievement of a normal occlusion with more crowding between adjacent teeth [4].

To correct the class II in the case of non-extraction orthodontic therapy, for adults, it is evident that the arch length gain related to derotation of the maxillary first molars is not always sufficient to correct Class II malocclusion. More options as distalization or a combination of derotation and distalization are needed to achieve Class I premolar articulation.

While searching the literature, some systematic reviews and a meta-analysis have been performed on the means of molar distalization and their effectiveness [5 ,6 ,7]. However, there was no systematic review treating maxillary molar derotation. To address this; a systematic review of the literature was conducted to evaluate the effectiveness of derotation in the correction of minimal dental class II.

MATERIALS AND METHODS

This systematic review was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [8]. Also, it has been reported in line with AMSTAR (Assessing the methodological quality of systematic reviews) Guidelines

2.1 Focused clinical question:

Can derotation be a therapeutic option for minimal class II cases?

In order to answer this question, we set the following objectives:

-Determining how many millimeters of displacement can be gained from derotation;

- Finding the effective devices in derotation;

- Mentioning unwanted side effects encountered during derotation.

2.1.1 Inclusion criteria

We included articles meeting all the following criteria:

- Rotated Cl II molar
- Human studies, randomized and non-randomized control trials, cohort studies, and descriptive studies; studies concerning the orthodontic treatment in adults and adolescents,
- No restrictions on language or year of publication were placed.

2.1.2 Exclusion criteria

We excluded all publications dealing with:

- literature reviews;
- Animal studies ;
- Case reports ;
- In vitro studies ;
- Mesialization of mandibular molars ; Class III malocclusion

2.2 Eligibility criteria

Studies were assessed for eligibility based on PICO Format [9]: (Table 1)

2.3 Information sources

Medline (PubMed, Ovid MEDLINE, and EBSCO), Google Scholar, Science Direct, Cochrane Library (Cochrane review, Trails), and The Cochrane Central Register of Controlled Trials were screened for eligible studies related to the focused question. No beginning date was used, and the last date of the search was December 13th, 2022. Additional studies were searched in the reference lists of all articles included.

2.4 Search strategy:

The structured search strategy equation used in all the databases were as follows: (Class II malocclusion) AND ((molar distalization) OR (molar derotation)) AND (orthodontic)

2.5 Selection process:

Titles and abstracts of retrieved papers from our search strategy were screened in duplicate using the Zotero software. Potentially pertinent studies were collected based on screen the title and abstract by authors. These reports were classified as absolutely eligible, not eligible, or controversial. Full-text versions of absolutely eligible reports were analyzed and the reports that satisfied all of the inclusion criteria were used for data extraction.

2.6 Data Collection and Items:

All the studies meeting the inclusion criteria underwent data extraction, using a specially designed form. We used a standardized data extraction sheet containing the following items: first author/year of publication, study design, sample, intervention type, measured outcomes, and results.

2.7 Risk of Bias assessment:

The risk of bias is assessed using the following tools for in vivo studies:

– In prospective studies, the risk of bias is evaluated using the Newcastle–Ottawa Scale. [10] (table 4)

– In retrospective studies, the risk of bias is evaluated using the Quality Assessment Tool for Quantitative Studies. [11]

RESULTS

3.1 Trial Flow:

The search strategy resulted in 1342 articles. Respecting all selection phases, based on the eligibility criteria, 5 articles qualified for final analysis. Figure 1 displays the different steps of the articles' selection included in the present systematic review. (Fig.1)

3.2 Study Characteristics and Study Quality:

- **Study Characteristics:**

The selected studies cover a long research period, with the oldest study published in 1964 and the most recent study published in 2022. The number of clinical study participants ranged from 19 to 84, with Study groups cl II malocclusion for the adult and young patients. All of the included studies were published in English (Table 2) and offer a detailed analysis of each article selected for the present systematic review.

- **Study Quality:**

The Newcastle–Ottawa Scale rated the 2 prospective studies as moderate quality (Table 3).

The Quality Assessment Tool for Quantitative Studies rated 1 as moderate and 2 included retrospective studies as low quality (Table 4).

