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Retention Systems for Implant-Retained Overdentures

Abstract: There have been demographic and cultural changes in the past few decades with regards to edentulism. Conventional mucosa-borne dentures can be poorly accepted by some patients. Implant overdentures have a useful role to play in the treatment of some of these patients. Some form of attachment mechanism between the implants and the prosthesis is normally required. This paper updates the reader on the different types of attachment systems and bars available.

Clinical Relevance: It is important that dentists and technicians are able to understand the advantages and disadvantages of different attachment types for overdentures, in order to select the most appropriate technique for each patient.

Dent Update 2013; 40: 28–31

Despite improvements in oral health seen in the UK since the 1970s, the preliminary results from the 2009 Adult Dental Health Survey have shown that 6% of the adult population of England and Wales were edentulous.[1] Although this is a large reduction from 37% in 1968, it means that there is still a significant demand for complete dentures.[2] Furthermore, the population as a whole is ageing, with increased numbers living beyond their 85th birthdays. People are also becoming edentulous later in life, with partially dentate adults becoming the norm until old age.[1] The combination of these demographic changes means that the edentulous group can be extremely challenging to treat effectively for a variety of social, psychological, physiological, biomechanical and anatomical reasons.

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Whilst the majority of patients is reasonably happy with a well made upper complete denture, many are not as satisfied with a lower complete denture. Patients frequently complain of looseness and social embarrassment due to movement of the prosthesis during function. It is recognized that patients with complete dentures function with lower occlusal forces than subjects with natural teeth.[3] This can lead to reduced masticatory efficiency.

For the purposes of this article, the following definitions will be used:

Stability is the quality of the dental prosthesis to resist displacement by functional horizontal or rotational stresses.[4]

Support is the resistance to displacement towards the basal tissue or underlying structures.[4]

Retention is the quality inherent in the dental prosthesis acting to resist the forces of dislodgment along the path of placement.[4]

A poor lower alveolar ridge can result in problems such as a lack of stability and lack of support.

Some patients are able to develop a high degree of neuromuscular control of the tongue, to stabilize the lower denture effectively. However, some never develop the required degree of control. It is these patients who may require additional help to achieve a satisfactory level of oral function. In many cases, dental implants can provide this help. This can be achieved with a variety of retention systems. Stability, retention and support can be dramatically improved, with commensurate improvements in chewing ability, speech and social confidence.[5]

Osseointegrated implants and connection options

There are several ways to connect the prosthesis to implants. This can be done either directly on to the bar, as in a bar and clip system, or by using direct attachments.[6] The latter include studs, Locators©, and magnets. These attachment systems may be used on their own, or as secondary retention systems in combination with a bar.

Studies have shown superior patient-based outcomes using two-implant mandibular overdentures compared to conventional lower dentures.[7] These led to the publication of the McGill Consensus in 2002, which stated that the treatment of choice for an edentulous mandible should be a two-implant retained overdenture.[8] Implants can effectively solve problems of retention and stability, and can also contribute to providing support.

There are two main ways to use implants in an overdenture situation: either by linking them or not linking them. There are advantages and disadvantages to both, a discussion of which is outside the scope of this article. Linking implants is done with the use of a rigid bar. Bars vary in their design, material and manufacturing process. An explanation of the various types follows.

Bar designs

With two implants, bars can be made in a straight line (Figure 1). Alternatively, they can include cantilevered sections (Figure 2). The prosthesis (implant-retained overdenture in this case) contains clips that fit over the bar directly (Figure 3). The different types of connection allow different types of prosthesis movement to occur. Movement can be vertical, horizontal or rotational. It is important to appreciate how the prosthesis moves. A rigidly held prosthesis will be *entirely implant-supported*, regardless of the fact that it is a removable overdenture. This may or may not be desirable in a given clinical situation. For example, the intention might be to transmit all the occlusal forces through either just the implants or, alternatively, it may be the intention to share the load between the implants and mucosa.

