

National clinical guidelines for the management of unerupted maxillary incisors in children

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Key points

Describes the updated national clinical guidelines for the management of unerupted maxillary incisors in children.

Presents the most up-to-date evidence to support clinical decision-making.

Informs GPs who play an important role in managing the developing dentition.

Educates dentists on the issues that need to be considered when managing unerupted maxillary incisor teeth in children.

This article summarises recently updated guidelines produced by the Clinical Governance Directorate of the British Orthodontic Society through the Clinical Standards Committee of the Faculty of Dental Surgery, Royal College of Surgeons of England (FDSRCS) on the management of unerupted maxillary incisor teeth in children. The maxillary incisor teeth usually erupt in the early mixed dentition but eruption disturbances can occur and are often attributable to local factors. A failure of eruption will affect the developing occlusion and potentially influence psychological development of the child. The general principles of management for delayed eruption or impaction of these teeth is to ensure that adequate space exists in the dental arch and to remove any obstruction to eruption. Consideration should also be given to further promoting eruption through surgical exposure of the incisor, with or without subsequent orthodontic traction. A number of factors influence the decision-making process, including patient age, medical history, potential compliance, aetiology and position of the unerupted incisor. Treatment planning should be complemented by careful clinical assessment and the use of appropriate special investigations. To optimise the treatment outcome a multidisciplinary specialist approach is recommended.

Introduction

It is important for general dental practitioners to familiarise themselves with appropriate clinical guidelines. The Faculty of Dental Surgery at the Royal College of Surgeons of England (FDSRCS Eng) develops and maintains a wide range of clinical guidelines through its Clinical Standards Committee.

These are either the product of the committee itself or the endorsement of work by other bodies, such as professional societies. This paper represents updated guidance produced in 2017 by the Clinical Governance Directorate of the British Orthodontic Society through the FDSRCS Eng on the management of unerupted maxillary incisor teeth in children.¹

Failure of eruption associated with maxillary permanent incisor teeth usually presents in the mixed dentition stage and is often noticed between the ages of 7–9 years. The maxillary incisors are vulnerable to eruption failure secondary to space loss, obstruction or trauma. The anterior maxilla is a common site for the development of supernumerary teeth or odontomes; while the developing permanent maxillary incisors are also susceptible to dilaceration and eruption failure following trauma affecting the primary incisor dentition. Missing and unerupted maxillary incisors can be regarded as unattractive and have a potentially negative influence on facial and dental

aesthetics, which may impact upon self-esteem and social interaction.² Early diagnosis and appropriate management is recommended.

These guidelines are based on current evidence and should be continually developed, as further evidence is made available. There are currently no high-quality randomised clinical trials investigating treatment interventions for the management of unerupted maxillary incisors and with the exception of one investigation, all current evidence is retrospective.

Diagnosis and management

Delayed eruption of the permanent maxillary incisor teeth can be considered when eruption of the contralateral incisor has occurred more than six months earlier; the maxillary incisors remain unerupted more than one year after eruption of the mandibular incisors; or there is significant deviation from the normal eruption sequence (for example, lateral incisors erupting before the central incisor).

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A number of local factors have been associated with delayed eruption of the maxillary incisor dentition (Box 1) (Figs 1A–E). The most common causes are physical obstruction due to the presence of supernumerary teeth or odontomes and trauma to the primary dentition, which may contribute to dilaceration of the permanent successor/s. Less frequent associations include cleft lip and palate³ and systemic conditions, which demonstrate the development of multiple supernumerary teeth as part of their phenotypic spectrum (cleidocranial dysplasia, Gardner's syndrome).⁴

Incidence, prevalence and associated features

There is much variation in the reported incidence of maxillary permanent incisor impaction within the literature. In an investigation of Caucasian skulls, five impacted central incisors were identified in a sample of 1,462 (0.34%) with only 1.96% of all the identified impacted maxillary teeth being central incisors.⁶ In another sample population aged between 17–26 years, an incidence of 0.04% impacted maxillary central incisors was observed.⁷ In a cohort of patients referred to regional hospitals in the United Kingdom and aged between 6 and a half to 14 years, the prevalence of supernumeraries in the maxilla was reported as 2.6%, resulting in failed eruption of 42% of the maxillary central incisor teeth.⁸ It is often stated that the maxillary central incisor is the third-most commonly impacted tooth after the third permanent molars and maxillary canine. Failure of eruption associated with maxillary permanent incisors is more frequently seen in the presence of other inherited dental anomalies, such as enamel hypoplasia, supernumerary teeth and ectopic teeth.⁵ However, by far the most frequent cause of eruption failure is the presence of a supernumerary tooth (see Figs 1 B and C).

