Amelogenesis imperfecta – lifelong management. Restorative management of the adult patient

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IN BRIEF

- Outlines the clinical presentation of amelogenesis imperfecta (AI) and how to differentiate it from other developmental anomalies.
- Highlights the challenges faced in the rehabilitation of patients presenting with AI.
- Discusses the advantages and disadvantages of various restorative treatment modalities available.

PRACTICE

The biggest challenge restorative dentists face in rehabilitating patients with amelogenesis imperfecta (AI) is trying to restore aesthetics, function and occlusal stability while keeping the treatment as conservative as possible. The goals of treatment should be to prolong the life of the patient's own teeth and avoid or delay the need for extractions and subsequent replacement with conventional fixed, removable or implant retained prostheses. In order to achieve these goals a stepwise approach to treatment planning is required starting with the most conservative but aesthetically acceptable treatment. This article discusses the management of AI and presents the various treatment options available for restoring the adult patient who presents to the dentist with AI.

INTRODUCTION

Amelogenesis is a two-staged process where a protein rich matrix is initially laid down during the secretary phase, followed by the mineralisation phase where the proteins are replaced by hydroxyapatite crystals. This results in the highly mineralised enamel structure. Amelogenesis imperfecta (AI) is a hereditary condition that affects the formation of the enamel matrix or the enamel mineralisation process of both the primary and secondary dentition. It is a clinically and genetically heterogeneous group of conditions that affects both the quantity and quality of the enamel structure and the overall appearance of all or nearly all the teeth in more or less an equal manner, without reference to chronology.[1,2] More recently it has been suggested that AI may have a syndromic association due to changes noted in other parts of the body.[2] AI has either autosomal dominant, autosomal recessive, sex-linked or sporadic inheritance patterns and its prevalence varies from 1:700 to 1:16,000 depending on the population studied.[3]

The most common classification used for AI is based primarily on phenotype alone.[4] Four major categories have been described which include: hypoplastic, hypomatured, hypocalcified and hypomatured – hypoplastic with taurodontism. Table 1 shows the typical characteristics of each of the different AI phenotypes however, it is important to note that any of the phenotypes may coexist in the same patient or on the same tooth. These four major phenotypes have been further divided into 15 subtypes based on mode of inheritance (Table 2).

A clinical diagnosis of AI can be aided by asking the patient four questions as shown in Table 3.[3] This will help differentiate AI from other enamel defects such as fluorosis, which is known to be the commonest differential diagnosis and can be difficult to distinguish from AI clinically. The severity of AI can vary significantly between patients and often it is difficult to make a diagnosis of the phenotype from clinical examination alone. In some cases the different phenotypes described may coexist in the same patient and on the same tooth. Clinical presentation can range from mild discolouration, slight pitting and minimal post eruptive breakdown of enamel to severe discolouration, pitting or significant tooth surface loss due to rapid post eruptive breakdown of hypomineralised enamel. Figures 1b and 3d highlight the variation in clinical presentation and the difficulty clinicians face in making a clinical diagnosis of the phenotype present. From a practical perspective it may not be absolutely necessary to reach a definitive diagnosis of the phenotype as in most cases the management and the treatment options available are often the same.

Most patients with AI will first present to a general dental practitioner whose role in the management may involve a timely referral to the paediatric or restorative specialist, depending on the patient's age. This may be for treatment of complex cases or for treatment planning and advice in management of simpler cases. The paediatric specialist's role in the management of AI is to provide support and reassurance to the child and parents, motivate the child to maintain good oral hygiene and diet, preserve tooth structure and aesthetics and prevent pain, pathology and early tooth loss. The treatment provided by the paediatric specialist can be referred to as a transitional phase. Once the patient reaches late adolescence or early adulthood they are often referred to restorative specialist for life long management of their dentition in conjunction with the patient's general dental practitioner via a shared care approach.

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RESTORATIVE CHALLENGES

There are many challenges AI patients present with which need to be carefully managed as part of the overall rehabilitation for these patients. Table 4 summarises some of the common challenges and their causes that patients often present with. It is important that the restorative dentist takes these factors into account during treatment planning, if rehabilitation and life long management of the patient's dentition is to be successful.

