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Mandibular Incisor Extraction in Orthodontic Treatment: Evidence from a Systematic Review

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ABSTRACT

Extraction is still a contentious and interdisciplinary decision in orthodontics. In certain situations, knowing the relapse rate and treatment results is crucial. However, more research is required to evaluate the efficacy of mandibular incisal extraction (MIE) as a substitute therapy option for patients who are not growing. According to the PICO criteria, this research was conducted in response to a specific focus question: "Is mandibular incisor extraction a common choice in orthodontic treatment planning to resolve the crowing among non-growing patients?" According to the PRISMA criteria, keywords were employed in the data selection procedure. Between 2015 and 2020, human research with MIE in non-growers of both sexes that was published in high-impact, English-language journals was taken into consideration. However, due to stringent inclusion criteria, case reports, systematic reviews, opinions, survey-based cross-sectional research, and studies that were irrelevant to the current investigation were excluded from the many electronic databases "Google Scholar, Pubmed, Clarivate, Cochrane Library, and Saudi Digital Library." After removing duplicates, 1668 of the 6273 studies that were found were registered. Following a review of the abstract and title, 1653 was removed for a variety of reasons. Only eight articles were selected following a qualitative evaluation out of the fifteen that were read throughout the entire test. One reviewer warned of the possibility of bias because all of the evidence presented was level I and II. There was substantial consensus that skeletal class III camouflage and mandibular crowding were the most common signs of MIE. Regarding post-treatment recurrence, there was an ambiguous association between MIE and premolar extraction.

Keywords: Mandibular incisor, Extraction, Bolton discrepancy, Orthodontics, Review

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Introduction

Clinical observations and scientific studies have been conducted on the extraction of one or more teeth in orthodontics to achieve functional, harmonic, and normal occlusion [1, 2]. Additionally, the goal of orthodontic extraction is to create space in the arch to address crowding or proline teeth. It is still debatable whether or not to extract teeth for orthodontic therapy, and it is impossible to correct every malocclusion without doing so [3]. It takes a multidisciplinary decision to remove teeth for orthodontic therapy. According to Edward H. Angle, "moving teeth into normal occlusion with orthodontic forces would cause the jaws and associated bones to grow to accommodate the increase in size of the dentures" (1907) Calvin Case, on the other hand, held a different view regarding the stability of orthodontic therapy without the need of removal, which was rarely accomplished. Practitioners noticed that many non-extraction therapy cases began to relapse in the 1930s [4].

First premolars in the maxillary and mandibular jaw can be extracted for Angle class I with crowding, protrusion, or open bite; moreover, the first maxillary premolars can be extracted for Angle class II; additionally, the first maxillary premolars and second mandibular premolars can be extracted for Angle class II with excessive overjet

or crowding; and finally, the first lower bicuspids can be extracted for Angle class III. The extraction sequence for each type of malocclusion varies based on the patient's acceptance and the case [5].

Regarding the mesiodistal size of teeth in dental arches, Wayne A. Bolton has established a correlation that affects the interaction between the maxillary and mandibular jaws [6]. A perfect occlusion has long been regarded as the gold standard for evaluating the results of orthodontic treatment. However, the orthodontist should take into account each patient's aesthetic demand, stability, desired occlusion, and treatment objective before making a good treatment decision [1].

In numerous case studies, mandibular incisor extractions (MIE) are discussed as an orthodontic procedure to address crowding [7]. They fall short, nevertheless, in the auxiliary studies of prospective and/or retrospective cohort studies and high-quality randomized and/or nonrandomized clinical trials. The goal of the current systemic review was to thoroughly evaluate the body of research on MIE's efficacy as an alternative orthodontic treatment while being aware of its results, recurrence rate, and significance in certain situations.

Materials and Methods

Eligibility criteria

Included were high-impact journal publications about MIE in people that were published in English only between 2015 and May 2020. Included were randomized and nonrandomized therapeutic trials, as well as prospective retrospective cohort studies, with a mean age group of non-growing patients in both sexes **(Table 1)**. All of the eliminated studies were justified by the following reasons: they didn't fit our age group requirements, case reports, opinions, systemic reviews, cross-sectional survey-based research, or goals unrelated to the current investigation **(Figure 1)**.