Establishing the cause of eruption failure

Medical and dental history

A detailed medical and dental history should be obtained to determine any possible hereditary or environmental factors, which may be contributing to the delay in eruption. A history of trauma to the primary dentition should be sought and documented, with approximate dates of any traumatic episode(s) and a description of both the magnitude and direction of the traumatic impact.

Box 1 Local factors associated with delayed eruption of the maxillary incisors

- Early extraction or loss of primary teeth (with or without space loss)
- Prolonged retention of primary teeth
- Crowding in the upper labial segment
- Previous trauma
- Localised pathology (supernumerary teeth, odontomes, cystic formation)

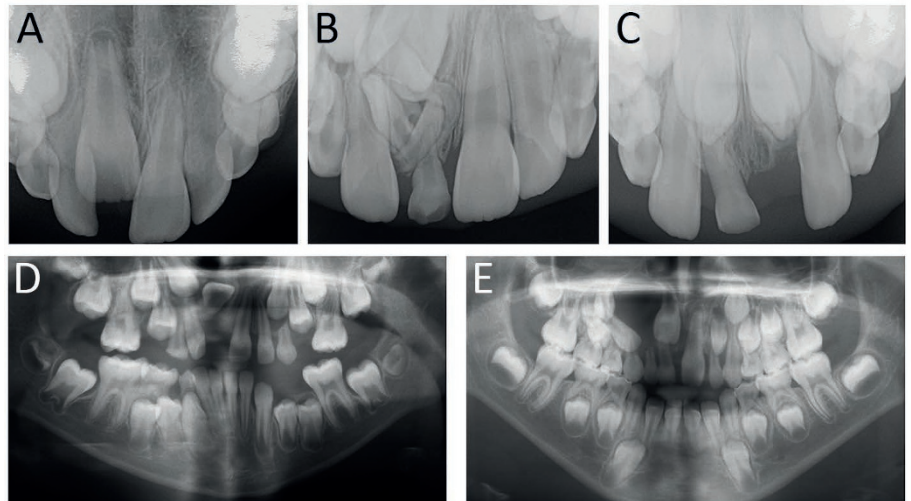


Fig. 1 (A) Delayed eruption of an 11 due to localised space loss; (B) Delayed eruption of an 11 due to the presence of a multiple supernumerary teeth; (C) Delayed eruption of both maxillary central incisors due to the presence of paired tuberculate supernumerary teeth; (D) Dilaceration of an 11 due to previous trauma; (E) Cystic region in the anterior maxilla impeding eruption of the 11 and causing displacement of the 12

Clinical examination

An intra-oral examination should be undertaken to identify any primary teeth retained significantly beyond their normal exfoliation dates. Clinical features such as spacing and rotations and displacement of permanent teeth should be recorded in the upper incisor region.^{9,10} Space loss due to drift of the adjacent lateral incisor into the central incisor position may suggest a disturbance in normal dental development. The presence of labial or palatal swellings, which may indicate the site of an unerupted incisor, should be noted, in addition to the angulation and inclination of adjacent teeth and availability of suitable space for eruption of the incisors (approximately 9 mm for a permanent maxillary central incisor and 7 mm for a permanent maxillary lateral incisor).¹¹

Radiographic examination

Failure of eruption associated with one or more permanent maxillary incisor teeth or retention of the primary incisors beyond the normal age-range warrants further investigation. Intra-oral radiographs can assist in making a diagnosis.^{12,13} Periapical views and/or an upper standard occlusal

radiograph can be useful in determining the presence and position of maxillary incisor teeth and any underlying developmental anomalies or pathology. These radiographs can also facilitate the use of horizontal or vertical parallax in order to localise the bucco-lingual position of the unerupted tooth.¹⁴ A cephalometric radiograph can also be of value in the location and assessment of unerupted, malformed or misplaced incisors, particularly in relation to the height of impaction and bucco-lingual inclination of the crown and root of the tooth (Fig. 2).