RESTORATIVE TREATMENT OPTIONS

Treatment options available to restore patients with AI vary considerably depending on several factors such as age of the patient, patient motivation, periodontal condition, endodontic status, loss of tooth structure, severity of disorder, socioeconomic status and most importantly the patient's availability for treatment and cooperation.[5,6] Often these patients present young and want a quick result which will improve the appearance of their teeth allowing them to be accepted by their peers and society in general. However, adopting a stepwise approach is essential to help preserve and retain the patient's own teeth for as long as possible and avoid or delay the need for prosthetic replacement.

ORAL HYGIENE, DIETARY ADVICE, DESENSITISATION AND STABILISATION

It is crucial that prevention should be included in the initial stages of all treatment plans with a particular focus on providing effective oral hygiene instruction and patient motivation. Treatment of dentine hypersensitivity using either desensitising agents, topical fluoride preparations and/or CCP-ACP (casein phosphopeptide-amorphous calcium phosphate) containing products that promote remineralisation should also be introduced at this stage as this will help with the maintenance of good oral hygiene. If the patient has any periodontal problems these should be addressed with non-surgical and/or surgical periodontal therapy as appropriate. Comprehensive dietary analysis and advice is also essential. It is important to highlight to patients that AI carries a higher caries risk and therefore poor diet control can have a devastating effect on

Table 1 Clinical and radiographic appearance of the major phenotypes of AI

Hypoplastic form Reduction in the quantity of the enamel matrix usually with normal mineralisation	**Hypomaturation form** Defect in the quality of mineralisation process with normal quantity of matrix formation	**Hypocalcified form** Defect in the quality of the mineralisation process with normal quantity of matrix formation
Clinical appearance		
Reduced thickness of enamel	Normal thickness of enamel	Normal thickness of enamel with loss of translucency
Enamel is usually well mineralised and is therefore less prone to attrition than the other forms of AI	Enamel is hypomineralised and prone to post eruptive breakdown and attrition	Enamel is very hypomineralised and often of a soft cheesy consistency. Prone to early rapid post eruptive breakdown and can easily be worn away
The colour can vary from normal colour and translucency to a yellow to dark brown colour depending on how thin the enamel is and the degree of shine through of the underlying dentine	Colour may be affected by post eruptive uptake of staining from the oral environment and the degree of post-eruptive breakdown. It can vary broadly from mottled opaque white to Yellow-brown or red-brown discolouration	Colour may be affected by post eruptive uptake of staining from the oral environment and the degree of post eruptive breakdown and exposure of underlying dentine. Teeth tend to be darker in colour than other types of AI
Spacing between teeth as thinner enamel often reduces tooth size		
Rough, irregular or pitted enamel with or without vertical ridges or grooves		
Radiographic appearance		
Enamel contrasts normally from dentine	Enamel has similar radiodensity as dentine	Enamel is less radiopaque than the dentine

Table 2 Classification of AI based on phenotype and mode of inheritance

Subtype	Phenoype	Phenotype and mode of inheritance
Type I	**Hypoplastic**	
Type IA		Hypoplastic, pitted autosomal dominant
Type IB		Hypoplastic, local autosomal dominant
Type IC		Hypoplastic, local autosomal recessive
Type ID		Hypoplastic, smooth autosomal dominant
Type IE		Hypoplastic, smooth X-linked dominant
Type IF		Hypoplastic, rough autosomal dominant
Type IG		Enamel agenesis, autosomal recessive
Type II	**Hypomaturation**	
Type IIA		Hypomaturation, pigmented autosomal recessive
Type IIB		Hypomaturation, X-linked recessive
Type IIC		Hypomaturation, snow-capped teeth, X-linked
Type IID		Hypomaturation, snow-capped teeth, autosomal dominant?
Type IIi	**Hypocalcified**	
Type IIIA		Autosomal dominant
Type IIIB		Autosomal recessive
Type IV	**Hypomaturation–hypoplastic with taurodontism**	
Type IVA		Hypomaturation-hypoplastic with taurodontism, autosomal dominant
Type IVB		Hypoplastic-hypomaturation with taurodontism, autosomal dominant

Table 3 Questions to aid diagnosis of AI as described by Crawford *et al.*[3]

1. Has anyone else in the family had anything like this?
2. Has there been anything in the patient's medical history which might have caused sufficient metabolic disturbance to affect enamel formation?
3. Are all the teeth affected in a similar manner?
4. Is there a chronological distribution to the appearance to the defect?

