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REVIEW

Minimally invasive intraoral removal of mesiodens via a transnasal, non-endoscopic approach: a systematic review on the purpose of 10 cases

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Abstract
Mesiodens, which emerge towards the nasal cavity, often require consultation in maxillofacial practice. Typically accessed through wide palatal flaps with ostectomy, this method involves limited visibility and poses the risk of damaging the roots and apex of adjacent dental structures. This study advocates a minimally invasive technique that involves vestibulotomy between the central incisors, facilitating direct and rapid access through nasal floor dissection, minimizing comorbidities. A systematic review was performed, following the PRISMA guidelines, apropos on ten clinical cases reported in this study. The MEDLINE/Pubmed and Web of Science databases were searched. Several variables were considered and are presented comprehensively in tables and figures. Additionally, 10 case reports with mesiodens in the maxilla were submitted to surgical treatment using a minimally invasive intraoral transnasal disinclusion. The initial literature search resulted in 37 articles, of which 9 met the inclusion criteria for the analysis. Regarding postoperative complications, no bone exposure, incisor root damage, extensive surgical approach, palatal or vestibular hematoma, or palatal necrosis was observed. However, 10% experienced superficial damage to the nasopalatine neurovascular, while 80% and 20% presented mild and moderate postoperative facial edema, respectively. Hypoesthesia in 20% of patients recovered in the first week, 40% in the first month and 40% at 3 months. The minimally invasive intraoral, transnasal, non-endoscopic approach emerges as a safe and predictable alternative to conventional surgical techniques. Presumes minimal postoperative complications, mitigating the risk of excessive bone removal and damage to adjacent structures.

Keywords Systematic review · Supernumeraries · Mesiodens · Oral surgery · Transoral approach · Transnasal approach

Introduction

Supernumerary teeth (DS) are defined as teeth or structures similar to them, which may or may not erupt and may numerically exceed 20 and 32 primary and permanent teeth, respectively [1–4]. They are an anomaly in the development of the pattern and morphogenesis of the dental support areas of the jaws [1]. There are similarities between morphology and common dentition in some cases [3].

DS are classified according to their morphology as conical, tuberculate, supplementary, or in some cases odontogenic tumours such as an odontoma. They may affect a single tooth or several; be unilateral or bilateral; rash or impact; and uni- or bimaxillary [1–6]. They may also be classified according to their location into mesiodens, paramolar, and dystomolar, and may also have vertical, inverted, or transverse orientation [6].

The occurrence of DS may be described as an abnormal developmental event or as related to syndromes such as cleidocranial dysplasia or Gardner Syndrome, among others [1–3]. Some alterations during embryogenesis and the early stages of dental development may lead to the formation of supernumerary teeth [7] however, their aetiology is

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uncertain. There is currently no evidence to indicate the timing and pattern of supernumerary tooth formation. Several hypotheses have been proposed to explain their origin and development, including atavism, dental yolk dichotomy, dental lamina hyperactivity, embryological aberrations, theory of the zone of progress, unified aetiology, and hereditary genetic factors [1–5, 7]. DS have a prevalence ranging from 0.4 to 3.0% [4]. Studies have reported DS to be more frequent in men than in women [2–6]. They are located in the maxilla [4, 6] with a range of 67–97% [6]. Its prevalence is between 0.2% and 0.8% in temporary dentition and between 0.5% and 5.3% in permanent dentition [2, 5–7].

In permanent dentition, DS can cause dental anomalies such as diastema, impaction, rotated permanent teeth (adjacent to the DS), delayed eruption, ectopic eruption, crowding, periapical resorption of permanent teeth, and formation of inflammatory follicular cysts [2, 3, 6].

DS are found mainly as radiographic findings in clinical practice [5]. Clinical and imaging examination is crucial for the detection of DS. Conical beam computed tomography (CBCT) has been introduced as a complementary diagnostic method, enabling a complete preoperative examination which accesses the precise characteristics and adjacent structures more reliably. It is currently the gold standard in three-dimensional imaging; however, other methods such as periapical and occlusal radiography are still used according to the literature [6].