DISCUSSION

In the case of minimal class II molar, an accurate diagnosis should be the determining factor in the choice of the appropriate corrective therapy, i.e. derotation, distalization or a combination of both. With the multitude of methods studied to clinically assess molar rotation including that proposed by Cetlin, and Ricket [1], It seems easy to say that molar rotation diagnosis is simple.

Except that when analyzed in all 3 spatial directions a distal molar relationship, as judged from the buccal aspect, may be the result of both tilting and rotation and therefore not express the position of the longer and more prominent lingual root [17].

In a study by Melsen and Liu of 500 consecutive Class II cases, 73% were Class I or minimal Class II when analyzed from the lingual aspect. [17] In such cases, the distal molar rotation would contribute significantly to the correction of the Class II molar relationship. [18]

A double-blind study by Guitini et al in 2011 revealed that subjects with Class II malocclusion in mixed dentition have a mesial rotation of the upper molars in about 84% of cases.

Thus, correction of molar rotation can provide between 1 and 2 mm of gain in arch length and improvement in molar relationships per side in 5 out of 6 Class II patients. However, these studies remain observational, which led us to systematically search the literature for interventional studies confirming this finding.

During this search, we did not find any clinical or experimental studies comparing the effects of molar derotation versus molar distalization.

The effect of molar derotation on the correction of occlusal cl II has been studied in the laboratory by a few authors. The teams of foresman and invergal revealed these findings: Foresman et al [19] found that, experimentally, the mesiodistal arch space of the upper first molar may increase by up to 2 mm due to mesio lingual rotation.For every approximately 3° of rotation, there will be a 0.25 mm width increase. Invergall et al [20] recommend the use of the transpalatal arch in TMA instead of steel in cases where significant derotation is required. They suggest activating an expansion after the final phase of derotation to compensate for the contraction force that occurs during this movement for both types of arches.

As for the clinical studies, they reveal other findings:

Dahlquist et al. (1996). [13] analyzed the effect of a transpalatal arch alone for molar derotation. They found in their study that the first rotated upper molars can be derotated effectively with a transpalatal arch in a reasonable time (median 122 day); The results of derotation in terms of space gain and mesiodistal movement of the mesiooral cusp of the molar are not predictable. In some cases, significant space gain and distal movement of

the mesiobuccal cusp are achieved. in other cases, the space is lost and the mesiobuccal cusp displaces mesially. Space gained by derotation varied between 0.3 and 0.5.

It should be noted that the transpalate loops were all oriented in the mesial direction, which calls into question the results of the Ney study that recorded, during swallowing,a mesially directed tipping moment on the first molars by a transpalatal arch with a mesially directed loop and a distally directed moment with an arch with a distally directed loop. [21]

In contrast to invergal et al. who found that a derotation is always accompanied by a dental arch retraction, Dalquist et al. found clinically that a small derotation can have the effect of an expansion, whereas a large derotation causes a contraction.[13]. which justifies the recommendations drawn from the laboratory experiments and which prefers to add the expansion movement after clinical evaluation of the final phase of derotation [15]

McDonald et al. (2001) evaluate the effect of maxillary first molar rotation on arch length in patients whose Class II, division 1 malocclusion was treated with a straight-pull headgear. They found that the distal movement was a combination of rotation and distal translation or tipping; High correlations were observed between molar rotation and tooth displacement with a space-saving of 1 mm. A basic implication of these findings is not only the necessity for a distal force to generate the changes in molar rotation and associated differential displacement but the primacy of this force in the model.[14]

According to Hourfar et al 2014, The skeletally anchored ‘Frog’ appliance is an effective appliance in cases where maxillary molars need to be derotated and distalized.

A notable advantage of the use of a skeletal anchorage appliance to create a derotation for, is the ability to prevent mesial displacement [15]. This effect is usually observed when using a traditional trans-palatal archwire [13, 20]. The appliance provides excellent vertical control and can therefore be used safely in patients with hyper divergent skeletal patterns.

Bellini-Pereira 2021 found that in the case of using distalisers for correcting moderate class II molar, rotation is directly affected by the side of force application, whether from the buccal, palatal, or both sides. The three studied appliances are effective in distalising movement. However, In the case of the Jones Jig (JJ), the force applied from the buccal side promoted distal rotation [16]. This is consistent with the study of Shetty et al who found that JJ appliance showed a molar rotation of more than 6 degrees - greater than the rotation provided by the pendulum [22].