Table 4 Restorative challenges faced

Restorative challenges	Causes
Psychosocial problems Low self esteem Reclusive and withdrawn	Often due to being bullied at school as a child
Poor oral hygiene Chronic gingivitis	Patients avoid cleaning due to sensitivity Some avoid cleaning due to poor motivation as teeth are of a poor appearance
Sensitivity Difficult to etch or clean teeth without LA	Thin enamel Exposed dentine
Caries	Poor oral hygiene combined with thin enamel or hypomineralised enamel makes AI affected teeth more prone to rapid caries progression
Discolouration	Yellow dentine shining through thin enamel or may be complete lack of enamel Can be difficult to mask with conservative techniques
Loss of occlusal vertical dimension or alveolar space Loss of interocclusal space	Due to rapid tooth surface loss which may be compensated for by down growth of the maxillary complex Teeth trying to maintain opposing contacts Often require complex rehabilitation involving a reorganised approach and an increase in the occlusal vertical dimension
Reduced inter root space	Thin enamel or rapid loss of enamel post eruption results in teeth drifting closer together Risk of damage to adjacent teeth Difficult to prepare teeth for crowns and take impressions
Large pulp to crown ratio	Young teeth with large pulps. Lack of secondary dentine Increased risk of tooth losing vitality
Gingival maturation resulting in exposure of restoration margin	Occurs over a few months post full eruption of tooth If restoration placed too early then margin may become visible after maturation. If lab made restoration then it may need replacing
Decreased bond strength of resin to enamel	Higher protein content in AI affected enamel Results in abnormal etch pattern Etch pattern varies between phenotypes Different phenotypes can therefore give different bond strengths
Bonding to dentine	Due to rapid loss of enamel in some AI patients bonding to dentine is required

both unrestored and restored teeth. If indicated any carious lesions present should be restored without delay; alternatively teeth with poor prognosis or those that are deemed unrestorable should be considered for extraction. Often motivating patients with AI to improve and maintain good oral hygiene can be difficult when they are unhappy about the appearance of their teeth. Oral hygiene usually improves once the patient has been rehabilitated often resulting in recession around the restoration margins, which can be difficult to manage depending on the choice of restoration.

BLEACHING AND MICROABRASION

In patients with AI, preservation of tooth structure is vital and minimally invasive treatment options must be considered where possible. Microabrasion using an acidic slurry containing 18% hydrochloric acid and pumice is often effective in removing superficial stains and improving the appearance of the teeth.[7] Ashkinazi *et al.* demonstrated the use of this technique in patients with enamel hypomaturation. At four-year follow up they showed that the improvements in aesthetics were maintained.[8] An alternative conservative approach is the use of long-term bleaching or tooth whitening. Up until recently the use of bleaching agents for dental treatment was considered to be illegal practice. However, a recent position statement from the General Dental Council indicated that the use of 0.1-6% hydrogen peroxide in patients over 18 years as part of their dental treatment is now acceptable provided the patient has had an appropriate assessment by a dentist.[9] Satisfactory aesthetic improvement has been reported[10] following six weeks of external vital night guard bleaching, using 10% carbamide peroxide (approximately 3% hydrogen peroxide). While this conservative treatment option may be effective, it can give rise to sensitivity. Alternating the bleaching agent with the use of a desensitising agent or fluoride containing toothpastes can help in managing the sensitivity.[10] The process of bleaching can significantly decrease the bond strength of resin-based materials to the bleached tooth surface compared to the unbleached surface. Delaying the final restoration for two weeks and leaving the enamel surface exposed to saliva has been shown to eradicate the adverse effect of bleaching on bond strength.[11] In many cases these treatment modalities alone are not enough to restore aesthetics and may need to be combined with other treatments (Fig. 1). The use of microabrasion or bleaching initially can help reduce some of the discolouration making it easier to conservatively mask the teeth with other treatment modalities.