Treatment of patients depends on the type of DS, position, and possible expected complications based on location and adjacent anatomical structures [3, 5]. Options can range from conservative management to surgical removal of the tooth [5]. However, there is no consensus on when the best time is to extract SDs [3, 6].

The approaches currently used have several advantages and disadvantages. They include the crevicular vestibular flaps, crevicular palatines, palatines with discharge, vestibular bottom, and mixed [8].

Mesiodens, these are defined as supernumerary teeth located in the midline of the maxilla, between the central incisors, and they are the most prevalent type of DS [2, 3, 5, 8, 9], affecting 0.15–1.9% of the general population [7]. They are frequently found in mixed dentition with an incidence rate of 0.6–1.7%, and are the most common paediatric malformation. Mesiodens occur more frequently in men than in women with a ratio of 1.7:1 to 3.1:1 [8]. Most mesiodens (75%) are impacted, usually in the palatal direction. The rest are partially or completely erupted to the oral cavity. In some cases, the crown of the impacted mesiodens may be located towards the base of the nasal cavity in an inverted position, which may be related to the base or nasal septum. Removal of mesiodens in the inverted position is usually performed through the palatal intraoral approach; the vestibular approach is also used in cases where the crown or root of the mesiodens is in a ventral position to the roots of the superior incisors [9].

The traditional vestibular and palatal approaches used in the removal of impacted mesiodens with the crown oriented deep towards the nasal floor are usually accompanied by important complications, such as haemorrhage or sinus orocosal communication, among others [10].

Removal via an intraoral transnasal vestibular approach is the optimal treatment for mesiodens located in the nasal cavity. There are also alternatives such as the endoscopically assisted transnasal approach, which is recommended by some authors for the removal of supernumeraries located towards the nasal cavity, and even those located below the nasal mucosa [9]. This procedure seeks to optimise and minimise the comorbidities associated with removal. The aim of this study is to compare the minimally invasive intraoral non-endoscopic transnasal removal technique with other techniques reported in the scientific literature.

Materials and methods

Systematic review

Study design

A systematic literature review was performed according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. The research question used was “What minimally invasive intraoral transnasal surgical techniques without endoscopic assistance are described in the literature for the removal of mesiodens supernumerary teeth?”.

Eligibility criteria

Eligible studies were full-texts describing human patients who were diagnosed with at least one supernumerary nasal tooth or tooth close to the nasal cavity in the anterior area of the upper jaw, who must have undergone surgical intervention to remove the mesiodens transnasally. We included cohort, clinical trials (randomised or non-randomised), prospective, comparative, retrospective, case series, case reports and technical notes, with no restrictions on the year of publication, follow-up time, and language of publication. Animal studies were excluded, as well as narrative reviews, systematic reviews, and in vitro studies. In addition, studies describing supernumerary mesiodens not related to the nasal cavity or another area of the maxilla, and surgical approaches other than the transnasal intraoral route, were excluded.

Information sources

To identify potentially relevant articles, the bibliographic databases MEDLINE/Pubmed and Web of Science were searched. In addition, articles were found in other sources of information. Three authors conducted the search independently between November 10 and 17, 2023.

Search strategy

In accordance with the protocol described, an electronic search was carried out according to the selected databases. The search key used was "(((“Nose“[Mesh]) AND “Mouth“[Mesh]) AND “Tooth, Supernumerary“[Mesh]) NOT “Endoscopy“[Mesh])", which was adapted to each database. In addition, a search with free and manual terms was carried out individually.

Article selection

The selection of articles was conducted independently by three reviewers. The main data was exported to the Mendeley reference manager. The three reviewers independently analyzed the titles and abstracts and identified the articles eligible for full review. The disagreements were resolved by consensus and discussion by the three reviewers together with a fourth reviewer who acted as judge to resolve the disagreements generated.