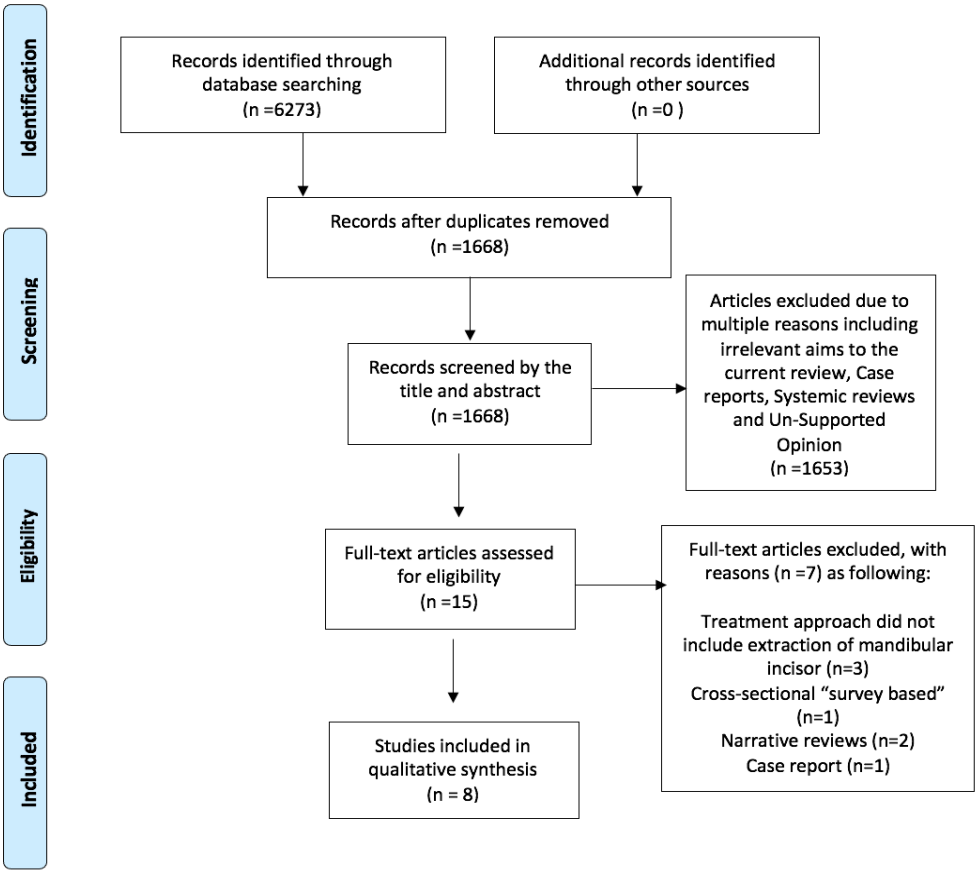

Figure 1. The PRISMA flow diagram

Information sources, search strategy, and study selection

Upon receipt of ethical approval from Riyadh Elm University's IRB committee (SRS/2020/8/189). The Cochrane Library, Clarivate, Saudi Digital Library (SDL), PubMed, and Google Scholar were the five electronic resources

that were searched. **Figure 1** illustrates how the search strategy for data selection adhered to the PRISMA approach.

Following a specific focus question based on the PICO criteria, the search was conducted in two phases: "Is mandibular incisor extraction a common choice in orthodontic treatment planning to resolve the crowding among non-growing patients?"

In the first stage, the following keywords were included: (Extraction of mandibular incisors), (Orthodontic mandibular incisors), and (anterior crowding).

Then in the second stage, (Bolton discrepancies) were added, since we noticed a lack of literature covering that concerning mandibular incisor extraction, and to prevent any limitation in review outcomes.

Data items and collection

One reviewer (the first author) collected the data and, following the final evaluation of the complete text (n = 15), independently assessed the papers' methodological quality. Consequently, as indicated in **Table 1**, each of the eight final articles was applied separately to meet our eligibility requirements.

