Management of Locked Non-Retrievable Implant-Retained

Overdentures - Case Reports

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Abstract

Overdentures supported and/or retained by implants, are effective treatment modalities for edentulous patients, especially for maladaptive denture-wearers. These prostheses are reported to have improved retention, resulting in enhanced function, comfort and overall quality of life for patients. The implants supporting and retaining overdentures may be splinted by utilizing a bar, or may be non-splinted and utilize individual attachments of different shapes and sizes. In cases where attachments are contemplated, a direct or indirect technique may be utilized to incorporate the matrices (housings) into the intaglio surface of the prostheses. When a direct method is utilized, or replacement of an attachment matrix is necessitated, attempts need to be made to prevent "locking" of the prosthesis intraorally.

This paper will describe two related case reports. The first is on a 75-year-old female and describes the management of a locked-in mandibular implant-retained overdenture with individual attachments. In this case, attempts to pick-up the attachment matrix intraorally led to locking-in of the prosthesis due to inadequate and inappropriate block-out of the abutment. The second case describes the process of intra-oral pick-up of prosthesis matrices on a milled bar retaining a maxillary overdenture, in a 60-year-old male. This procedure resulted in locking of the prosthesis and the management of the situation is described.

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Introduction

Implant-supported overdentures offer much improved stability, function, mastication, proprioception, comfort, retention and quality of life. To retain implant overdentures, different types of attachment systems are available. The optimal type of attachment mechanism is dependant on the prosthesis type, number and angulation of implants, patient dexterity, expectations, and financial capabilities [1, 2]. Despite a relatively forgiving path of placement with implant-retained overdentures, precise placement of the attachments is elemental to the success of the implants and optimal function and comfort of prostheses. An improper relationship between the prosthesis with implants and the supporting tissues can cause excessive forces on the implants, trauma to the underlying mucosa and bone, premature wear of the components and even loss of implants' integration [3].

Both Indirect and Direct methods may be used to incorporate the attachment matrices into the prosthesis. The indirect technique incorporates matrix components into the intaglio surfaces of prostheses using laboratory procedures. For this method, the impression records the implant/abutment positions utilizing impression copings and analogues. Prosthesis attachments are connected onto the master cast, and the matrices are incorporated by a laboratory processing procedure [4]. The indirect technique is associated with reduced chair-time, a homogenous and heat-polymerized resin acrylic base with superior mechanical properties and minimal residual monomer, optimal polishing, and avoidance of contact of monomer with tissues. However; the use of implant analogues and laboratory procedures may introduce an element of misfit and inaccuracy in which case additional time may be needed to adjust the prosthesis leaving the patient without a prosthesis for a period of time [4-6].

The direct technique involves the intraoral pick-up of the attachment matrices usually at the time of prosthesis insertion. This procedure is more time-consuming, does not require specific laboratory procedures and makes use of a pick-up resin to make prosthetic connection. This method requires accuracy and control of the position of the prosthesis during the polymerization of the pick-up resin; moreover, the direct use of auto or light polymerizing resin exposes the prosthesis to disadvantages including water resorption, difficult polishing, resin voids and more rapid degradation. Special care must be taken to avoid flow of resin into undercuts, which may create difficulties in prosthesis removal or may make removal traumatic [5]. It is elemental to provide sufficient block-out of the attachment abutments, so that when the prosthesis is seated firmly, it is not displaced. Low viscosity impression material can be used to indicate any prosthesis/attachment contact and the contact can then be eliminated before attachment connection is made [3]. Impression material can be used in the matrix receptacles of the overdenture to accurately orient and stabilize the position of the prosthesis while a single matrix component is being attached. Vent holes need to be placed in the prosthesis to allow the escape of excess resin and prevent build-up of hydrostatic forces that could force the resin down the side of the implant abutment [3, 5].