Cone beam computed tomography (CBCT) technology is now widely available for imaging the maxillo-facial region and can, in selected cases, be useful to investigate impacted and ectopic teeth, providing a clear three-dimensional view of these teeth and the associated structures. CBCT has a greater overall effective dose than conventional radiography and should therefore only be prescribed when the required information cannot be adequately obtained using lower dose conventional radiography.¹⁵ If dilaceration of an incisor root is suspected, CBCT may be valuable in treatment planning, as the degree of aberrant crown-root

angulation can be assessed and imaging used to plan the optimal direction of traction required, ensuring that both the crown and root are maintained in alveolar bone during alignment of the tooth (Figs 3A–D).

General principles of management

Despite a lack of definitive treatment protocols, the general principles of managing delayed eruption or impaction of the permanent maxillary incisor teeth, include: (1) the provision of adequate space in the dental arch; and (2) removal of any obstruction to eruption. Consideration should also be given to further promoting eruption through surgical exposure of the incisor, with or without subsequent orthodontic traction. Definitive treatment planning will depend on patient factors, such as medical history, age and potential compliance; while dental factors include the presence of retained primary teeth, the position and stage of development of the impacted incisor, the nature of any physical obstruction to eruption and the presence of any unfavourable root formation (dilaceration).

The potential risks of treatment include failure of eruption, ankylosis, external root resorption, poor gingival aesthetics and occasionally, damage to adjacent teeth. These risks should be carefully explained to the patient and parent(s). However, in the majority of



Fig. 2 A lateral skull radiograph can be useful in identifying the position and morphology of unerupted dilacerated maxillary incisors

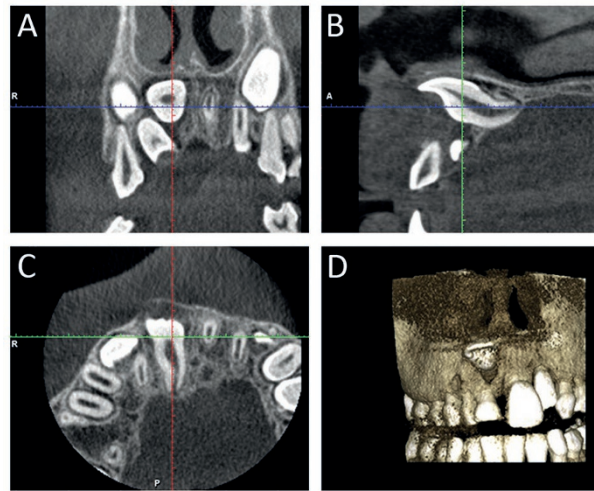


Fig. 3 (A–D) Cone beam CT imaging provides three-dimensional visualisation of a dilacerated and unerupted 11

cases, treatment is relatively straightforward and successful. A number of factors should be considered in treatment planning and these are detailed below.

Patient factors

Medical history

A number of medical conditions can potentially impact on orthodontic and/or surgical treatment¹⁶ and it is important to establish a comprehensive medical history for any patient before embarking on treatment for an impacted maxillary incisor.

Age

The optimal age for surgical removal of a supernumerary tooth is unknown because in most cases the age at removal will be influenced by the age when the diagnosis was made. Retrospective analysis suggests that spontaneous eruption of an unerupted permanent maxillary incisor is more likely to occur if any associated supernumerary is removed between 8–9 years of age.^{17,18} However, patient age has also been reported as a non-significant factor in determining spontaneous eruption.¹⁹

Compliance

It is important to evaluate potential future compliance for any orthodontic patient, although most children are able to cope relatively easily with treatment for an impacted maxillary incisor. However, this problem can affect younger children and a judgement should be made about their ability to undergo treatment.