Table 1. Review eligibility criteria

Criteria	Inclusions	Exclusions
Type of study	In human studies Randomized and nonrandomized clinical trials Prospective and/or retrospective cohort studies.	Animal studies Case reports Systemic review Survey-based cross-sectional studies The unsupported opinion of the expert or replies to the author/editor Books/conferences/abstracts
Sources	Journal high impact factor	Low-quality level studies
Year of publication	From 2015-May 2020	Published papers before 2015
Language	English language	Other languages
Age group	The average age of non-growing patients.	Growing patients
Dentition	Permanent dentition	Primary dentition
Treatment protocol	Mandibular incisor extraction in comparison to other treatment modalities.	Extractions of any other teeth, expansion, interproximal reduction (IPR), and/or distalization alone
Cases	Moderate and/or Severe discrepancy/Crowding	Spacing Open-bite Crossbite and other skeletal problems
Intervention	Conventional orthodontic appliances and/or clear aligners	Orthognathic surgical procedures
Outcome measures	The primary outcomes were measured in dentoalveolar and soft tissue correction, including clinical, study model, and/or radiographical measurements and the duration of treatment.	3D radiography

Summary measures and approach to synthesis

One impartial reviewer used a well-designed quality assessment technique (The Cochrane technique) to evaluate the quality of the eight final papers for risk of bias. By analyzing and evaluating sample selection, performance, outcome assessor detection, attrition, and reporting, sampling bias was evaluated. **Table 2** enumerates the primary methodological points of the eight papers, whose overall score ranges from low to moderate bias risk.

Table 2. Criteria for judging the risk of bias in the 'Risk of bias' assessment tool – reproduced from the Cochrane tool

Bias Type	Bias	Kaya *et al*., 2015	Mahmoudzadeh *et al*., 2018	Lee *et al*., 2019	Kamal *et al*., 2017
Selection	Random sequence generation	Low	Low	Low	Low
	Allocation concealment	Unclear	Low	Low	Low
Performance	Blinding of personnel and participants	High	Unclear	Unclear	Unclear
Detection	Blinding of outcome assessors	Unclear	High	High	High
Attrition	Incomplete outcome data	Low	Low	Low	Low
Reporting	Selective reporting	Low	Low	Low	Low
Overall assessment		Moderate	Low	Low	Low
Bias Type	**Bias**	**Vilhjálmsson *et al*., 2019**	**Antoszewska-Smith *et al*., 2017**	**Khan *et al*., 2017**	**Suleman *et al*., 2018**
Selection	Random sequence generation	Low	Low	Low	Low
	Allocation concealment	Unclear	Unclear	Unclear	Unclear
Performance	Blinding of personnel and participants	Unclear	Unclear	Unclear	Unclear
Detection	Blinding of outcome assessors	High	Unclear	Unclear	Unclear
Attrition	Incomplete outcome data	Low	Low	Low	Low
Reporting	Selective reporting	Low	Low	Low	Low
Overall assessment		Moderate	Moderate	Moderate	Moderate

The following criteria were used to determine if the risk was uncertain, high, or low: 1. Unfinished result data: attrition bias brought on by the quantity, kind, or treatment of unfinished outcome data. 2. Selective reporting: bias in reporting due to selective reporting of results. 4. Blinding of outcome evaluation: bias in detection caused by outcome assessors' awareness of the therapies that were assigned 3. Blinding of participants and staff: performance bias brought on by participants and staff's awareness of the assigned interventions 2. Selection bias (biased allocation to interventions) due to insufficient assignment concealment before evaluation is known as allocation concealment. 1. Random sequence generation: insufficient randomized sequence generation leads to selection bias (biased allocation to interventions).