In cases of inadequate or lack of circumferential block-out or not venting of the prosthesis, it is possible for the prosthesis to be locked-in during the connection procedure. The purpose of these case reports is to describe the management of "locked-in" implant-retained overdentures, highlighting the significance of proper technique in the direct method of incorporating the matrix component in the intaglio surface of implant-retained overdentures.

Case Report (1)

Chief Complaint and History of Chief Complaint: A 75-year-old female patient presented to the Clinic on an emergency visit with a chief complaint of a non-retrievable mandibular implant-retained overdenture. The patient was completely edentulous; the maxilla was restored with a conventional removable complete dental prosthesis and the mandible was restored with a mandibular implant-retained overdenture on implants in the 33 and 43 positions. The implants (NobelReplace RP) had ball attachments in place (Ball abutment, Titanium NobelReplace RP 2 mm). She reported recent detachment of the attachment matrix from the prosthesis associated with the right mandibular implant and a visit to a denturist for the intraoral pick-up of the matrix. During the repair, the practitioner locked the prosthesis in the mouth and the prosthesis had not been removed in several weeks. The patient expressed concern with the inability to retrieve the prosthesis and discomfort due to food entrapment under the mandibular overdenture.

Clinical and Radiographic Examination: Comprehensive extra and intraoral examination was performed. Findings upon extraoral examination were not remarkable. Upon intraoral examination minor swelling and irritation on the buccal alveolar mucosa associated with the 43 implant site was visible. A minor fracture on the buccal flange border of the prosthesis was also visible at the same site. This corroborated with the patient's report of attempts at the removal of the prosthesis with a metallic fork (Figure 1). Upon examination of the mandibular prosthesis, simple removal was attempted but was not successful. Minor movement of the prosthesis was evident on the left side but no movement was felt on the right side. Previously obtained periapical images revealed mal-alignment of the 43 implant attachment matrix on the ball abutment. Based on clinical and radiographic findings, diagnosis of a non-retrievable mandibular implant-retained overdenture due to acrylic trapping while picking up the 43 implant attachment matrix was made. After explanation of treatment options to the patient and obtaining informed consent for provision of care, the situation was managed in the following manner:

Case One

Fig 1: Initial clinical presentation displaying damage to the prosthesis acrylic base on the buccal flange border, mesial of the 43 prosthetic tooth site as a result of patient's efforts to remove the prosthesis with a metallic fork. Soft tissue swelling can be observed at the edge of the flange.

Fig 2: Initial attempts to remove the prosthesis by a crown removing back-action hammer were not successful in retrieving the locked-in prosthesis.

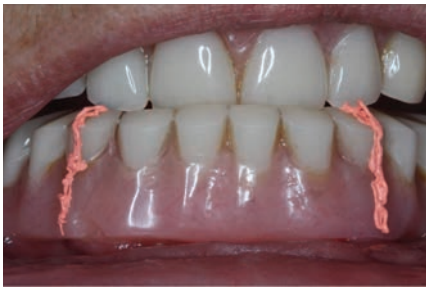
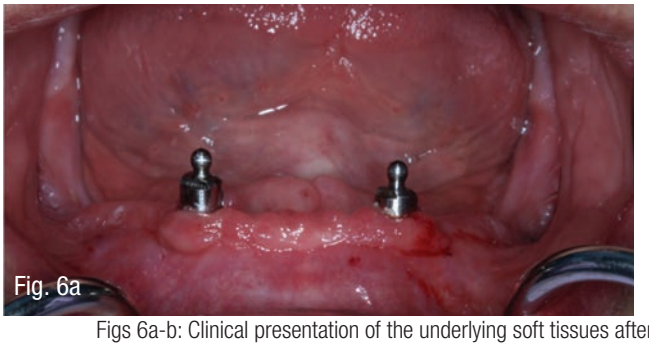
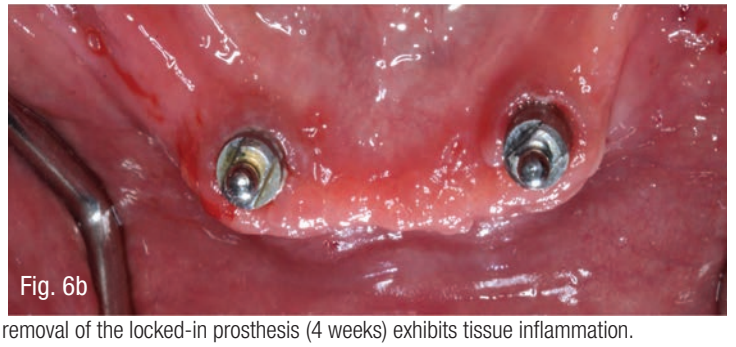


