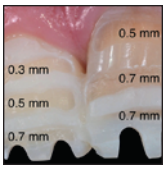
Minimally Invasive Treatment of an Ankylosed, Severely Discolored, and Intruded Central Incisor with a Masking Ceramic Veneer: A Clinical Report



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Dental therapy of traumatically ankylosed maxillary anterior teeth with an additional slight root resorption represents a great challenge for the restorative team and requires intensive planning and communication between patient, dentist, orthodontist, periodontist, and dental technician. The inhibition of vertical growth often makes dental intervention indispensable. Porcelain laminate veneers have been successfully used for more than two decades, mainly on anterior teeth, and was the minimally invasive treatment option for the present case report. Preprosthetic planning with a digital approach of the width-length ratio and the red-white esthetics were important prerequisites for a satisfactory treatment result. The treatment goal was clarified using a wax-up and a corresponding template for intraoral verification with a mock-up. The template also served as a preparation guide. Despite all risk factors, including the endodontic treatment, the 3 mm intruded position, and the slight root resorption, the patient and the restorative team decided to restore the situation with two feldspathic-ceramic veneers to provide an esthetic, time-saving, nonsurgical process for the patient.
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An ankylosis of a tooth represents the abnormal adhesion of alveolar bone, predominantly to cementum.[1] Diagnosis is possible with clinical or radiologic evaluations, whereas early detection is limited with radiographic assessment due to the two-dimensional perspective.[2] After a tooth trauma, the vital periodontal ligament of the root surface usually presents severe damage with irreversible defects of the cementoblasts. This leads to necrosis with local signs of inflammation and often ends in partial to total root resorption.[3,4] Furthermore, the clinical diagnosis can be made with a tooth in infraocclusion without possible movement and with the application of orthodontic forces.[5,6]

Numerous treatment alternatives are available in addition restoration with a veneer, composite restored build-up, or single crown when orthodontic movements are not possible, but most involve surgical procedures. These procedures include: *(1)* extraction of the ankylosed tooth with a bone augmentation and implantation, *(2)* decoronation, *(3)* surgical subluxation, *(4)* distraction osteogenesis, *(5)* ostectomy, *(6)* transplantation, *(7)* connective tissue graft, and *(8)* osteocorticotomy.[1,5,7–19]

Veneer restorations represent a minimally invasive, time-saving treatment option. The required tooth substance removal varies from

Fig 1 *Preoperative frontal view. The esthetic appearance was impaired by the darkened color and the ankylosed position.*

Fig 2 *Preoperative frontal maxillary occlusal view.*

nonprep possibilities[20] to 30% dependent on the preparation design for veneers,[21,22] compared to up to 70% for a full crown preparation.[22,23] Because of these results and the experience of more than two decades, treatment decisions have shifted toward minimally invasive options.[24,25] The possible preparation designs, such as medium (contact area and width are maintained) and long wrap design (complete elimination of the contact area), can be tailored to the specific clinical situation. A long wrap design offers more variations concerning shape and position of the planned restoration. For patients with a severe discoloration rate, large fillings, black triangles, and/or a tooth malposition, this design is preferable.[26] It is also recommended for veneered restorations in the immediate vicinity of crowns to create the contact point in ceramic, for example.[26] An optimal bond of the veneer restorations to tooth structure is particularly important for preparations completely located in the enamel structure,[27] and enamel preservation is an essential factor in the success of a veneering restoration.[28,29] Furthermore, an optimal adhesive treatment and a correct luting material are necessary.[27] A recent study found an intraoral 12-year survival rate of 99% for porcelain laminate veneers for enamel-based preparation designs.[29] In a review of porcelain veneers in 2000, the maintenance of the restorations over the medium and long term were already excellent, the patients were satisfied with the esthetic and functional outcome, and no adverse effects on gingival health in patients with a sufficient oral hygiene were seen.[27] Kreulen et al[30] analyzed a survival rate of 92% after 3 years in a meta-analysis in 1998, where most failures were due to debonding or fracture of the veneering restoration. Furthermore, the remaining unaffected tooth structure volume increases its fracture resistance.[31,32]

There are some advantages to the selected restoration technique. It is a time-saving procedure without any surgical intervention. Hard tooth tissue is preserved due to the minimally invasive preparation compared to full crowns, therefore pulpal and gingival failure rates are reduced. A study that investigated rates of vitality loss on veneer abutment teeth over 20 years found the low failure rate of 2.51% and concluded that the technique had a positive effect on the vitality of restored teeth.[33] Favorable mechanical and optical/esthetic properties can be achieved with feldspathic-ceramic materials sintered on refractor dies as in the present case report.[34,35]