Data extraction

According to the data collection and extraction of each of the studies included, several variables were considered, which were tabulated in the Microsoft Excel platform, presented in detail in the form of tables and figures.

Risk of bias

In this study, no bias analysis was performed because most of the articles studied are clinical cases or case series, so a high risk of bias is assumed.

Case series

Ten clinical cases of children and adolescents diagnosed with mesiodens included in the maxilla were reported in private practice between 2011 and 2023. The demographics of the patients, type of mesiodens, and the surgical technique used for their removal were extracted. Informed consent was signed for the use of patient information and photographs. The identity of the patients remained anonymous according to the ethical principles of the Declaration of Helsinki.

All cases were treated by the same surgeon. Diagnosis and examination under CBCT was performed before surgery (Fig. 1). The CBCT was processed in software for analysis, obtaining a multiplanar reconstruction and 3D reconstruction images. The images were observed at multiple angulations to evaluate the relationship between the axial position of the mesiodens and adjacent teeth or dental germs and their relationship with the nasal cavity.

The surgical treatment plan for all selected cases consisted of a minimally invasive intraoral transnasal removal. The procedures were performed in the central ward under general anaesthesia with orotracheal intubation. Local anaesthetic lidocaine 2% was infiltrated with epinephrine 1:100,000, both vestibular and nasal floor mucosa. The surgical approach involved a vestibular access with an extension of up to 1 cm over the apices of the central incisors, widening towards the labial mucosa so as not to damage the adhered gum. Subperiostic dissection was then performed in the nasal spine and part of the ascending process of the maxilla delimiting the nasal lateral wall. Following this, a careful dissection of the nasal floor mucosa was performed: it was carefully separated with nasal valves and a rotating mechanical instrument with irrigation was used for conservative osteotomy to expose the crown or root of the mesiodens (Fig. 1A).

Removal of the mesiodens was performed through the bone window provided by the surgical approach. The supernumerary tooth was extracted by blunt instrument. If necessary, haemostasis materials were available. Subsequently, the primary closure of the vestibule was performed, opposing the tissues linearly, using 4 – 0 vicryl suture with a discontinuous or simple stitch (Fig. 1C).

The surgeries were performed without complications. The patients were discharged on the same day of the procedure. Clinical and radiological follow-up was performed 1 month, 3 months, 6 months, and 1 year after surgery.

Results

Systematic review

During the initial identification process, 37 potential articles were found for review, of which three duplicates were removed from the databases. Thus, 34 publications underwent an in-depth review of the title and abstract, resulting in a total of 33 potential manuscripts being selected for full-text evaluation. When applying the exclusion and inclusion criteria, 23 articles were excluded; nine articles were therefore considered for analysis (Fig. 2).

Of the articles included, one is a prospective cohort study, seven are case reports, and one is a case report and