Fig 3: Gutta-percha radiographic markers were placed on the prosthesis in the 33 and 34 sites to aid in localizing the implants, attachment and matrix components.

Figs 4a-b: Periapical images showing the gutta-percha markers, which were placed on the buccal surface of the prosthesis to localize the underlying implants and associated components. Markers confirmed that the implant locations were associated with 33 and 43 prosthetic teeth on the overdenture.

Fig 5: A conservative trough was cut around the 43 matrix component without damaging the prosthetic teeth.



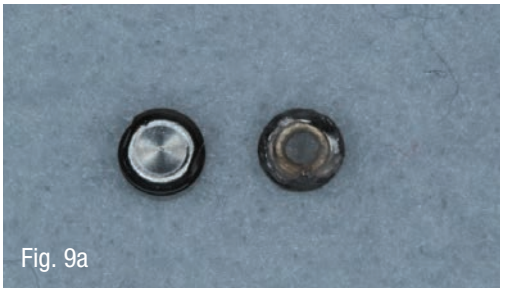


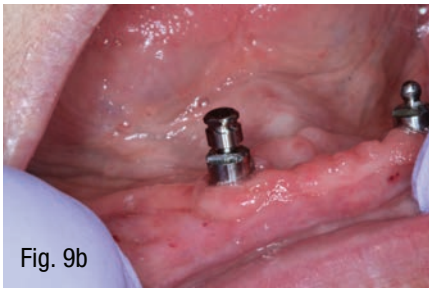
Figs 6a-b: Clinical presentation of the underlying soft tissues after removal of the locked-in prosthesis (4 weeks) exhibits tissue inflammation.

Figs 7a-c: Appearance of the prosthesis after removal, note the food debris, damaged attachment matrix, O-ring and excess acrylic leading to locking-in of the prosthesis.

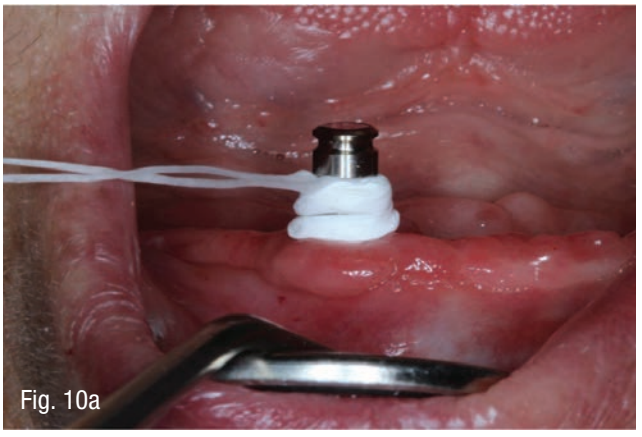
Case One

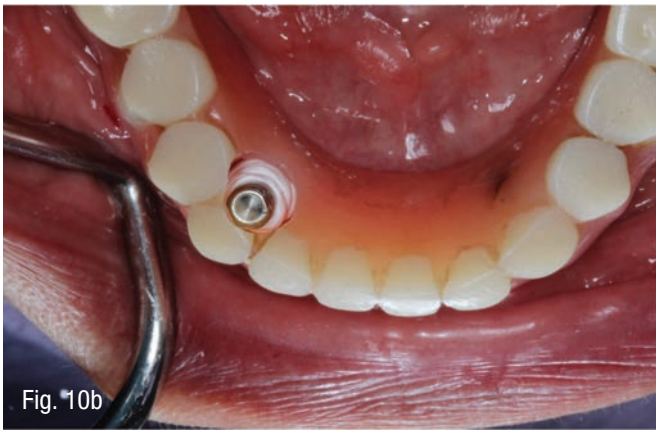
Fig 8: Enlarged vent hole without damage to the buccal surface of the prosthesis is evident.