Case Presentation

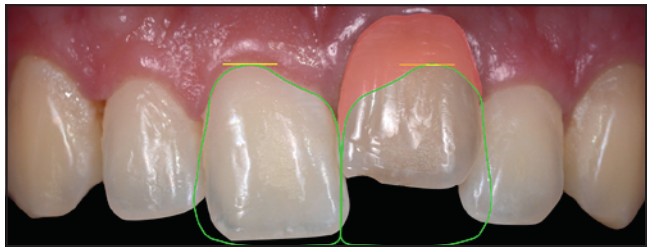
A 26-year-old patient presented at the Department of Prosthodontics of the Ludwig-Maximilians Universität München (Germany) with dissatisfaction with the esthetic appearance of his maxillary central incisors after tooth trauma.

Despite the darkened color (Figs 1 and 2), the root resorption (Fig 3), and the additional intruded and ankylosed position, the left central incisor presented with no pathologic findings. Due to the ankylosed position, the left central incisor was 3 mm clinically shorter than the right incisor but had a balanced length-to-width ratio.

At the first visit, insufficient oral hygiene was observed, with obvious general gingival inflammation. This was corrected in the pretreatment phase with extensive oral hygiene instructions/controls and a dental cleaning before the preparation. A complete clinical examination, a

Fig 3 (left) *Preoperative periapical radiograph of the maxillary central incisors.*

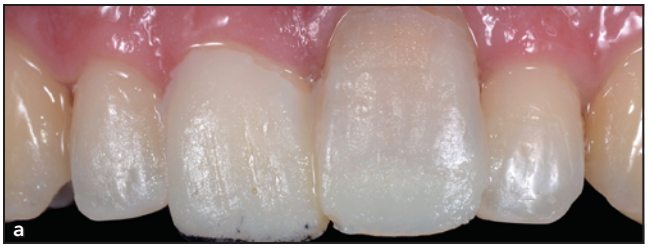
Fig 4 (below) *Digital approach for both planned ceramic veneers with the simulated width-length proportion and red-white esthetics.*

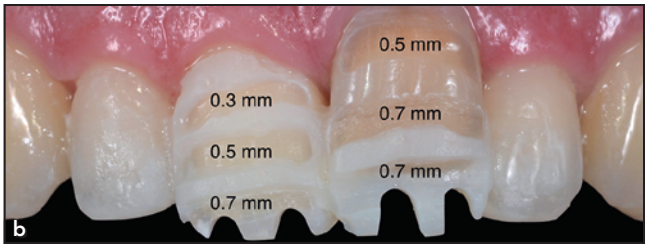


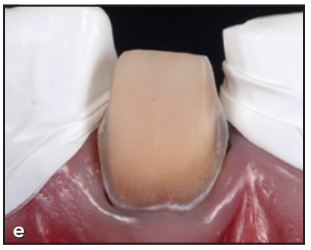
periapical radiograph (Fig 3), and intraoral photo documentation with additional manufactured diagnostic casts were the first treatment steps. These casts were mounted in a semiadjustable articulator (Artex CR, Amann Girrbach) with the help of an arbitrary facebow record and a bite registration in habitual intercuspation. The interdisciplinary consultation with the orthodontic department came to the conclusion that the single tooth could not be erupted due to the ankylosis. All relevant treatment options, such as full-crown or a nonprep veneer, and surgical possibilities were discussed with the patient. The patient decided on the minimally invasive veneering technique and desired the most esthetic alternative, with two veneers for the maxillary central incisors to mask their malposition, discoloration, and disproportion (Fig 1). The patient refused the surgical treatment option with a connective tissue graft because he preferred an uncomplicated solution; a single internal bleaching was rejected due to the root resorption. Based on the analysis of the master casts and the digital analysis of the width-to-length ratio and red-white esthetics (Fig 4), a wax-up was fabricated. The wax-up served as guide for the planned anterior tooth morphology; the intraoral mock-up (Luxatemp Star, DMG) served as an important communication tool with the patient to define the esthetic and functional parameters for the treatment goal. Minor mock-up modifications could easily proceed at this stage.