Dental factors

Retained primary teeth

Any retained primary tooth should be extracted. Where the permanent maxillary incisor is close to eruption or when there is no other obvious causative factor, spontaneous eruption of the permanent successor may occur.

Position of the impacted incisor

The vertical position of the impacted permanent maxillary incisor has been shown to influence both successful spontaneous eruption and the time taken to erupt.^{20,21} A small retrospective study demonstrated that the higher the vertical position of an unerupted maxillary incisor, the less likely it was to erupt spontaneously after an obstructing supernumerary tooth was removed. In this investigation, only 28.6% of unilaterally impacted permanent maxillary incisors erupted spontaneously when their initial position was at the level of the apical third of the root of the contralateral erupted maxillary incisor.²¹

Developmental stage of the impacted incisor

The stage of development of an impacted permanent maxillary central incisor may also influence eruption of this tooth. Some reports suggest that incisors with immature roots are more likely to erupt spontaneously following supernumerary removal than those with mature roots.^{22,23} However, other studies have found no association between the eruption of unerupted maxillary incisors and their stage of root development.¹⁹

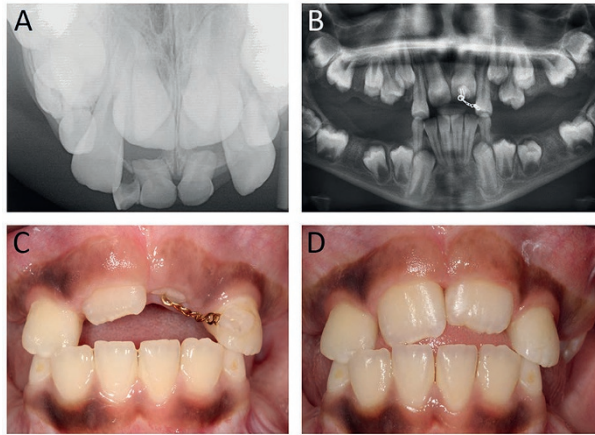


Fig. 4 (A) Bilateral supernumerary teeth impeding eruption of the permanent maxillary incisors; (B) Extraction of the primary central incisors and supernumerary teeth (and first permanent molars) with surgical exposure and bonding of the 21; (C, D) Spontaneous eruption of the 11 and 21 without orthodontic traction. In this case, the relatively low vertical position of the central incisors in relation to the occlusal plane favoured spontaneous eruption

Nature of any physical obstruction to eruption

If the cause of any obstruction is a supernumerary tooth, both the morphology of this tooth and the resultant degree of incisor displacement will influence the success of spontaneous eruption of the permanent maxillary incisor following surgical removal of the supernumerary.^{8,21,22,24–26} Tuberculate supernumerary teeth and odontomes are more likely to obstruct permanent maxillary incisor eruption, with a greater resultant displacement than conical supernumerary teeth.^{18,23,24,26,27} It has been further reported that one third of compound and one half of complex odontomes prevent the eruption of associated teeth.²⁸

Unfavourable root formation

Dilaceration is defined as an acute deviation of the long axis of the tooth, located to the crown or the root portion and originating from a traumatic non-axial displacement of already formed hard tissue in relation to the developing soft tissue.²⁹ This malformation can affect the permanent maxillary incisors and is thought to be caused by environmental (trauma to primary predecessors) and developmental factors. Traumatic injuries to the primary dentition are relatively common, with a prevalence ranging from 11–30%.³⁰ The potential benefits of aligning permanent maxillary incisors with root dilacerations in adolescent patients, include maintenance of dental aesthetics, associated psychosocial benefits and the preservation of alveolar bone for future osseous-retained restorations. Dilacerated incisors may be brought into the line of the arch following exposure and

application of orthodontic traction.^{31,32} An adult sample has shown limited evidence of favourable long-term periodontal outcomes following the orthodontic eruption of dilacerated permanent maxillary incisors.³³ It has also been suggested that dilacerated permanent maxillary incisors will take longer to align successfully and have a poorer prognosis for successful eruption than those impacted due to simple obstruction.²⁰ The use of a lateral skull radiograph or CBCT can be beneficial if dilaceration is suspected from standard radiographic views. The extent of the dilaceration, inclination of the crown and root and the quality and quantity of the alveolar bone at the site where the tooth will be moved can be assessed with greater clarity in three dimensions. Ultimately, the extent of the dilaceration and inclination of the crown will determine whether attempting orthodontic alignment is feasible.