CROWN LENGTHENING SURGERY

Often patients with AI have reduced clinical crown height due to loss of tooth structure resulting from enamel chipping away and tooth wear. This tooth surface loss may be compensated for by dento-alveolar compensation leaving a 'gummy' appearance to the patient's smile.[12] Prior to the teeth being restored it is therefore important to determine whether or not there has been any dento-alveolar compensation and the position of the incisal edge and gingival margin in relation to

the upper lip when it is at rest and more importantly when the patient is smiling. It is also important to assess the amount of tooth display visible. Ideally in a young female patient there should be 3-4 mm of incisal display of the upper incisors and approximately 1-2 mm less in a young male patient when the upper lip is at rest.[13] When smiling the upper lip should be close to the cervical margin of the teeth with no more than 1.5-2 mm gingival display.[14] If the teeth were to be restored to ideal size and shape in the presence of significant alveolar compensation, it can leave the patient with too much tooth display when the lip is at rest or when smiling and a 'gummy' appearance to the smile. The teeth should also be assessed to see if there is sufficient clinical crown height available to provide adequate retention and resistance form for the planned restorations. Crown lengthening surgery can be used to increase the clinical crown height available, reduce the 'gummy' appearance and restore the ideal aesthetic relationship between teeth and gingival tissues within the soft tissue frame of the upper lip (Fig. 2). However, care must be taken to assess important factors such as root length, bone support and taper of the root before carrying out this invasive procedure. In poorly assessed cases crown-lengthening surgery can result in mobility of the teeth and unpredictable gingival recession. Due to the tapered nature of the root, crown lengthened teeth have reduced thickness of dentine between the external root surface and the pulp chamber towards the new gingival margin. Crown preparations on these teeth are likely to have an increased risk of the teeth loosing vitality due to pulpal trauma.

Figs 1a–e A mild case of AI which has been treated with microabrasion initially (1d) followed by placement of direct composite veneers (1e). Microabrasion has significantly improved the discolouration making it easier to restore aesthetics with minimal intervention using composite resin

COMPOSITE RESINS

Direct composite

There is some evidence to suggest that teeth affected by AI do not show a typical etch pattern and this can potentially reduce the bond strength of enamel to the composite resin.[15] Despite this, the continued development of adhesive bonding systems has increased the popularity of direct composite restorations to restore both aesthetics and function in patients with AI.[16] These restorations are appropriate to restore aesthetics and eliminate sensitivity, particularly in a young adult patient where definitive restorations are contraindicated until eruption of the clinical crown is complete and the soft tissue has matured. As the gingival tissue matures and recedes to the cemento-enamel junction (CEJ), the margin of the restoration will become exposed along with further exposure of the discoloured cervical tooth structure. Similarly, often the lack of motivation to maintain good oral hygiene until the patient has been rehabilitated can result in a similar appearance of recession and exposure of the restoration margin as the gingival health improves following restorative treatment (Fig. 4b and Fig. 5f). Unlike with porcelain restorations, recession can be easily masked with composite by refurbishing the restoration to the new gingival margin without the need to replace the whole restoration.

Composite resins can be used in mild cases to veneer the surface of the teeth (Fig. 1) or for more extensive build ups in more advanced cases (Fig. 3).[16] The advantage of direct composite restorations are that they do not require complex laboratory procedures, the treatment is reversible and it is relatively quick. Sound tooth structure is preserved, as they require very minimal bevelling preparation of the teeth or no preparation at all. It is also a relatively inexpensive treatment option compared to the others and the results obtained can be highly satisfactory, both aesthetically and functionally. However, the use of direct composite resin is technique sensitive and if restorations are not adequately placed, polished and maintained, they can stain over time and may also result in wear, chipping or debonding.[17,18]

Indirect composite

Indirect composite onlays or crowns can be used to restore posterior teeth where extensive tooth tissue loss has occurred and moisture control is difficult to achieve for direct build up of teeth with composite (Fig. 3). Recent advances in laboratory composites such as the addition of ceramic fillers have improved their wear resistance, physical properties and colour stability. Laboratory made composite

Figs 2a–e Crown lengthening surgery to increase clinical crown height, reduce gingival show and improve overall aesthetic proportions

restorations also exhibit improved marginal fit, anatomic contour and reduced shrinkage.[19] Indirect resin composite restorations have shown promising success rates. One study showed a 93% success rate of indirect composite restorations on premolars and molars over a three-year period.[20] A seven-year follow up study by Donly *et al.*[19] showed indirect composites placed on premolar teeth had increased longevity than those on molars. This may be due to the fact it is easier to maintain moisture control more anteriorly during cementation and that maintenance is also easier around premolars than molars.