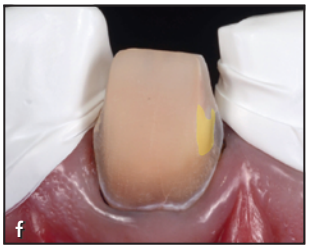
To correct the malposition of the maxillary central incisors and discoloration of the left central incisor, minimally invasive vestibular depth preparations were conducted with the mock-up in situ. This was done to ensure an economical reduction of the remaining tooth structure. More space was given to the veneer on the discolored abutment tooth to allow a better masking option (Figs 5a to 5d). After preparation, local dentin surfaces were sealed with the immediate dentin-sealing technique (Fig 5e). Maxillary and mandibular full-arch impressions (Impregum Penta, 3M ESPE) and a bite registration (Bite Compound, GC) were made. The facebow record for the wax-up was used through cross mounting. The die shade was evaluated for the masking technique (IPS Natural Die Material, Ivoclar Vivadent) (Fig 5f). The feldspathic-ceramic veneers (Creation Willi Geller)—one with additional pink ceramic to mask the original length of the tooth—were manufactured using the refractory die technique (Figs 6 and 7). An esthetic try-in of the restorations was performed with a try-in paste (Variolink Esthetic Try-In Paste, Ivoclar Vivadent). By varying the value of the try-in paste on the vital right central incisor into Warm + and on the ankylosed and discolored left central incisor into Light +, further improvement of the esthetic appearance could be accomplished (Figs 8 and 9).

Both veneers were inserted using the adhesive technique. The teeth were conditioned with a multistep dentin adhesive (Syntac, Ivoclar Vivadent) using the total-etch technique. The feldspathic-ceramic veneers were etched for 90 seconds with hydrofluoric acid (IPS Ceramic Etching Gel < 5%, Ivoclar









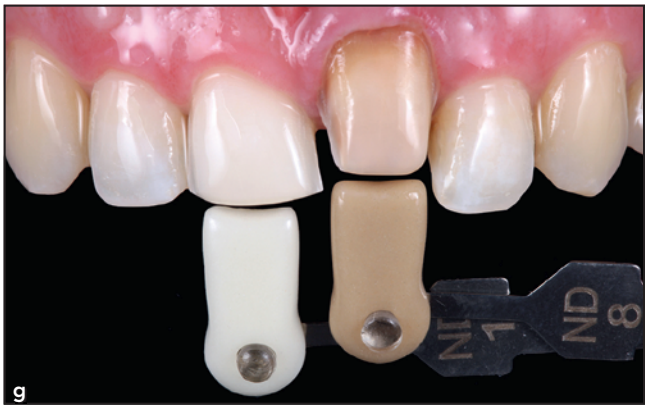


Fig 5 (a) *Intraoral mock-up according to the wax-up.* (b) *Depth marks through the intraoral mock-up.* (c) *Pencil-drawn depth marks through the intraoral mock-up as a minimally invasive preparation guideline.* (d) *All preparation burs used (Komet: 8801.314.23; 801.314.23; 6844.314.014; 6844.314.016; 3M ESPE: Sof-LexTM Polishing Discs, coarse to superfine).* (e) *Local dentin exposure was immediately sealed* (yellow-marked area). (f) *Final veneer preparation the shade determination of the prepared tooth.*

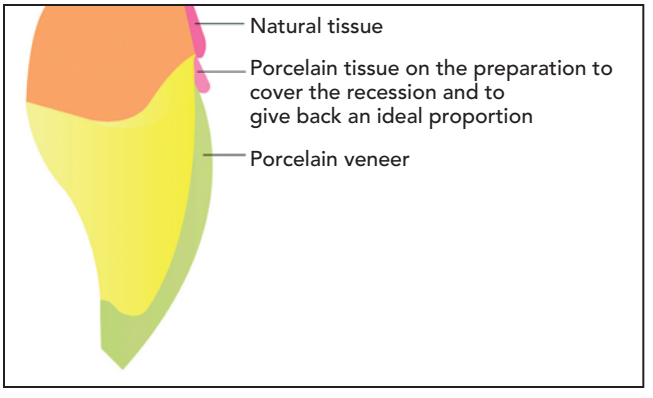


Fig 6 (left) *Schematic illustration of the masking porcelain tissue design to reinstall an ideal proportion and consider no overcontouring.*

Fig 7 (below) *Minimally invasive feldspathic-ceramic veneers for the restoration of the facial surface of the maxillary central incisors.*