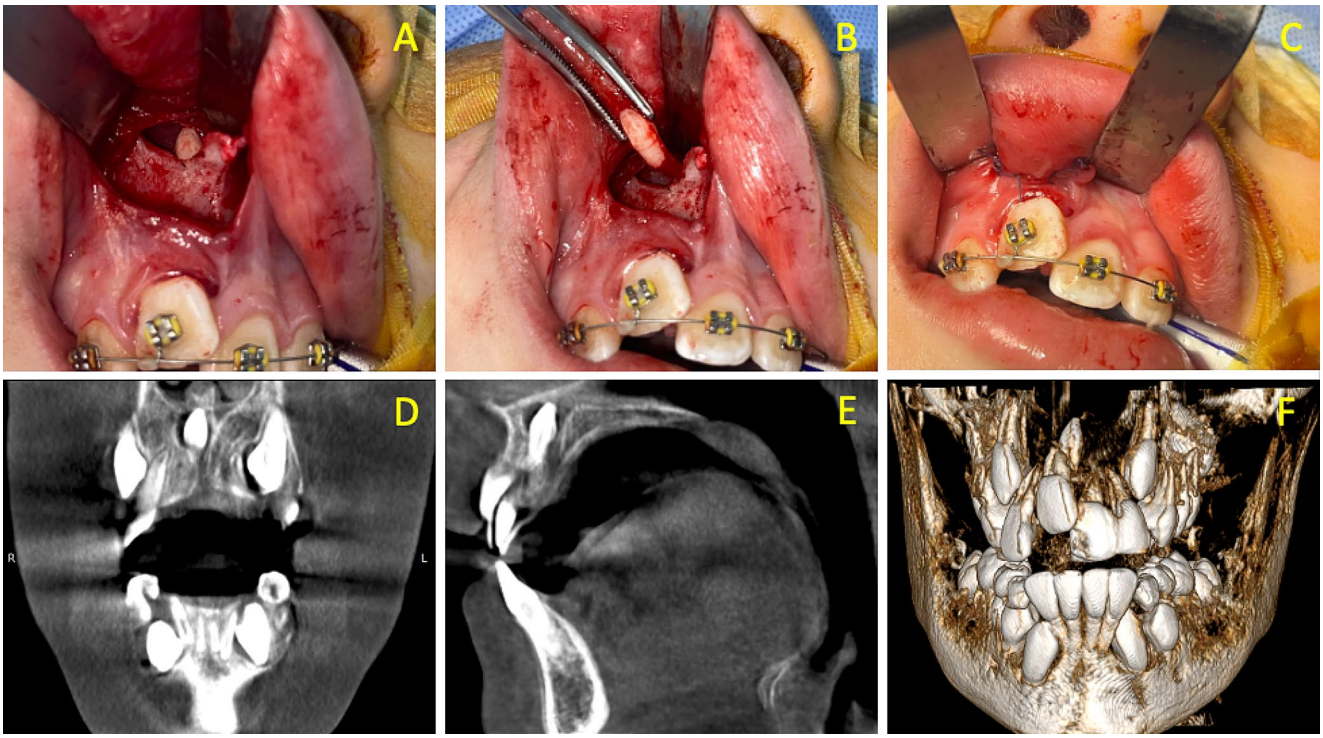

Fig. 1 Minimally invasive intraoral transnasal approach. (**A**) Access with bone, nasal floor, and mesiodens exposure. (**B**) Mesiodens removal through the bone window. (**C**) Linear closure by first intention with discontinuous or simple stitch. (**D**) and (**E**) Preoperative imaging examination: CBCT coronal (**D**) and sagittal sections (**E**), illustrating the midline position of the mesiodens in the maxilla. (**F**) 3D reconstruction

literature review. The articles included a total of 21 patients who underwent mesiodens removal through a transnasal intraoral approach. The demographic and descriptive data of the patients along with the description of the surgical technique are described in Table 1.

Case series

Of the 10 patients included in this study, 40% were male and 60% female, with a male-to-female ratio of 3:2. The age range of these patients was 9 to 13 years, with a mean age of 11 years. The age prevalences were: 9 (10%), 10 (30%), 11 (20%), 12 (30%) and 13 (10%) years of age. All of the patients included are of Chilean nationality; among these, 50% had mixed dentition in the first phase, 30% mixed dentition in the second phase, and 20% had permanent dentition.

The position, orientation, and surgical approach of the mesiodens included in the maxilla were described and analysed according to preoperative CBCT images and the surgeon's practical experience. There were 10 mesiodens; one in each patient. 100% were not erupted; 80% had an inverted vertical orientation and 20% were vertical with the crown oriented caudally i.e., with the root oriented towards the nasal floor. All were treated surgically via a transnasal intraoral approach. Among the indications for surgical removal, 90% of the 10 patients presented for orthodontic indications and 10% due to referral from paediatric dentistry prior to orthodontics.