Results and Discussion

6273 studies were found through the literature search. Once the duplicates were eliminated, 1,668 studies were registered. After reviewing the abstract and title of the acquired material, 1653 were removed for several reasons: irrelevant study objectives, case reports, systemic reviews, viewpoints, or cross-sectional studies based on surveys. After reading the complete texts of fifteen papers, eight were selected based on a qualitative evaluation that met stringent eligibility requirements. The remainder are listed numerically in the " PRISMA Flow Diagram" **(Figure 1)**. Two retrospective studies, four retrospective and cross-sectional studies, and two descriptive, retrospective, and cross-sectional studies were among the final eight publications. The control group consisted of a single article. The articles' data were taken from groups of interest.

Table 3. Characteristics of included studies. NA: Not Applicable, MIE: Mandibular incisor extraction, PAR: Peer Assessment rating, PME: Premolar extraction, NE: Non-extraction

	Sample size	Method

	1
Authors	Kaya, B *et al*., 2015
Study type	Retrospective study
Setting	Department of Orthodontics, Başkent University
Age characteristic	N=32 (18F/14M) Group 1: 16 patients (9F/ 7M) mean age 20±4.6 years; treated with 1 mandibular incisor extraction. Group2: 16 patients (9F/7M) mean age: 19.4±3.4 years; treated with four first premolar extractions
Controls	None
Parameters measured	Maxillary space analysis, mandibular space analysis, maxillary irregularity, mandibular irregularity, Bolton excess in the mandible and dental, skeletal, and soft tissues. Cephalometric between- and within-group comparisons.
Treatment appliance used	Orthodontic treatment with 0.022×0.018-inch slot edgewise appliances. Duration: Group1: 18.3 ± 4.2 months Groups 2: 25.0 ± 5.6 months treatment time was significant
Retention	NA
Post-retention	NA

2	Mahmoudzadeh, M. *et al*., 2018	Retrospective cross-sectional study	Hamedan University of Medical Science, Hamedan, Iran	N=120 (99F/21M) Group 1:40 patients treated with single mandibular incisor extraction (31F/9M) mean age 21.62±4.7 group 2:40 patients treated with No extraction (33F/7M) mean age 24.87±6.3 group 3:40 patients treated with Premolar extraction (35F/5M) mean age 22.9±5.8	None	Post retention impressions were obtained from the patients and the casts were compared in 3 times: before the treatment, after the treatment, and ≥2 years after retention with a mean of 3.5 years	Treated using MBT prescription straight wire appliance (slot size of 0.028×0.022 inches)	74 (61.7%) using Hawley retainers, and 46 (38.3%) using clear retainers. Duration: Single extraction group: 8.6± 4.9 Non-extraction group: 7.2 ±4.1 Premolar extraction group: 8.4 ±5.1	Duration: Single extraction group: 3.35±0.9 Non-extraction group: 3.5 ±2.13
3	Lee, S *et al*., 2019	Retrospective cross-sectional Study	The University of Otago.	N=14 (5F/9M) Treated with mandibular incisor extraction. Mean age 16.0 ± 4.4 years Treatment duration of 19.5 ± 6.4 months	N=14 (9F/5M) treated without extractions Mean age 15.8 ± 3.9 years Treatment duration of 18.0 ± 4.4 months	Clinical history(pre- and post-treatment study casts, intraoral photographs, and wax setups) of those undergoing orthodontic postgraduate students	Full fixed appliances	NA	NA

4	Kamal, A.T *et al.*, 2017	Retrospective cross-sectional study
	Dental clinics at AgaKhan University Hospital, Karachi, Pakistan.	
	N:108 patients Group 1:36 patients treated with premolar extractions with a mean age of 19.2 ± 3.6 years. Group2: 36 patients treated with no extraction with a mean age of 18.9 ± 4.1 years Group3: 36 patients treated with 1 mandibular incisor extraction with a mean age of 19.0±2.3 years	
	None	
	The PAR index was used to assess the pre-and post-treatment dental casts for each of the subjects.	
	Orthodontic treatment with the straight-wire appliance 0.022 ± 0.028-in Roth prescriptions in both arches	
	NA	
	NA	
5	Vilhjálmsson, G *et al.*, 2019	Retrospective study
	The University of Connecticut or 6 private practices	
	N:37 patients (25F/12M) and the age of the patients is Age<20years, 25 patients Age 20-40 years, 9 patients Age>40 years, 3 patients.	
	None	
	Effectiveness and treatment time of the treatment.	
	Comprehensive orthodontic appliance and extraction site preparation	
	In one case of the 37 patients, retention was mentioned in case1. Bonded retainers	
	In one case of the 37 patients, post-retention was mentioned in case 1. 4-year recall, with excellent stability.	