Management options

The general principles of management include the removal of any obstructions to eruption and the provision of adequate space in the dental arch. Depending upon the position of the impacted incisor, eruption can be further facilitated by surgical exposure with or without the use of orthodontic traction.

Removal of a physical obstruction

The presence of a supernumerary tooth or odontome is responsible for delayed eruption or impaction of the permanent maxillary incisors in approximately 28–60% of cases.^{8,27,34–37} Indeed, 90–98% of maxillary supernumerary

teeth develop within the midline and maxillary central incisor region.⁹

Following the removal of a supernumerary tooth, retrospective evaluation suggests that between 49–91% of permanent maxillary incisors will erupt spontaneously.^{18,22,23,38} (Figs 4A–D). Although these figures appear to be favourable, there is large variation in the reported time required for the incisor to erupt, which can be up to 18 months.¹⁸ For optimal results, it would seem sensible to suggest that the supernumerary tooth is removed with minimal disturbance to the follicle of the unerupted incisor, although there is no evidence with regard to this.

Removal of the obstruction with creation of space

Eruption of the maxillary incisor can be further facilitated with space creation in conjunction with removal of the obstruction. Retrospective evaluation has suggested that following the removal of a supernumerary tooth, spontaneous eruption is more likely if space exists in the dental arch to accommodate the unerupted incisor.^{19,21,25,37–39} However, impacted incisors often still require further surgical intervention^{22,23,26,38} and some form of orthodontic alignment.¹⁹ Prospective analysis further supports space creation in facilitating eruption, with 82% of incisors erupting spontaneously when combined with maxillary expansion.⁴⁰

Space can be created with a simple removable appliance in selected cases or fixed appliances (sectional or full arch) with or without extraction of the primary canines. Adequate space creation using fixed orthodontic appliances before any surgical intervention has been shown to significantly reduce overall treatment time.^{19,40,41}

Surgical orthodontic treatment

In addition to the removal of any obstruction, surgical exposure of the maxillary incisor tooth may also be indicated. In these circumstances, early orthodontic traction can enhance this facilitated eruption.²⁴ There is currently a lack of evidence to inform the decision as to whether unerupted permanent maxillary incisors should be surgically exposed at the same time as removal of any obstruction, or whether spontaneous eruption should be given the opportunity to occur. Following the removal of a supernumerary tooth, between 30–54% of impacted permanent maxillary incisors will require further surgical intervention to facilitate their eruption.^{22,23,26,38} It is good clinical practice to avoid the need for repeat general anaesthesia whenever possible and so it is prudent to consider surgical exposure and