A recent study by Roberta Lione et al. 2022, showed that the clear aligner CA effectively produces an arch expansion and upper molars’ distal rotation. Upper molar derotation provides a 1 mm of gain in arch perimeter and occlusal improvement. [4]

According to our review, only two prospective studies and one retrospective study were considered to be of moderate quality [4,13,16]. A true comparison of the effect of derotation with different devices or of the

effectiveness between derotation alone and derotation combined with distalization was impossible due to the lack of comparative studies in this area. The limitations of our results call for further clinical studies to increase the certainty of the evidence found.

CONCLUSION

Our review has shown that there was weak evidence that molar de-rotation can produce a significant molar distalization to correct a minimal Class II cases, however, the analyzed data has suggested the following:

- Derotation could correct a minimal Class II of about 1-2 mm if there is pure rotational movement without mesialization.
- Derotation with a transpalatal arch could provide a space gain of 0.5 mm per side but the direction of mesio-distal displacement of the molars is unpredictable.
- Derotation with a clear aligner could provide a space gain of 1 mm per side and the direction of mesio-distal molar displacement is 60% predictable.
- In moderate occlusal class II, the frog is effective, allowing derotation and distalization without loss of anchorage, and it also provides excellent vertical control. The arch space gain with FROG is 1.9 mm per side. Therefore, derotation combined with distalization with this device could correct moderate occlusal Class II.
- Derotation and distalization of molars may be sufficient to resolve moderate maxillary crowding [15].
- For severe Class II cases, distalization of maxillary molars with a skeletal anchored distalizer or other therapies such as mandibular molar mesialization should be used.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Provenance and peer review

- Not commissioned, externally peer-reviewed.
- Ethical approval
- Not applicable (Systematic Review).

Consent

This is a systematic review of published prospective and retrospective studies research involving human participants. This is an analysis of published cases and did not require informed consent.

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Table (1): Studies were assessed for eligibility based on PICO criteria

Component	**Description**
Population/Problem	Rotated Maxillary molars in class II
Intervention	Molar derotation
Comparison	Molar distalization /Molar distalization and derotation/no intervention
Outcomes	Principal: Amount of distal movement in mm Secondary: -Interfering movements (tipping /anchorage loss/ arch expansion) - Devices used

Table (2): Descriptive Data of Included In vivo Studies

Title/Author/Year of publication / Journal	Study design	Sample: size / initial malocclusion /Age	Intervention type /measurement tool tooth displacement / method measurements of upper molar rotation.	Measured outcomes	Results
1.The effect of a transpalatal arch for the correction of first molar rotation Dahlquist et al 1996 [13] European Journal of Orthodontics	Clinical Prospective study	84 patients, *50 rotated first molar (8-13years) *34 normal occlusion (12 -18 years)	Clinical molar derotation with transpalatal arch Tool: measurement of dental casts before and after treatment with microscope Method: Angle 1 (Friel, 1959) Angle 2 (Henry, 1956) Angle 3 (Orton, 1966) Distance 4 (Ricketts, 1969)	*Direction of molar displacement during rotation movement *Unwanted side effects	*The first rotated upper molars can be derotated effectively with a transpalatal arch * Gain nearly between 0.3 mm 0.5mm per side *Average time (122 day) *The results of derotation in terms of space gain and mesiodistal movement of the mesiooral cusp of the molar are not predictable. Rotated molar move in mesial or distal direction *centre of rotation is not stable varying during derotation *parasite movement varied from 1.2 contraction and 4 mm expanssion *Expansion for small derotation and contraction for large derotation
2.Effect of molar rotation on arch length McDonald et al. 2001[14] Clinical Orthodontic Research	Clinical Retrospective study	19 patients *Class II, division 1 malocclusion *(7 to12 years)	Derotation resulting in Traitement cl II molar with headgear Tool: measurement of dental casts before and after treatment with palatal plug Method: angle Z ((personalised measurement of study)	Gain in mm of arch length from molar derotation	* The distal movement was a combination of rotation and distal translation or tipping. . * Gain nearly 3 mm with 1mm derotation *if both are required it is better to start with the distal force to avoid loss of space earlier *Molar derotation provided 1 mm per side of gain in arch perimeter. *if centre of rotation is distal no loss of space, if it mesial the loss of space is in mesial.
An active, skeletally anchored transpalatal appliance for derotation, distalization and vertical control of maxillary first molars	Clinical single-centre, retrospective study	.43patients a half cusp Class II molar relationship (11 to 13.5 year)	Clinical molar derotation and distalization with frog Appliance +miniscrew in midpalatal area Tool: measurement of dental casts before and after treatment with digital caliper Method: Angular measurement described by Kinzinger et al	Gain in mm of arch length from molar derotation and distalisation and their contribution to correct class II molar	*The skeletal 'Frog' is effective in derotating and distalizing maxillary molars without anchorage loss and with excellent vertical control. *The most of the correction was achieved by derotation *Molar **derotation and distalization** was sufficient to resolve **moderate maxillary crowding**,achieving a Class I