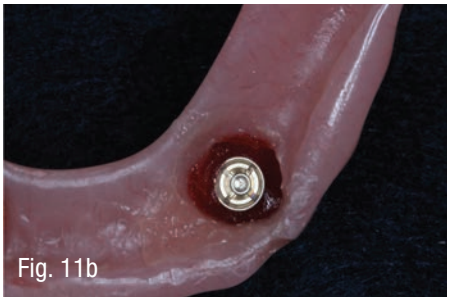


Figs 9a-b: The damaged retrieved attachment matrix (right) and a new attachment matrix (left) for comparison (a). The fresh attachment matrix inserted on the 43 implant ball abutment to be picked up intraorally (b).





Figs 10a-b: Undercuts inferior to the attachment matrix blocked out with Teflon tape and secured with floss (a). Prosthesis inserted, presence of sufficient space between the intaglio surface of the prosthesis and the metal matrix was confirmed (b).



Figs 11a-c: The same prosthetic treatment in the provisional stage. In this second sequence of images, the preparation follows the BOPT technique [9]

Management: Initially the "back-action hammer" was used to attempt dislodgment the prosthesis from the underlying abutments (Figure 2). It was evident that the prosthesis was loose on the left side and completely non-retrievable on the right side. In an attempt to isolate the force to the 43 region, the 33 site was held down while the removal force was applied. This procedure was not successful and therefore the decision was made to cut through the prosthesis to separate the matrix. Choosing this method could cause significant damage to the prosthesis.

Since the exact location of the implants could not be directly visualized due to the prosthesis flange, gutta-percha markers were placed on the buccal surfaces of the 33 and 43 prosthetic teeth extending onto the buccal polished surface (Figure 3) and periapical radiographs were obtained. It was confirmed that the locations of the implants were associated with 33 and 43 prosthetic teeth (Figure 4). A round acrylic bur was used to cut a conservative trough around the estimated location of the 43 implant and abutment lingual to the 43 prosthetic tooth. This was undertaken with no damage to the prosthetic teeth (Figure 5). After visualizing the matrix metal and confirming accurate location of the trough, a diamond bur in a high-speed hand-piece was utilized to complete the trough around the attachment components.

Upon completion of this step, the prosthesis and attachment matrix were detached from the ball abutment and the prosthesis was removed without difficulty. Subsequently, general erythema of the underlying soft tissues and food debris on the intaglio surface of the prosthesis were visible. It was also observed that the receptacle area associated with the attachment matrix was filled with hard acrylic suggestive of lack of sufficient block-out during previous attempts in picking up the matrix. The matrix component was damaged and not usable (Figures 6, 7). The overdenture and soft tissues were thoroughly irrigated with Chlorhexidine Gluconate 0.12%, the matrix and O-ring were removed and the vent hole in the prosthesis was enlarged and cleaned of remnant acrylic resin (Figure 8). A fresh attachment matrix component (Gold Cap Ball abutment insert, NobleReplace, Nobel Biocare, Canada Inc.) was connected to the 43 implant ball abutment and parallelism with the 33 matrix was confirmed (Figure 9). Undercuts inferior to the matrix were blocked out with Teflon tape, secured with floss and presence of sufficient space between the intaglio surface of the overdenture and the matrix was confirmed visually (Figure 10).