Regarding postoperative complications associated with the intraoral transnasal approach, no maxillary bone exposure, upper incisor root damage, extensive surgical approach, palatal or vestibular hematoma, or palatal necrosis was observed. However, 10% of the patients had superficial damage to the nasopalatine neurovascular bundle with cauterisation; 80% had mild postoperative facial oedema; and 20% moderate oedema. The duration of hypoesthesia varied among patients, ranging from 1 week to 3 months, of which 20% recovered within the first week, 40% within the first month, and 40% within 3 months (Table 2).

Discussion

Supernumerary teeth are developmental abnormalities that can manifest in both temporary and permanent dentition. They affect the maxilla as well as the mandible, and can affect any tooth. Mesiodens is the most common supernumerary tooth [11]. The location, orientation, and structures adjacent to a DS should be examined preoperatively using three-dimensional imaging, such as computed tomography

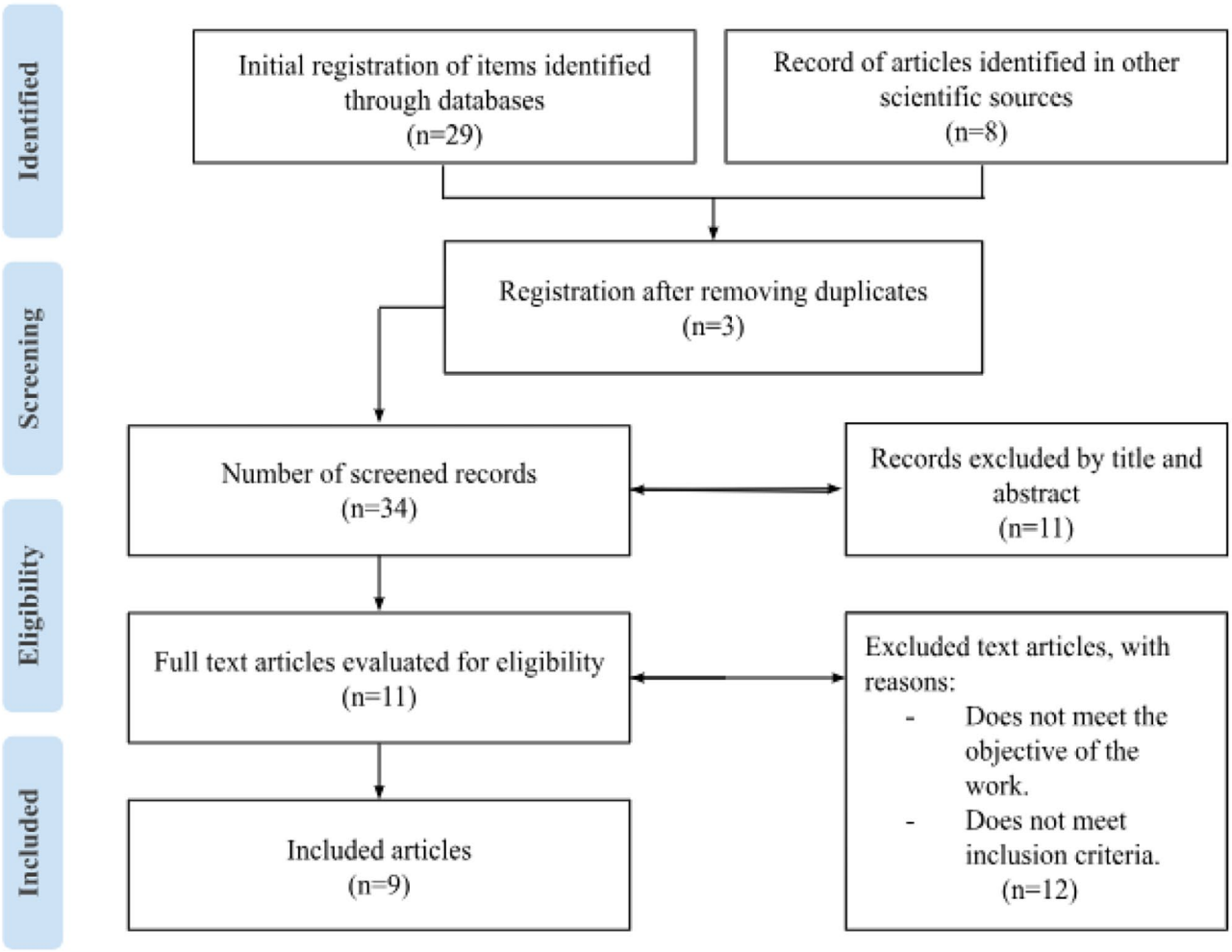

Fig. 2 PRISMA Flow diagram

(CT) or CBCT, in order to determine the type of treatment and optimal surgical approach for each case. When a DS causes symptoms or clinical signs, removal is necessary [12].

Traditional intraoral approaches, such as the vestibular or palatal access, are used in cases where the mesiodens are close to the alveolar process. However, these accesses are not ideal for the removal of deeply impacted and inverted DS located towards the nasal cavity, which, when addressed by conventional methods, require excessive bone removal, which may cause damage to neighbouring structures, germs or roots of adjacent permanent teeth, and to the nasopalatine neurovascular bundle. A new technique of extraoral transnasal approach through endoscopy has been introduced, which is highly effective and minimally invasive, but it has not yet become widespread due to its low accessibility and high economic costs [13].

In the current article, 10 cases of mesiodens in the maxillary midline were presented, which were extracted through a minimally invasive non-endoscopic intraoral transnasal approach, which provides a direct view of the surgical site, avoiding excessive bone removal to access the mesiodens [12].