6	Antoszewska-Smith, J *et al*., 2017	Retrospective cross-sectional study	Department of Dentofacial Orthopedics and Orthodontics and Department of Prosthodontics, Wroclaw Medical University, Wroclaw, Poland	N=302 patients Group 1: Less than 3mm dentoalveolar-discrepancy treated with the dental arch expansion, 100 patients Group2: From 1 to <5mm dentoalveolar discrepancy treated with interproximal enamel reduction, 101 patients Group3:>5mm dentoalveolar discrepancy treated with extraction of 1 lower incisor, 101 patients	None	Assessment of the reliability of Little' s Irregularity Index and establishing an effective algorithm for the treatment of adult patients with crowding in the mandibular front area.	Group1: dental arch expansion Group2: interproximal enamel reduction Group3: 1 lower incisor extraction	The lowest value of retention was found in group 1 and the highest was found in group 3	After one year of retention, there was a major relapse occurred following expansion (group1) and after interproximal enamel reduction (group 2).
7	Khan, W.U *et al*., 2017	Descriptive, retrospective cross-sectional	Department of Orthodontics, Islamabad Dental Hospital.	N=916 Group1:10-15 years Group2:16-20 years Group3:21-25 years Group4:26-30 years Group5:31-35 years	None	Prevalence of crowding, frequency, and pattern of extraction	Different pattern of extraction	NA	The post-retention alignment was more favorable in single-incisor (71%) and two-incisor (44%) extraction cases as compared to premolar extraction cases (30%).

8	Suleman, S *et al.*, 2018	A descriptive, retrospective cross-sectional study	Department of Orthodontics, Islamabad Dental Hospital.	N=92 (43F/49M) the mean age of patients was 20 years	None	The frequency of various indications for mandibular incisor extraction	NA	Greater stability in the anterior region has Been reported after mandibular single incisor extraction	The extraction of lower incisor has a great post treatment stability

To alleviate crowding in orthodontic patients who are not growing, this systematic review evaluated a variety of MIE literature types, taking into account the patients' profiles, recurrence rates, long-term stability, and aesthetic outcomes. As a result, MIE and its results were taken into consideration in addition to various treatment techniques such as premolar extraction, interproximal reduction (IPR), and non-extraction types of arch extension. The fact that all of the papers in this publication offered level I and II evidence is regarded as a significant strength. The complete quality evaluation is referenced in **Table 2**.

The topic of mandibular incisor extraction, which corresponds to the current systematic review's focus question, was covered in all eight articles. Four lower incisor extractions were described [8-13]. In terms of the results of premolar and mandibular incisor extraction, three were contrasted [14-16]. In addition to varied treatment modalities, such as IPR and dental arch extension, two displayed different extraction patterns and MIE [10, 17]. The data collected from the included studies is shown in **Table 3** and includes the following: study type, post-retention, parameters measured, author, year, setting, sample, retention, treatment appliance used, and level of evidence.

Cephalometric measurements, analysis, and abnormalities of the maxillary and mandibular spaces, mandibular Bolton excess, and skeletal, dental, and soft tissue were all compared by Kaya *et al*. [14]. Therefore, in situations when localized therapy is required with minimal alteration to the dental arch, mandibular lower incisor extraction may be a more conservative option than four premolar extractions. The study failed to disclose the relapse rate of both therapies, even though it demonstrated that there were no significant sagittal skeletal changes at the end of either treatment and that the overjet and overbite remained unaltered [14].

Nonetheless, a study that looked at the long-term stability of three different treatment approaches in lowering mandibular incisor crowding at three different intervals—before treatment, following active treatment, and ≥ 2 years after retention with an average of 3.5 years—found a range of outcomes. They discovered that there was no significant relationship between various treatment modalities and post-treatment relapse and that crowding relapse was evident in all therapies [15].