The new matrix component was picked up with auto-polymerizing inlay pattern resin (Duralay, Reliance, Dental Mfg, Worth, Illinois 60482). Resin was placed on the top and retentive grooves of the matrix and the intaglio surface of the prosthesis. The prosthesis was seated, and after ensuring accurate position using occlusion as a guide, it was held in place with finger pressure. Excess resin was observed to escape through the lingual perforation and the patient was subsequently asked to close in maximum intercuspation position. After completion of polymerization, the prosthesis was removed and acrylic around the matrix was checked to ensure that the component was securely positioned (Figure 11). The result was an optimally retained and retrievable prosthesis.

Case report (2)

Chief Complaint and History of Chief Complaint: A 61-year-old male patient presented to the Graduate Prosthodontic Clinic at the University of Toronto, Faculty of Dentistry with a chief complaint of a non-retentive maxillary implant-supported bar-retained overdenture.

The patient was completely edentulous; the maxilla and mandible were restored with implant-supported overdentures retained on milled titanium bars (Figure 12). The patient had never been satisfied with the retention of the maxillary prosthesis since fabrication (2015), reporting relatively easy dislodgment in vertical direction. He desired a more retentive maxillary prosthesis.

Clinical and Radiographic Examination: After completion of extraoral examination revealing non-significant findings, comprehensive intraoral examination was performed. Upon intraoral examination significant wear of the 4 locator abutments (Figure 13) and inadequate simultaneous engagement of the matrix elements by the matrices during insertion of the maxillary prosthesis was noted. The mandibular prosthesis and locators were in optimal condition. Upon radiographic examination, all implants appeared to be optimally osseointegrated with acceptable bone levels and the bars adequately seated on the implants in both jaws.

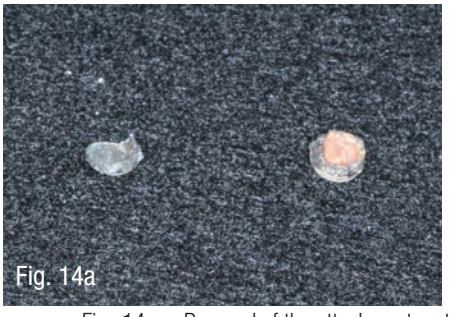
Management: The diagnosis was lack of sufficient retention of the maxillary overdenture prosthesis due to significant wear of the locator abutments and also inadequate engagement of the abutments resulting in a slight rocking motion, lack of optimal lateral stability and retention. A treatment plan including replacement of the patrices (locator abutments) on the maxillary bar and intraoral pick-up of the locator abutment matrices to accurately incorporate them in the prosthesis was formulated and communicated with the patient. Informed consent was obtained and care was provided in the following manner:

All 4 locator abutments on the maxillary bar were replaced with fresh abutments. This resulted in improvement in retention; however, the issue with non-simultaneous and inadequate engagement of the abutments by the matrix elements still persisted. The matrix elements were picked up intraorally separately on the right and left sides. The matrices were removed by drilling around them from the intaglio surface of the prosthesis and a small vent hole was created without damage to the prosthetic teeth. The retrieved attachment matrices were damaged and not suitable for further use (Figure 14). White block-out spacer rings were placed on the attachment matrices (Figure 15) and auto-polymerizing pink PMMA acrylic resin was used to pick-up the left side attachments first. This was done uneventfully and resulted in optimally positioned and secured matrices in the intaglio surface of the prosthesis. When the same procedure was performed for pick-up of the right side matrices, the prosthesis got locked in and simple retrieval was not successful. Digital dislodging forces and the "back-action hammer" were not sufficient for retrieval; hence, a diamond bur in a high-speed hand-piece was used to cut a trough around the estimated location of abutments lingual to the prosthetic teeth with no damage to the prosthetic teeth. Due to inability to remove the prostheses after preparation of a conservative trough, the hole was extended and the matrix element was completely removed. This resulted in damage to the underlying locator abutment and the matrix. The prosthesis was then removed revealing the remainder of the pink auto-polymerizing acrylic resin on the bar and the intaglio surface of the prosthesis framework. This was suggestive of excessive amount of acrylic utilized and pushed around the parallel walls of the milled bar, which due to the intimate fit with the framework resulted in a non-retrievable prosthesis. It was also evident that the locator abutment patrix and matrix components were not reusable (Figure 16).