Between one and nine patients were presented in each of the articles of the systemic review, with ages between 7 and 15 years. There was a notable predilection for the male gender: of a total of 21 patients, two were female, 10 were male, and nine had no data available.

As in the case series, Hauer et al. [9], Macedo et al. [14], Sharifi et al. [10], Figueroa et al. [15], Elseyoufi et al. [16] and Ku et al. [17] used CBCT as the radiological study; unlike Sammartino et al. [12], Sukegawa et al. [13] and Yamamoto et al. [18], who used CT. Additionally, several of the authors mentioned in the review used panoramic radiography as an imaging complement to the aforementioned three-dimensional studies.

With regard to mesiodens, 20% reported in the case series had a vertical position with crown located caudally.

Table 1 Epidemiological and descriptive data of the studies included in the Systematic Review along with the description of the surgical technique

Author	Year	Type of study	Patients	Age	Gender	Reason for consultation	Type of dentition	Intraoral examination	Type of radiological study	Anaesthesia
Sammartino et al.	2011	Case Report	1	15	M	Referral by Otorhinolaryngology	Permanent	Without alterations	Rx. panoramic and CT	G
Sukegawa et al.	2015	Case Report	1	15	M	Referral for deeply impacted supernumerary tooth	Permanent	Without alterations	Rx. panoramic and CT	L and IS
Hauer et al.	2018	Prospective study	9	11.7 ± 3.1	NA	Orthodontic referral and/or poor dental position	Mixed 1st phase, 2nd phase and permanent	NA	Rx. panoramic, rx. periapical and CBCT	G and L
Macedo et al.	2019	Case Report	1	13	F	Orthodontic referral	Mixed 2nd phase	Aesthetic alterations in the anterior sector	CBCT	G and L
Yamamoto et al.	2019	Case Report	3	11, 8, and 8	M	Referral due to dental malposition	Mixed 1st and 2nd phase	NA	CT	G and L
Sharifi et al.	2021	Case Report	1	9	M	Radiographic finding	Mixed 2nd phase	Without alterations	Rx. panoramic and CBCT	G and L
Figueroa et al.	2022	Case report and literature review	1	10	M	Orthodontic referral due to radiographic finding	Mixed 2nd phase	NA	CBCT	G and L
Elseyoufi et al.	2023	Case Report	1	13	M	Orthodontic referral	Permanent	Midline maxillary diastema	Rx. panoramic and CBCT	G
Ku et al.	2023	Case Report	3	7, 8, and 9	M/F/M	NA	Mixed 1st and 2nd phase	NA	Rx. panoramic and CBCT	G and L