PORCELAIN VENEERS

These restorations are popular in the anterior region because they can achieve excellent aesthetic results with a relatively conservative tooth preparation when compared to a full coverage crown. Patient acceptance of porcelain veneers is also high and is reported at 80-100% in patient satisfaction surveys.[21,22] *In vitro* studies have identified some disadvantages, such as marginal adaptation and bonding problems;[23] however, clinical case reports continue to show success of these restorations.[1]

When restoring teeth affected by AI with either composite or porcelain veneers, some of the underlying tooth structure may be relatively dark and the translucent nature of these restorations is often unable to adequately mask the discolouration. This can result in poor aesthetics of the restored teeth. Intrinsic opaque porcelain layers incorporated into the restoration or opaque resins used during cementation can help to disguise this although this often results in a loss of translucency, which also detracts from the final appearance.

Most authors advocate some but variable tooth preparation for porcelain veneers (Fig. 4). The teeth can be very sensitive in AI patients and often requires the use local anaesthetic, which is often not necessary when placing direct composite veneers. The use of porcelain veneers in young patients may be associated with early repeat treatments due to gingival maturation resulting in exposure of the veneer margin and further exposure of the discoloured cervical tooth structure. This often requires further destructive preparation to the tooth.

METAL ONLAYS

The use of precious or non-precious metal onlays to restore and protect the occlusal surface of worn posterior teeth can be an effective treatment option. This type of restoration relies more on adhesion of the restoration to the tooth and less on the mechanical retentive features of tooth preparation often needed with conventional onlays or crowns.[24] Often the preparation for these restorations is minimal and involves a chamfer margin of 0.5-1 mm which wraps over the cusps, removal of any sharp edges and approximately 1.0-1.5 mm occlusal clearance. It is therefore particularly useful where there is lack of clinical crown height and where conservation of remaining tooth tissue is essential. Metal onlays can control sensitivity and compensate for the loss in occlusal vertical dimension.[25] While these restorations are ideal for posterior teeth, there is an increasing trend towards patients requesting tooth coloured restorations, particularly in this group of patients.

CROWNS

Of the many options available for restoring teeth affected by AI, conventional crowns have been the most predictable and durable aesthetic restoration to date.[26] The obvious disadvantage of this approach is that it is very tooth destructive. It is a highly invasive procedure for an already compromised and worn dentition in patients that are often young with immature dental pulps. Complications associated with crowned teeth in AI patients have been reported and include: loss of cementation, material fracture, caries and the need for endodontic treatment.[1,27] Figure 5 gives an example of a AI patient who has been rehabilitated using conventional crowns.

From the various types of crowns available to restore posterior teeth, gold crowns require the most conservative preparations followed by metal ceramic crowns and the most invasive being high strength all ceramic crowns. However, the use of gold may not be acceptable to patients due to aesthetics. Patients should be informed of the advantages and disadvantages of the various materials so that an informed decision can be made. Some patients may be happy to have gold restorations in the posterior part of the mouth once the risks and benefits of the alternative crown options are discussed.

In the anterior region and posteriorly for patients where aesthetics is a concern, metal ceramic crowns can be considered. To preserve tooth tissue the crowns should be carefully designed to restrict the porcelain to areas that are of aesthetic importance, such as the buccal and labial surfaces and perhaps only the mesio-buccal aspect of molar teeth. Wherever possible a minimal preparation metal margin should be made to preserve tooth tissue, such as the lingual/palatal and mesial/distal aspects of teeth. The literature is abundant with case reports using metal ceramic crowns in patients with AI.[6,28,29]

Figs 3a–n A 29-year-old gentleman who most likely has hypoplastic AI with significant post eruptive tooth surface loss. Rehabilitation involved crown lengthening surgery of the upper anterior teeth (Fig. 2) followed by minimally invasive direct composite restorations on the anterior and premolar teeth and indirect composite onlays on the posterior molars. The case shows restoration of aesthetics, function and occlusal stability with minimal damage to the remaining dentition

A retrospective study assessing the number and type of restorations present in a sample of 15 patients showed that from a total of 213 restorations 57% were metal ceramic crowns which showed good survival at five years.[1]