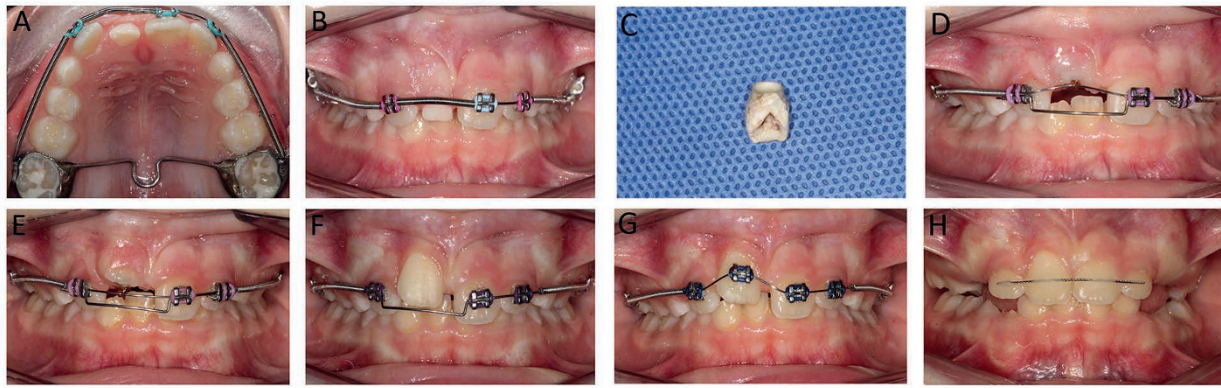


Fig. 5 (A, B) Impeded eruption of an 11 due to the presence of a supernumerary tooth. An upper fixed appliance with a trans-palatal arch was placed; (C) The retained primary incisor was extracted along with the supernumerary tooth and (D, E) the 11 surgically exposed with bonding of a gold chain and piggy-back mechanics instituted utilising nickel-titanium and stainless steel archwires to mechanically erupt it; (F) Eruption of the 11; (G) Orthodontic bracket bonded to the 11 for final alignment; (H) Removal of the fixed appliance and placement of a labial bonded retainer for retention

bonding of an orthodontic attachment at the time of supernumerary removal. This attachment can then be used later if required, to align the incisor and therefore avoid the need for a second general anaesthetic.⁴² The success of surgical exposure combined with orthodontic traction has been reported to exceed 90%, with the height of the impacted incisor appearing to influence the duration of such treatment.²⁰ Ideally, if young patients have a good standard of oral hygiene, and can tolerate and are compliant with fixed orthodontic appliances, then these represent the appliances of choice to apply light traction to the exposed incisor. As the majority of patients with unerupted maxillary incisors present in the mixed dentition stage, the first permanent molars, lateral incisors and the contralateral central incisor tooth are usually included in the fixed appliance, as these are often the only permanent teeth that have erupted at this time. In this situation, a 2 × 4 fixed appliance can be useful for space creation, space maintenance and the application of traction to the unerupted incisor if required⁴³ (Figs 5A-H).

Either an open exposure or closed eruption procedure can be employed to promote eruption of unerupted maxillary incisors.

Open surgical exposure

The open exposure of an unerupted permanent maxillary incisor, by means of a simple elliptical incision of the overlying soft tissue, is rarely indicated but may be useful when there is a soft tissue impaction, with the tooth occupying a very superficial position just beneath the mucosa. The vertical position of the incisor and width of the attached mucosa must allow a band of attached gingiva to be retained after the exposure, so that

this can form a healthy gingival attachment to the tooth over time when it is in its final position.^{44,45} Where the vertical height of the unerupted incisor precludes a simple soft tissue excision over the crown of the tooth, because a normal gingival attachment will not be generated, an apically repositioned flap can be used to expose the crown, provided that it is not significantly mesially or distally displaced. This technique has been associated with increased incisor crown length and poor soft tissue aesthetics.⁴⁵⁻⁴⁷ While open exposure affords the orthodontist the advantage of bonding to the unerupted incisor under a dry field and planning the direction of traction applied, post-operative hygiene and care following an apically repositioned flap can be challenging for the younger patient.

Closed eruption technique

In the closed eruption technique, a mucoperiosteal flap incorporating the attached gingiva is raised and an attachment is bonded to the impacted incisor before the flap is replaced into its original position (Figs 6A-F). The attachment should incorporate a gold chain or traction ligature to facilitate the application of orthodontic force.⁴⁸⁻⁵⁰ Ideally, the attachment should be low profile and bonded to the palatal surface of the unerupted incisor to allow orthodontic traction to be applied in the most favourable direction and to reduce the risk of fenestration of the attachment through the thin overlying alveolar mucosa as the tooth is aligned. Clinical photographs taken with the flap raised and attachment bonded at the time of