Abbreviations: F = Female; M = Male; NA = Not available; Rx = Radiography; G = General; L = Local; IS = Intravenous sedation; Nº=NUMBER; MD = Mesiodens; ENA = Espina nasal anterior

Table 2 Distribution of patients according to variables

	Gender	Age	Dentition	Mesiodens orientation type	Removal indications	Postoperative signs and symptoms
1	M	10	Mixed 1st phase	Inverted vertical	Orthodontics	- Mild postoperative facial oedema - Hypoesthesia duration 1 week
2	M	12	Permanent	Inverted vertical	Orthodontics	- Not present
3	F	10	Mixed 1st phase	Inverted vertical	Orthodontics	- Mild postoperative facial oedema
4	M	13	Permanent	Vertical with crown towards caudal	Orthodontics	- Mild postoperative facial oedema - Hypoesthesia duration 1 week
5	F	12	Mixed 2nd phase	Inverted vertical	Orthodontics	- Not present
6	F	11	Mixed 2nd phase	Inverted vertical	Orthodontics	- Not present
7	F	9	Mixed 1st phase	Inverted vertical	Paediatric dentistry	- Not present
8	M	11	Mixed 1st phase	Vertical with crown towards caudal	Orthodontics	- Moderate postoperative facial oedema - Hypoesthesia duration 1 month
9	F	10	Mixed 1st phase	Inverted vertical	Orthodontics	- Not present
10	F	12	Mixed 2nd phase	Inverted vertical	Orthodontics	- Not present

Abbreviations: F = Female; M = Male.

In the systematic review, however, 100% had an inverted mesiodens position.

As in the case series, all patients described in the systematic review articles were operated under general anaesthesia, with the exception of Sukegawa et al. [13], who used intravenous sedation.

In contrast to the approach performed in the case series, which consisted of a linear incision, Sukegawa et al. [13] made a "v"-shaped incision around the superior labial frenulum. Sharifi et al. [10] made a horizontal vestibular incision with two discharges at both ends.

The minimally invasive approach used in the case series implies using an incision of less than 1 cm in length, this

being the smallest extension compared to the other articles presented in this review. Hauer et al. [9] performed a removal technique with a 3 cm extension approach; Sharifi et al. [10], Sukegawa et al. [13], Ku et al. [17], and Figueroa et al. [15] reported an extension between lateral incisors with an average length of 3.746 cm [19]; Elseyoufi et al. [16] and Sammartino et al. [12] reported an extension between the canines of approximately 4.9661 cm [19]; and Macedo et al. [14] and Yamamoto et al. [18] did not present these data.

In contrast to the technique described in the case series, which consisted of the use of rotating mechanical instruments to perform a conservative osteotomy, allowing the crown or root to be exposed and thus remove the mesiodens through a bone window; Yamamoto et al. [18] described removing the floor bone using small chisels in order to expose the mesiodens and remove it. On the other hand, Sammartino et al. [12] used odontosection to perform the extraction of the crown and root of the mesiodens separately. Instead of using rotating instruments, Sukegawa et al. [13] and Elseyoufi et al. [16] referred to using a piezosurgery device for the osteotomy, with consequent removal of bone and exposure of the mesiodens in order to then be able to remove it.