Jan Hourfar et al 2014[15] • Journal of Orthodontics					molar relationship at the end of orthodontic treatment * derotation observed was of about 9 degrees. *bodily posterior displacement **was 1.9 mm**
Sagittal, rotational and transverse changes with three intraoral distalization force systems: Jones jig, distal jet and first class Bellini-Pereira et al 2021 [16] • Journal of Clinical and Experimental Dentistry	Clinical Retrospective study	**59 patients** Class II malocclusion <u>Groupe 1</u> 22 patients treated with the Jones Jig appliance; <u>Group 2</u> 20 patients treated with the Distal Jet, and <u>Group 3</u> 17 patients treated with the First Class appliance. (12 to 13 year)	Clinical molar distalization with three intraoral distalization force systems: Jones jig, distal jet and first class and rotational effect Method: angle of rotation (personalised measurement of study) Tool: OrthoAnalyzerTM software mesuring digitized models.	to compare the maxillary sagittal, rotational and transverse changes of patients treated with three different distalization force systems: Jones Jig, Distal Jet and First Class appliances,	all the appliances tested were capable to perform molar **distalization** effectively with amounts ranging from 2.93 **to 3.71 mm** the Jones Jig, the force applied from the buccal side promoted **distal rotation** Distal Jet appliance applied force from the palatal side **promoted mesial rotation** the First Class group showed distalization without significant rotational effects since **the force was applied from both sides.** It is reasonable to state that molar rotation is directly affected by the side of force application, whether from the buccal, palatal or both sides.
The Efficacy and Predictability of Maxillary First Molar Derotation with Invisalign: A Prospective Clinical Study in Growing Subjects **Roberta Lione 2022**[4] • Applied Sciences	Clinical Prospective Study	– **36 patients** – – Class II edge-to-edge dental malocclusion , – – (9.9 ± 1.9 years)	Clinical molar derotation with Invisalign Clear Aligners (CA). measured in dental Pre-treatment (T1) and post-treatment (T2) digital casts Tool: ClinCheck software Method :Henry's angle (HA)	Gain in mm of arch length from molar derotation Predictability of derotation with clincheck software	*CA is an effective tool for upper distal molar rotation with an observed 60% predictability. *Molar derotation **provided 1 mm of gain in arch perimeter**. * derotation observed was of about 6 degrees. *6 ° of derotation provide 1mm of space