Gısli Vilhjalmsson *et al*. shed light on significant objectives that concern the dentist while following this approach; black triangles, tooth discrepancies, and patient concern about the visible site of extraction. They described how to avoid those challenges by simply lingually tilting the mandibular incisor before extraction. The success rate for patients under 20 who had no black triangles before treatment was about 100%. Even though this study was limited to the Icelandic population and did not include other populations, the treatment term could be extended by two to six months using this method. Black triangles show periodontal disease, therefore including multiple populations with a history of poor oral hygiene could change the results [9].

Several studies evaluated the dental casts before and after treatment modalities using the Peer Assessment Rating (PAR) index, which is regarded as a valid and dependable instrument in orthodontics [8, 16]. Despite its

shortcomings, the PAR index did not take into account soft tissue profiles, functional occlusion, periodontal and tooth health, patient satisfaction, or cephalometric alterations [4].

Sherry Lee *et al*. assess the treatment attractiveness of MIE cases with non-extraction controls by examining clinical records, intraoral photos, and wax setups before and after treatment. The findings showed that, in properly chosen situations, mandibular incisor extraction may produce appropriate results that are as appealing as those managed without extraction, and that the study benefited from a longitudinal review [8]. Antoszewska-Smith *et al*. [10] assessed the reliability of Little's Irregularity Index and established an effective algorithm for the treatment of adult patients with crowding in the mandibular front area [10, 18].

The frequency, pattern of extraction and prevalence of crowding were ascertained by Waheed Ullah Khan *et al*. [17]. Numerous factors, including patient compliance, appliance selection, and treatment management to achieve a functional, stable occlusion and aesthetic result, might affect orthodontic treatment planning and tooth extraction. Improved appearance, edge-to-edge occlusion, ectopic eruption, open bite and crossbite of anterior teeth, periodontally compromised incisors, lower anterior crowding or protrusion anomalies in number and size, class III malocclusion, class I malocclusion with anterior tooth size discrepancies and severe mandibular anterior segment crowding, and for Class II The primary causes for mandibular incisor extraction are overjet and the restoration of normal occlusion, which should be accomplished in conjunction with maxillary premolar extraction [9, 11, 14-17, 19, 20].

Additionally, MIE contraindications include triangular-shaped mandibular incisors, profound overbite, periodontal disorders, and extra anterior maxillary tooth size [19]. One MIE has the following benefits: preserving the overall arch shape, cutting expenses, reducing anterior area relapse, and minimizing profile change and treatment duration [8, 11, 14, 16, 21, 22]. However, before deciding to remove the mandibular incisor, elements including clinical expertise, diagnostic wax setup, and initial records should be taken into account [23].

However, the drawbacks include acceptable aesthetics, midline discrepancy, shade differences between neighboring teeth, increased interdental gingival papillae loss, crowding recurrence, space reopening, unpleasant posterior occlusion, and overbite in the mandibular anterior region. An increase in the overjet will occur if there is no Bolton disparity [8, 14, 17, 21].

Conclusion

Several conclusions can be drawn on the indications and different impacts of MIE as an alternative for orthodontic purposes.

Significant consensus was reached on the most common signs of MIE in moderate to severe mandibular anterior crowding. Additionally, skeletal class III cases with a slight anterior crossbite were camouflaged, mostly when there was an excellent posterior intercuspation.

Regarding the post-treatment recurrence rate, there was an ambiguous association found between MIE and PME. However, several studies suggested that MIE might be a more conservative and successful option than PME when little dental arch modifications and therapy are needed, especially in adults.

Furthermore, the major problems with MIE are black triangles (that are caused by loss of interdental papilla height), tooth size discrepancy, and patient concern about the visible site of extraction. This was simply solved by lingual tipping of the mandibular incisor before extraction. To achieve optimal aesthetics, functional, and stable occlusion, as well as appropriate treatment management with outstanding patient compliance, clinicians should be aware of the factors that influence the decision to extract teeth in orthodontic cases.

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