Case Two

Figs 12a-b: Initial clinical presentation of the maxillary implant-supported bar-retained overdenture, exhibiting suboptimal retention.

Figs 13a-b: Locator abutments exhibiting significant wear and loss of structure resulting in less than ideal retentive ability.



Figs 14a-c: Removal of the attachment matrices (a) and provision of vent holes on the prosthesis (b). It is evident the removed matrices are damaged and not reusable (c).

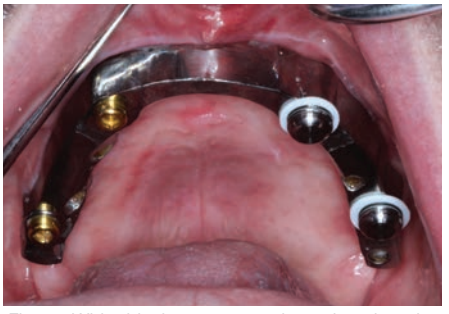
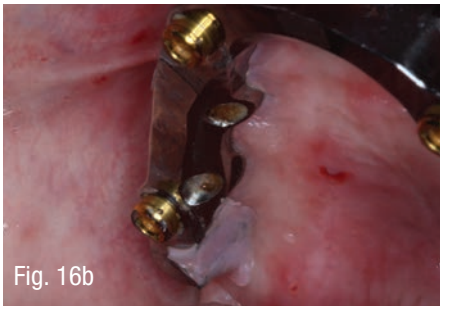


Fig 15: White block-out spacer rings placed on the attachment matrices.



Figs 16a-f: Remainder of the pink auto-polymerizing acrylic retained on the bar after retrieval of the overdenture (a, b), the intaglio and polished surfaces of overdenture (c, d, e) and the retrieved matrix (f).

Case Two


Fig. 17a

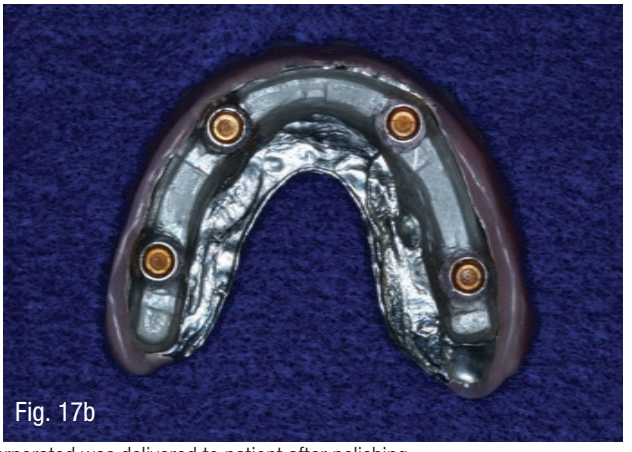


Fig. 17b

Figs 17a-b: The prosthesis with matrix elements incorporated was delivered to patient after polishing.

A fresh locator abutment was inserted and torqued in place and a fresh matrix component was inserted. Due to the intimate fit of the overdenture metal framework and the underlying bar, blocking out the bar structure yet ensuring adequate seating of the overdenture was challenging. A creative solution of applying a thin sheet of clear Cellophane on the bar was used to ensure adequate seating of the prosthesis, yet blocking out the parallel walls and underlying structures to prevent locking. Moreover a white block-out ring was placed on the locator abutment. The new matrix component was picked up with pink auto-polymerizing PMMA acrylic resin by applying the material directly on the matrix through the large vent hole. After completion of polymerization, the prosthesis was removed and acrylic around the matrix was checked to ensure that the component was securely positioned. The prosthesis had improved retention due to optimal engagement of the matrix components simultaneously (Figure 17).