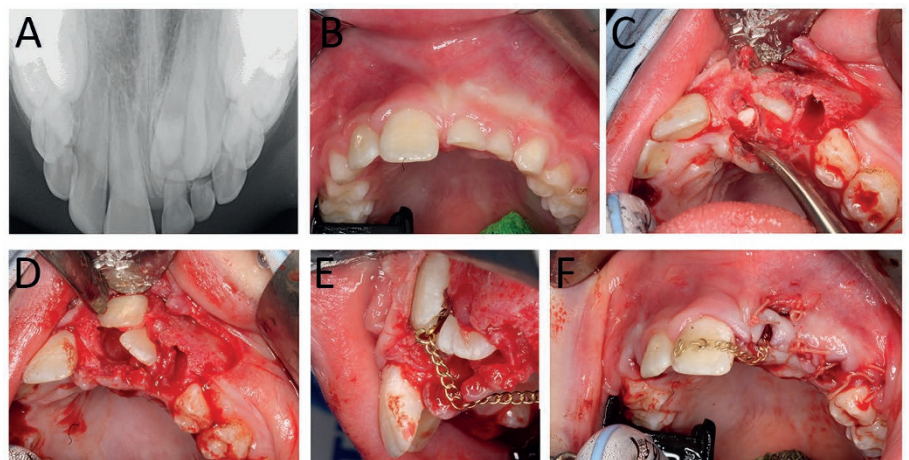


Fig. 6 (A, B) An impacted 21 due to the presence of a supernumerary tooth; (C, D) Raising of a mucoperiosteal flap to surgically expose and identify the supernumerary tooth, which was palatal to the 21; (D) Removal of the supernumerary tooth and bonding of a gold chain attachment to the palatal surface of the 21; (E) Closure of the soft tissues and gold chain temporarily secured to the adjacent 11 with composite adhesive

surgery may be helpful in planning the direction of future traction (Fig. 6E), especially if both permanent central incisors are unerupted.

Open versus closed eruption techniques

There are only a few studies that have specifically compared open versus closed eruption techniques for impacted permanent maxillary incisor teeth. Early studies demonstrated superior results for closed eruption in terms of gingival, periodontal and pulpal status. Longitudinal assessment of closed versus open eruption has reported longer clinical crowns and decreased bone support in association with open eruption.⁴⁶

Incisor removal

When a permanent maxillary incisor has to be removed due to significant dilaceration or ankylosis and infra-occlusion, space should be maintained for subsequent replacement, initially with a fixed or removable prosthesis. In the longer-term, an implant-retained prosthesis may be considered.^{51,52} Prolonged absence of a tooth within the dental arch can lead to significant loss of alveolar volume in the affected region. This bone loss can result in a reduction of both height and width of the alveolus, which may subsequently require augmentation and potentially complicating both implant placement and long-term success. Alternative management strategies, particularly in the younger child, include accepting the unerupted tooth and leaving it *in situ* until the start of definitive orthodontic treatment for any underlying malocclusion; or to proceed and bring the tooth into the line of the arch, even though it may be sacrificed later. Other options aimed at preserving alveolar bone following the extraction of an unerupted central incisor, include moving a reasonably sized lateral incisor tooth into the central incisor position for camouflage or to accept spontaneous space closure in the labial segment and then open up space with a fixed appliance before definitive restoration in the permanent dentition (Figs 7A–D).⁵²

Ankylosed maxillary incisors

A potentially unfavourable complication of aligning unerupted permanent maxillary incisors is ankylosis. The following treatment options are available for ankylosed permanent maxillary incisors:

- Periodic follow-up with possible composite build-up for any minor infra-occlusion

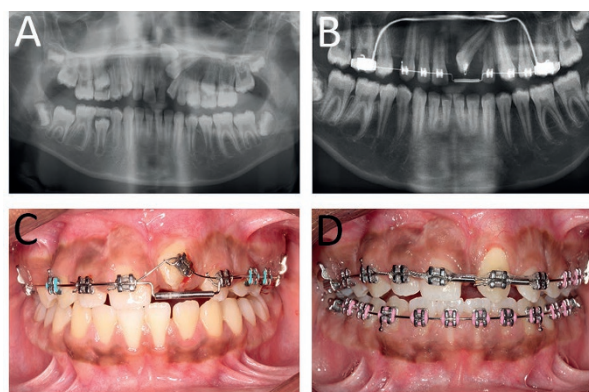


Fig. 7 (A) Unfavourably positioned 21 due to severe dilaceration and an ectopic position of the 23; (B) The 21 was surgically extracted and the 23 exposed and bonded; (C) An upper fixed appliance and 'piggy-back' mechanics used to align the 23; (D) Orthodontic alignment of the 23 into the 21 position