Over recent years the use of glass based all ceramic dentine bonded crowns made from feldspathic porcelain has increased because of their inherent aesthetics, excellent biocompatibility, good marginal fit and improved physical properties.[30] These restorations require minimal preparation of 0.5-0.7 mm circumferentially and often no or minimal preparation occlusally where tooth tissue has already been lost. Essentially these restorations are a 360 degree veneer and can be a conservative aesthetic treatment option for the anterior region, extending to the premolars on carefully selected cases. However, similar to veneer restorations a significant thickness of opaque porcelain layer needs to be incorporated into the crown to mask discolouration. This will reduce the translucent appearance to the crown and therefore compromise the aesthetics.

More recently high strength all ceramic restorations with alumina or zirconia cores have also been used in the rehabilitation of teeth affected by AI.[30,31] These restorations require heavier tooth preparation of 1.5-2 mm and therefore increase the risk of the teeth losing vitality.[27] There is also a risk of microleakage with zirconia restorations due to the inability to bond zirconia restorations to the underlying tooth structure.[30] Some reports have suggested that using these restorations in AI patients where tooth tissue has been lost, allows for minimal occlusal tooth preparation to restore the patient at an increased OVD. However, they still require the heavier axial and marginal finishing line preparations, which could traumatise the dental pulp.

Figs 4a–c The use of porcelain veneers to restore anterior teeth affected by AI. Figure 4a highlights the relatively destructive tooth preparation required for these restorations. Figure 4b shows recession around the cervical margin of 32. This is a common problem seen in these patients due to veneers being placed too early before gingival maturation or an improvement in oral hygiene measures following the positive impact of oral rehabilitation

Fig. 5a–h A young adult patient who has had extensive treatment through their teenage years to help preserve the underlying tooth structure. This patient has subsequently been rehabilitated with dentine bonded crowns on the anterior teeth and porcelain bonded and gold crowns on the posterior teeth. Overall there is a vast improvement in the aesthetics, function and occlusal stability, however, again due to an improvement in oral hygiene and/or gingival maturation, recession can develop around these teeth as shown in Figure 5f at 41/42. This is difficult to manage on teeth restored with porcelain restorations. The authors would like to acknowledge Mr S Robinson, Consultant in Restorative Dentistry for the clinical work carried out in this case

REMOVABLE DENTURES

Historically, treatment of patients with AI has included extractions and the fabrication of complete or partial dentures. These options are detrimental psychologically, irreversible and invasive,[5,6] and have become unacceptable, in light of the advances made in the field of aesthetic dentistry and adhesive techniques. Even when teeth are deemed unrestorable, they can be retained and the dentition restored with an over denture or onlay denture. The retention of teeth preserves alveolar bone[32] which in this group of patients may be important if implant treatment is to be considered at some point through their life.

Over dentures or onlay dentures are the least expensive form of treatment both economically and biologically due to the minimally invasive nature of treatment. They can prove useful in restoring aesthetics and providing a psychological benefit at a critical stage in the patient's development or where alternative invasive treatment is not a suitable treatment option for the patient.[33] The use of over dentures also requires careful assessment and planning because of the associated hazards, particularly increased plaque accumulation and susceptibility to caries, periodontal disease and variable patient acceptance.[33]

IMPLANTS

In advanced cases of AI where the teeth are unrestorable and the patient is seeking a fixed option, dental implants can be considered. Careful planning is essential and timing of extractions with respect to implant placement is very important to preserve bone, which will resorb away relatively quickly following tooth extraction.[32,34] In cases where there is insufficient bone width, it may be possible to graft the bone with guided bone regeneration, if the deficiency is minor or block onlay grafts in more severe cases. A maxillary sinus grafting procedure may be carried out which can give extra height of bone for implant placement in the posterior maxilla. In other areas of the mouth increasing bone height is extremely difficult and unpredictable. A retrospective study assessing cost implications for rehabilitation of AI patients using implants showed that the long-term cumulative treatment costs for implant cases were not statistically significantly different when compared with cases reconstructed with tooth-supported fixed prostheses.[35]