Discussion

Incorporating the matrix element of implant-retained overdentures is a technique sensitive procedure. Multiple factors should be considered, one of which is venting the prosthesis when attempting to pick-up the matrices so that excess acrylic escapes and does not flow down the implant abutment thereby locking in the prosthesis [1-4]. In the first case, there was no evidence of a vent hole present on the polished lingual surface of the prosthesis. This suggested that the incorporation of the matrix was performed under significant hydrostatic pressure, resulting in extension of acrylic beyond the planned location. A lack of block-out would enhance this effect and no block-out was noted in this area. In the second case, the firm fit of the prosthesis and framework and lack of block-out resulted in the irretrievability.

In some cases where the prosthesis is non-retrievable, the extension of the prosthesis flanges do not allow for localizing the underlying implants. To localize the implants, heated gutta-percha from a gutta-percha dispensing gun can be used safely and efficiently on the dry polished surface of the prosthesis and a subsequent radiograph (periapical or pantomograph) can be made. Other methods can also be used such as adhesive marker balls. All attempts should be made to not damage the prosthesis.

Different materials can be utilized for incorporating the matrix element into the overdenture base. Auto-polymerizing pink PMMA acrylic resin is commonly utilized due to esthetic compatibility and optimal bonding with the prosthesis base material; however, this material has a longer setting time in comparison with some other materials. Inlay pattern resin (Duralay, Reliance, Dental Mfg) may be used due to the faster setting time, and distinguishability from the surrounding material due to its red colour. In cases similar to the first one where recognizing the newly added material to identify the thickness of the remaining acrylic is favourable, inlay pattern resin may be preferable. Literature does suggest that if a different color of resin is used, excess material can easily be detected, removed and identified during possible future repairs [4, 5]. In addition, different hard relining materials and attachment orientation materials (either acrylic or composite resin based) can be utilized [4]. Acrylic resins used for this purpose are autopolymerizing and chemically bond to the prosthetic base whereas composite resin materials require the application of a bonding agent to the prosthesis base and are light-cured. The surface of the metal matrix can also be treated to enhance the chemical and mechanical bonding between the matrix and the pick-up acrylic material (silicoating and using various metal bonding agents).

It is noteworthy that implant-retained overdentures have thinner bases in the matrix region to accommodate the attachment components and this may result in fractures. To optimize strength, the literature suggests for clinicians to use auto-polymerizing PMMA acrylic resin in chair-side direct transfer of attachments and ideally create chemical retention to the metal of the matrices [8]. It is also important to use the appropriate amount of pick-up material to prevent locking incidents similar to the second case.

Implant overdentures can get locked-in if undercuts on abutments or bars are not blocked out appropriately[4]. Numerous block-out materials are suggested in the literature, including but not limited to rubber-dam, a perforated piece of an examination glove [5, 9], orthodontic rubber spacers[10], etc. Block-out materials should ideally be stiff, easily contoured and removable [9]. They should not bond to the prosthesis base or to the newly placed attachment resin. The first case made use of Teflon tape, which is easily placed and meets the criteria outlined. In the second case it was more difficult to block-out the bar due to the close fit of the overdenture framework and the underlying bar and therefore the use of a Cellophane sheet was tried and was successful.

It is crucial to ensure that sufficient space is present for material to attach the matrix to the prosthesis without the metallic component interfering with adequate seating of the prosthesis. Any such interference may lead to dislodgment of the prosthesis and inaccurate incorporation of the matrix component. It is also important to stabilize the matrices on abutments during the transfer procedure. Stabilizing devices are available from different companies (Directional rings, Bio Horizons Implant Systems, Inc, Birmingham, Ala) with 3 degrees of inclination. However, they may not allow for optimal parallelism and hence be insufficient. Rubber-dam material can block-out but will not stabilize the matrices [9], orthodontic rubber spacers [10] and light-polymerized composite resin (Z100; 3M ESPE, St Paul, MN) can be used to both block-out and stabilize [9]. In the first case Teflon tape was efficiently and predictably used as a block-out and stabilizing material and in the second case due to the intimate fit of the prosthesis and the underlying bar, stabilization was less of a concern.