- Repositioning of the ankylosed incisor (including surgical dislodgement and repositioning, osteotomy and repositioning or distraction osteogenesis)
- Extraction of the ankylosed incisor followed by orthodontic space closure
- Decoronation of the incisor, if growth is still active, to preserve the width and vertical height of the alveolar bone⁵³
- Extraction of the ankylosed incisor followed by replacement with conventional or implant prosthesis if the patient's growth is nearing completion.

There is currently insufficient high-level evidence for comparing the effectiveness of different treatment methods relating to the ankylosed maxillary incisor.⁵⁴

Autotransplantation

The autotransplantation of a developing premolar to replace a missing permanent maxillary incisor has been documented to provide a physiologically sound tooth and maintenance of the alveolar process with good long-term survival rates.⁵⁵ The most commonly selected combination is autotransplantation of the lower second premolar to replace a maxillary central incisor. The main advantage is physiological; the process involves placement of the patient's own vital tooth with a preserved periodontium, which is followed by morphological alteration through coronal re-shaping. The main disadvantage is that the tooth can have a poor morphology and require extensive restorative work. In addition, there can be problems with the functional occlusion due to the presence of a palatal cusp. Moreover, in some cases there can be rapid external root resorption and, ultimately, premature loss of the transplanted tooth.

Monitoring of further dental development

Patients with impacted permanent maxillary central incisors are reported to have an increased risk of further disruption to normal dental development. In a retrospective study, the prevalence of maxillary canine displacement on the same side as an unerupted incisor was reported to be significantly increased compared to the contralateral side.⁵⁶

Recommendations

The occurrence of unerupted or impacted permanent maxillary incisors may be associated with both developmental and environmental factors. This condition can lead to poor dental and facial aesthetics and malocclusion, including localised space loss. It is desirable for impacted maxillary incisor teeth to be accommodated in the dental arch at the earliest opportunity if practicable, to afford optimal dental, functional, aesthetic and psychosocial benefits to the patient.

- Young patients aged between 7–9 years of age presenting with an eruption disturbance of the permanent maxillary incisors should be referred for appropriate orthodontic assessment
- When treatment planning for an unerupted permanent maxillary incisor, it is important that space is available for the impacted tooth in the arch and that any obstruction is removed
- Other factors that can influence spontaneous eruption include vertical position, displacement and root development of the impacted incisor
- The most common reason for obstructed permanent maxillary incisor eruption is the presence of a supernumerary tooth.

Retrospective data suggests that a significant proportion of these incisors can be expected to erupt following removal of the obstruction

- In the younger patient (<9 years of age) with an immature permanent maxillary incisor, it may be reasonable to allow up to 9–12 months for spontaneous eruption after the removal of an obstruction, before considering further intervention
- In the older individual (>9 years of age) with a mature permanent maxillary incisor, it is reasonable to consider 'open' or 'closed' surgical exposure with bonding of an orthodontic attachment at the time of removal of an obstruction, particularly if the unerupted incisor is high
- It is desirable to avoid multiple procedures, particularly when surgical treatment has to be carried out under general anaesthesia. If surgery is required to remove an obstruction, then consideration should be given to simultaneous closed exposure and bonding of an orthodontic attachment with a gold chain
- Patient compliance must be assessed, as some younger patients may not be able to accept surgical exposure and traction with a removable or fixed appliance. Each individual case must be considered independently
- A dilacerated permanent maxillary incisor should be aligned in the dental arch with the use of a closed surgical exposure and orthodontic traction if at all possible
- Ideally, examination and treatment planning should be undertaken within a multi-disciplinary clinic. In this way, collective decisions can be made with paediatric dental and/or oral surgery colleagues regarding timing of treatment, the most appropriate choice of surgery and, if necessary, the best position of any attachment in order to optimise a favourable outcome.

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