While dental implant treatment may provide a predictable outcome, many young adult patients have educational, social

or work commitments, which may make it difficult for them to attend numerous appointments and/or undergo surgery. It is also important to wait until the patient has stopped growing before implant treatment is completed.[36] Studies have shown that implants placed in a growing patient do not behave like normal teeth. They become ankylosed in the bone resulting in infra occlusion of the implant restoration as the jaw bone continues to grow around it.[37] Taking these factors into account, implant treatment may not be the ideal treatment choice in the first instance for these young adult patients. It is also important to remember that implant treatment carried out when patients are in their twenties or thirties is likely to require revision treatment in the future. In view of the fact that medical technology is constantly improving, delaying implant treatment until later in life may be advantageous to the patient as newly developed materials and clinical techniques are likely to give more predictable long term outcomes.

MULTIDISCIPLINARY TEAM APPROACH

Many patients with AI can present with a gross malocclusion and an anterior open bite as well as poorly formed teeth. These patients will require a multidisciplinary team approach to rehabilitation, which may include orthodontic treatment, possible orthognathic surgery followed by specialist restorative treatment (Fig. 6). Following definitive treatment the patient will require a multidisciplinary shared care approach to maintenance between their general dental practitioner, dental hygienist and the specialists. This is essential to ensure good longevity to the restorations provided.

Fig. 6a–h Another example of what looks like hypoplastic AI with post eruptive tooth surface loss. As well as the poorly formed tooth structure there is an associated malocclusion and an anterior open bite (6a). This patient underwent extensive orthodontic treatment (6b) and orthognathic surgery to help improve the malocclusion and reduce the anterior open bite (6c). Subsequent restorative treatment involved minimally invasive direct composite bonding to the anterior and premolar teeth and gold crowns/onlays and a porcelain bonded crown on the posterior teeth to close the anterior open bite (6f), restore aesthetics, function and occlusal stability

DISCUSSION

Rehabilitation of patients with AI requires careful planning with the most important factor to consider being the age and cooperation of the patient. Management of these patients through childhood and the early teens is mainly focused around counselling, prevention and preservation of the deciduous, mixed and adult dentition. The restorative treatment prescribed from the late teens onwards should aim to establish health, function and aesthetics of the patient's own teeth and prevent or delay the need for extraction and prosthetic replacement. This life long management requires a stepwise approach to treatment planning starting with the most conservative treatment option first.

Treating this group of patients using an evidence-based approach is difficult as the quality of the evidence is generally poor with most of the evidence being case reports. Most of these predominantly describe the use of a removable prosthesis and conventional crown and bridgework. Very few studies present long-term follow up of patients treated for AI using the different treatment options available.

Reversible and non-invasive treatment with composite resin (with or without the use of microabrasion and bleaching) should be considered before the more destructive treatment options. The use of composite resins allows restoration of aesthetics, which is most important to the patient while preserving tooth tissue. Clinicians often avoid using composite resins, as they are susceptible to staining and technique sensitive. Staining can be effectively managed by regular polishing of the restorations. If necessary the surface layer can be removed and the restoration refurbished with a new surface layer without causing further damage to the underlying tooth structure. If the composites fracture or chip they can also be repaired easily without the need for removing the whole restoration[38] and similarly as

the gingival margin continues to mature to the CEJ in young adult patients the exposed tooth structure at the gingival margin can easily be covered by refurbishing the restoration. These advantages of using composites make them a cost effective restoration both biologically and economically compared to other more invasive and expensive restorations. Composite resins should therefore be considered as the initial restorative material of choice for all patients, especially when the patient is in their late teens and early twenties, as a medium term option. When they start to repeatedly fail or the maintenance burden becomes too great the treatment could progress to more invasive techniques. This may involve adhesive porcelain veneers, dentine bonded crowns and eventually full coverage gold, porcelain bonded to metal or all ceramic crowns. If such treatment can be delayed until later in the patient's life when the pulps have receded and gingival levels have stabilised, this will be beneficial to the patient as it will limit the biological insult of treatment on the dentition. Whilst initial results with composite resins are promising further research is required to assess the longevity of composite restorations in AI affected teeth. Despite the lack of good evidence, due to its reversible and minimally invasive nature, rehabilitation with composite resins should be considered as the first line of treatment for patients with AI.

The cases presented in Figures 1 and 3 were awarded the 2010 clinical case award by the British Society for Restorative Dentistry.

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