Macedo et al. [14], Sharifi et al. [10], and Figueroa et al. [15], as in the technique described by the case series, used 4 – 0 vicryl suture for primary closure. Yamamoto et al. [18] and Elseyoufi et al. [16] used 3 – 0 nylon and polyglactin sutures, respectively.

It is important to note that none of the studies analysed in the systematic review implicitly mentioned complications associated with any surgical procedure. Sukegawa et al. [13] and Sharifi et al. [10] described the absence of nosebleeds and/or damage to adjacent teeth. The case series presented in this article describes transient postoperative signs and symptoms associated with the intervention. It is known that any surgical intervention, no matter how invasive, can have postoperative complications such as haematoma, infection, oedema, pain, and need for reintervention). The lack of mention and/or denying the appearance of complications is considered a biasing factor when comparing different studies.

The vestibular approach involves a high risk of damaging adjacent teeth, especially in cases of inverted mesiodens. In order to prevent dental injuries, the palatal approach has been used, which has a high rate of damage to the neurovascular bundle and excessive removal of bone tissue [12, 18, 20]. The intraoral transnasal approach is considered adequate for inverted and impacted mesiodens in the nasal cavity, allowing closer access to the supernumerary tooth, less tissue damage, greater protection of neighbouring teeth and tooth germs, and avoids excessive bone removal, which reduces the incidence of oronasal fistulas [16].

Among the limitations of the systematic review, there are different names used in the literature to refer to the technique of the intraoral transnasal approach; and a lack of data regarding gender, morbid history, family history of supernumerary teeth, reason for consultation, intraoral examination, extent of the approach used, intra- and postoperative complications, and clinical and radiographic follow-up.

The aim of this study was to describe the minimally invasive intraoral removal technique via a transnasal non-endoscopic approach with a maximum extension approach of 1 cm, with other techniques reported in the scientific literature. The articles selected for the systematic review describe accesses with greater extensions to the technique described in this study. Our results confirm that the technique is innovative, minimally invasive, and unique with respect to the extension of the approach, reducing complications and comorbidities associated with any surgical procedure, such as oedema, haematoma, bleeding, postoperative infections, and damage to adjacent teeth. Furthermore, it complies with the principles described by Kong et al. [8] used in clinical analysis for the selection of an appropriate surgical approach, such as shorter linear distance to the mesiodens, less tissue damage, and protection of neighbouring teeth and underlying tooth germs.

Although there is a lack of studies that support the advantages of a minimally invasive transnasal technique for the removal of mesiodens, we conclude that it is a beneficial technique that surgeons should consider in cases in which supernumeraries are included in the maxilla, requiring a dissection of nasal floor, for direct, rapid access and with fewer associated comorbidities.

Conclusions

The minimally invasive intraoral, transnasal, non-endoscopic approach is an alternative to traditional surgical techniques which are associated with greater postoperative complications and comorbidities. This technique is characterised by being safe and predictable over time, with minimal postoperative complications, which reduces the probability of excessive bone removal and damage to adjacent structures.

Author contributions All authors contributed to the conception and design of the study. S.D., F.J. and G.M. prepared the material, collected and analyzed the data. The disagreements were resolved by consensus and discussion with a fourth reviewer, P.T., who acted as judge to resolve the disagreements generated. All authors read and approved the final manuscript.

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Data availability No datasets were generated or analysed during the current study.

Declarations

Competing interests The authors declare no competing interests.

Ethics approval This study was performed in line with the principles of the Declaration of Helsinki, the identity of the patients remained anonymous according to the ethical principles. For this study, all signed informed consents were obtained from the patients; that said, approval by an ethics committee was not justified or required.

Consent to participate The use of the clinical cases with their respective images is supported by the informed consent obtained and signed by all legally responsible adults of the individual participants included in this study.

Consent to publish The authors affirm that the legal guardians of the human research participants gave their informed consent for the publication of the images in Fig. 1a, b, c, d, e and f.

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