The prostheses may require gross removal of acrylic in the vicinity of implants to remove the matrix and the prosthesis. In some cases, sectioning the prosthesis, resulting in irreparable damage may be necessitated. In most cases when the prosthesis is relieved in the areas of implants, damage to the matrices is inevitable, even if only a trough is made. If an undamaged matrix is observed, it may be retrieved by heat-treating the metal matrix with an electric soldering instrument and removed from the acrylic resin with cotton pliers after loosening to be reused [7].

The direct method for attachment incorporation is reported to be superior to the indirect technique from both immediate (pressure sores) and long-term (liner and attachment replacement) aftercare perspectives. Long-term evaluations have revealed less prosthetic interventions to be required when the direct method is utilized. Using the indirect technique is stated to result in greater need for liner exchange due to loss of retention, sore spot relief and attachment replacement due to wear. This may be due to impression making discrepancies and denture laboratory processing during attachment incorporation contributing to attachment incorporation inaccuracy and a resultant increase in the need for aftercare. The direct technique minimizes the need for aftercare by overcoming such inaccuracies [4]. With this being the case, one must be well versed in the direct method, as it will be utilized not only at the beginning of treatment but also later in treatment should maintenance of the prosthesis be required.

Conclusion

These case reports highlight the diagnosis and management of non-retrievable implant-retained overdentures. The incident in the first case was due to misalignment of the matrix, not venting the prosthesis and insufficient or lack of block-out during direct pick-up of the implant ball abutment matrix. In the second case, complications occurred due to inadequate block-out and excessive amount of material utilized for pick-up. The direct technique of incorporating attachment matrices into the intaglio surface of implant-retained overdentures has multiple advantages; however, is highly technique sensitive. An important element is to provide sufficient block-out with an optimal material to ensure accurate incorporation of the matrix component and maintain retrievably of the prosthesis. ■

Bibliography

1. Sadig WM. Special technique for attachment incorporation with an implant overdenture. J Prosthet Dent 2003;89:93-96
2. Ku YC, Shen YF, Chang YM. Block-out prior to pick up impression of overdenture with ERA attachments. J Prosthet Dent 2002;87:695
3. Dominici JT, Kinderknecht KE, Patella-Clark E. Clinical procedure for stabilizing and connecting O-ring attachments to mandibular implants over denture. J Prosthet Dent 1996;76(3):330-333
4. Nisan J, Oz-Ari B, Gross O, Ghelfan O, Ghaushu G. Long-term prosthetic aftercare of direct vs. indirect attachment incorporation techniques to mandibular implant-supported overdenture. Clin Oral Impl Res 2011;22:627-630
5. Taddei C, Metz M, Walkman E, Etienne O. Direct procedure for connecting a mandibular implant-retained overdenture with ball attachments. J Prosthet Dent 2004;92(4):403-404
6. Ozkir SE, Yilmaz B, Kurkcuglu I, Culhaoglu A, Mutluay S. Surface roughness and adaptation of different materials to secure implant attachment housings. J Prosthet Dent 2017;117:87-92
7. 7. Hsu Y, Yang JJ. A technique for removing metal housing from acrylic resin. J Prosthet Dent 2014;112:381-382
8. Domingo KB, Burgess JO, Litaker MS, McCracken MS. Strength comparison of four techniques to secure implant attachment housings to compete dentures. J Prosthet Dent 2013;110:8-13
9. Hsu YT. Use of light-polymerized composite resin to stabilize ball attachments during transfer procedures. J Prosthet Dent 2005;94:470-471
10. Keys LG, Alarcon K. Simplified technique for blocking out undercuts during direct over denture matrix attachment. J Prosthet Dent 2002;88:111.