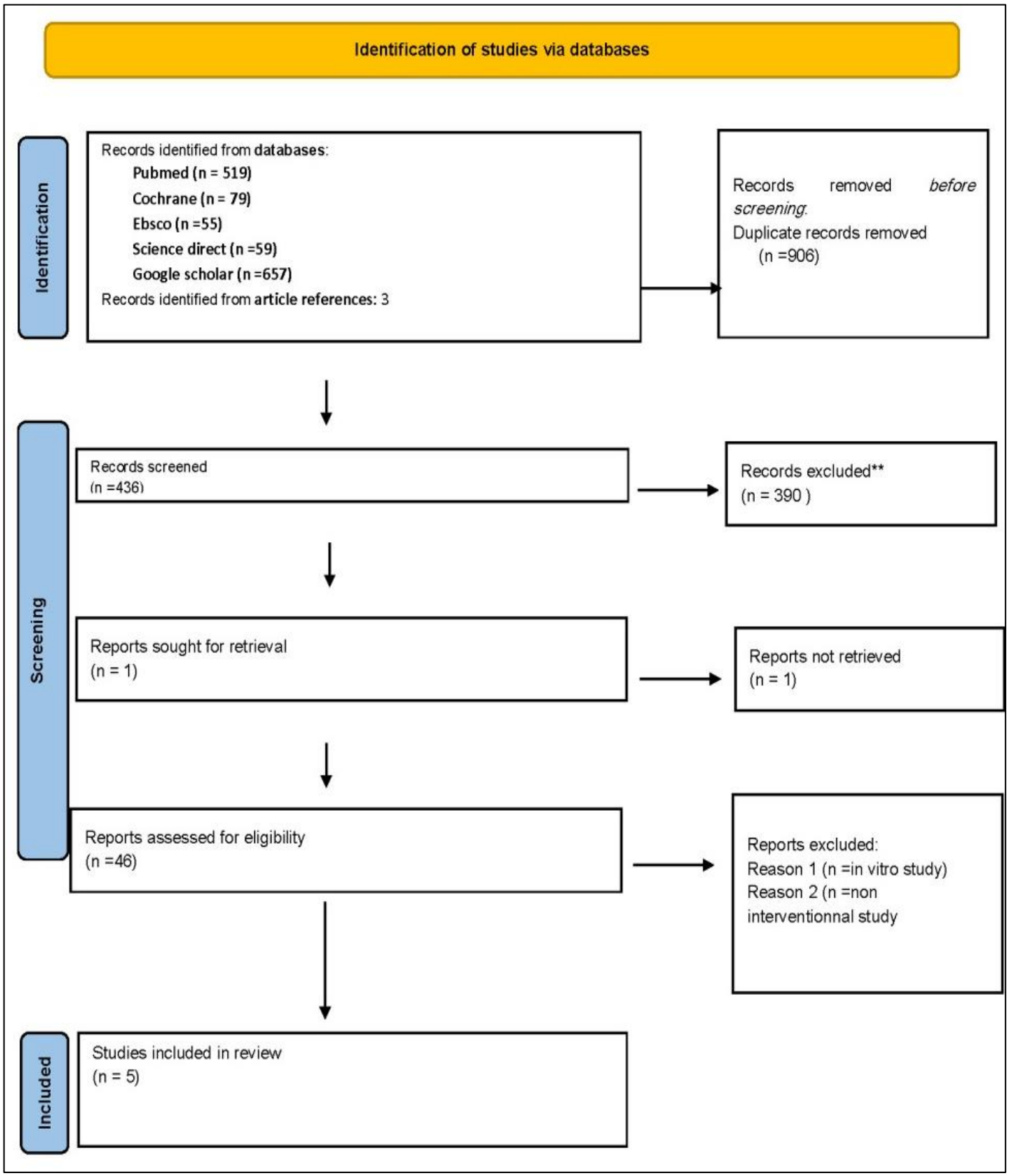

Figure (1): The selection process is illustrated in the Flowchart

*Consider, if feasible to do so, reporting the number of records identified from each database or register searched (rather than the total number across all databases/registers).

**If automation tools were used, indicate how many records were excluded by a human and how many were excluded by automation tools.

Table (3): Risk of Bias Assessment of Included Prospective Studies Using the Newcastle–Ottawa Scale

Quality Evaluation	Roberta Lione et al. 2022 [4]	Dahlquist et al. 1996 [13]
Selection – representativeness of molar derotation group – selection of control group – ascertainment of molar derotation group – demonstration that outcome of interest not present at the start of study	 * - * *	 * * - *
Comparability – comparability of participants in treatmentgroups and control groups	 _	 *
Outcome and follow-up – assessment of outcome with independent blinding – adequacy of follow-up – Lost to follow-up acceptable (,10% and reported)	 – * –	 * * –
Total quality score	4 Fair	6 Fair

Table (4): Risk of Bias Assessment of Included retrospective Studies Using Quality Assessment Tool for Quantitative Studies, developed for the Effective Public Health Practice Project (EPHPP)

STUDY	Risk Assessment Criteria						
	Selection Bias	Study Design	Confounders	Blinding	Data Collection Method	Withdrawals/ Dropouts	Overall Grade
McDonald et al 2001[14]	M	M	W	W	S	W	W
Jan Hourfar et al 2014[15]	M	M	W	M	S	W	W
Bellini-Pereira et al 2021[16]	M	M	S	M	M	W	M