Vivadent) and cleaned in an ultrasonic bath with a 96% ethanol solution (BrüggemannAlcohol, Wittenberg) for 5 minutes. The veneers were preheated (Calset, AdDent) and a silane-containing coupling agent (Monobond Plus, Ivoclar Vivadent) was applied for 5 minutes. Both veneer restorations were positioned for definitive insertion with two different values of light-curing composite (Variolink Esthetic LC

Fig 8 *Overlap of pre- and postoperative situations.*

Fig 9 *Postoperative maxillary frontal view after 1 week in the oral cavity. The restorations were placed using the adhesive technique.*

Fig 10 *Postoperative maxillary frontal view after 12 month of clinical service.*

Fig 11 (a) *Preoperative extraoral view of smile before and after 12 month of insertion.* (b) *Postoperative extraoral view of smile before and after 12 month of insertion.*

Warm + and Light +, Ivoclar Vivadent). Excess composite resin was removed after initial light polymerization of 3 seconds (PolyLUX II, Kavo). Afterward, margins were covered with an air barrier (Liquid Strip, Ivoclar Vivadent) and a light-curing procedure was performed in intervals of four times every 30 seconds from all aspects.

The patient was provided strict oral hygiene instructions and regular examination appointments.

After 1 year of insertion, intraoral and extraoral smile photopraphs and a periapical radiograph were made to check the outcome of the peroidontal tissue (Figs 10 to 12).

Fig 12 *Postoperative periapical radiograph of the central incisor with veneer restoration after 12 months of clinical service.*

Discussion

The present case report demonstrated a minimally invasive restoration technique in a patient with an ankylosed and intruded maxillary central incisor after an anterior tooth trauma. After the resulting root canal treatment and the ankylosis process, the single tooth was intruded about 3 mm in total length while presenting a correct width-to-length ratio.

If a discoloration is clearly obvious and esthetically disruptive, the veneer has to disguise this unbalanced appearance. A minimally extended preparation depth was used in the present case to allow the dental technician sufficient scope for masking the darkened tooth structure.[26] The coverage opportunity with feldspathic-ceramic veneers seems to make them a reliable and successful treatment option in such cases, with a survival rate of 93.5% reported in a previously published retrospective study.[33] Additionally, variation in value of the selected resin cement could adjust slight color differences in the veneer restorations. A full crown was rejected due to the need for tooth tissue reduction of up to 70%.

Multiple factors can affect the success of treatment with veneers, such as extended bruxism (strong functional stress), endodontic treatments, or insufficient enamel.[27,28,33] In the present study, the enamel was slightly reduced and an endodontic filling was made for the ankylosed tooth, which could compromise a successful outcome and survival. For the surgical procedure with a tissue graft, a large tooth substance reduction would have been necessary because of the anterior malposition. This would have significantly weakened the ankylosed tooth and was therefore rejected. The tooth also presented slight root resorption, but the patient decided after an extensive consultation to preserve the tooth as an abutment for the veneer restoration. Further studies suggest that teeth with severe external root resorptions should not be retained,[36–38] but the degree of resorption was not clearly stated. Generally, a restoration with veneers minimizes the risk of any endodontic devitalization due to the minimally invasive preparation designs and offers high esthetic potential in patients with discolored teeth. Achieving a maximal esthetic outcome, however, requires technique-sensitive procedures, an optimal functional guidance, and a suitable preparation design with correct adhesive techniques.[28,39–41] An additional risk factor for fracturing the left veneer is the incisal height difference of about 3 mm with greater functional stress.

Pink porcelain tissue in the present case was designed to give back an ideal proportion with no overcontouring. With this pink tissue, a new emergence profile was created to resemble a natural dentoenamel junction for optimal prevention of periodontal diseases. Overcontouring could lead to a negative biologic effect such as gingival recession or plaque accumulation.

In general, implants cannot be placed before skeletal growth is complete. The limiting factor for an esthetic outcome is often reduced vertical bone volume, which requires extensive bone augmentation before any implantation.

Nevertheless, little information and few case reports are available on this restoration procedure for an ankylosed single maxillary central incisor. More studies that investigate the long or full-wrap design and the survival rate of different restorations are needed.

Conclusions

Despite all risk factors, including the endodontic treatment, the 3-mm intruded position, and the slight root resorption, the patient and the restorative team decided to restore the situation with two feldspathic-ceramic veneers. The treatment goal was an esthetic, functional, time-saving, nonsurgical process for the patient. Nevertheless, intense preprosthetic planning with a digital approach to the width-length ratio and red-white esthetics was necessary.

Acknowledgments

The authors reported no conflicts of interest related to this study.

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