Most of the commonly used bar designs allow rotation to occur, if used in a single straight line, eg Dolder (egg-shaped in cross-section) and Hader (a parallel-sided beam with a rounded part towards the incisal). Therefore, when the patient chews on the posterior part of the prosthesis, rotation around the bar can result in loading the mucosa posteriorly. This may or may not have been the intention. If the bar is not in a single straight line, such as in Figures 2 and 3, the potential for rotational movement is lost as the cantilevered beams will prevent this rotation. This is a commonly misunderstood point. The prosthesis will fail to rotate, regardless of the cross-sectional shape of the beam. If no rotation of the prosthesis is possible, when the patient chews only on the back teeth, there will be *no mucosa support* posteriorly. Instead, the anterior implants are taking all the occlusal load. This is true regardless of the fact that the overdenture covers the traditional denture-supporting areas. This is because of the large difference in resilience of implants compared to mucosa. The prosthesis in this situation (Figures 2 and 3) is effectively completely implant-supported. This may have important implications for the magnitude and direction of stresses on the prostheses, components and implants. This may have adverse mechanical effects on the components and implants alike.

The clinician needs to plan the supporting elements of the future prosthesis *before* treatment is undertaken, as this can affect the distribution and number of implants that are placed, for example.

Attachment types

Bar and clip systems

The major bar types come with matching clips. These are incorporated into the prosthesis, either at the time of processing, or afterwards, as a pick-up procedure. Some systems include a spacer that can be incorporated at the time of processing. Use of the spacer means that there will be a space between the clip and the bar when the prosthesis is at rest in the patient's mouth. When the patient bites, the denture is then capable of some vertical movement. This means that there can be some mucosal support for occlusal loads, rather than only implant support.

A cast bar may be made incorporating proprietary components (Figures 1–3), or to an entirely custom design. The overdenture then needs to be made to fit over this custom design (Figures 4–6).

Stud attachments

Either synthetic rubber rings or metal lamellae (such as *Dalbo Plus*, Cendres+Métaux USA Inc) are retained within a prosthesis. Upon prosthesis insertion, they distort sufficiently to engage into a circular undercut on a metal post, which is part of an abutment screwed in to an implant. Used independently, they allow movement in all directions (Figure 7).

Magnets

Magnets suffer from two main disadvantages:

- The retentive force produced reduces sharply as the distance between the elements increases beyond very close contact (100 microns);
- Over time, there is a loss of magnetic attraction, sometimes accompanied by corrosion.[6]

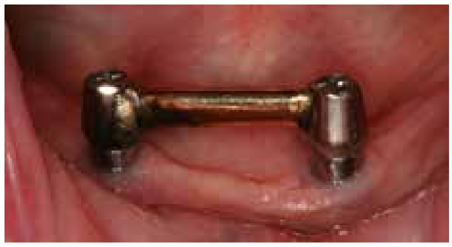

Figure 1. Straight gold Dolder bar on two implants.

Figure 2. Gold Dolder bar on two implants with cantilevered sections.

Figure 3. Three clips incorporated into acrylic denture (same patient as Figure 2).

Locators©

These are a newer type of connector which have a low profile compared to other common types of attachment. They therefore require less prosthetic space to use (Figure 8).

Nylon males within the denture attach to the Locator© abutments (Figure 9).

Bar passivity

It has been suggested that, in order to avoid undue stress on the implants, prosthetic components, screws or adjacent bone, the framework should fit passively.[9] This may reduce the likelihood of prosthetic complications. When trying in bars, a failure

Figure 4. Cast gold bar made to custom design.

Figure 5. Overdenture incorporating metal insert to fit over bar in Figure 6.

Figure 6. Custom-cast gold bar *in situ*. Space has been allowed for cleaning aids.

Figure 7. Stud abutments.

Figure 8. Locator© abutments.

Figure 9. Fit surface of overdenture showing blue nylon males.

Figure 10. Intra-oral soldering relation. The bar was sectioned and rejoined intra-orally using acrylic resin. It was then soldered in the laboratory.

of the Sheffield test implies that the bar is not fitting passively.

Amongst all casting alloys, the high gold alloys have a reputation amongst dentists and technicians for being a material that casts accurately. The casting shrinkage of alloys can be adequately compensated for by correct choice and handling of the investment material. Despite this, it can still be challenging to make passive bars over long spans.

Base metal alloys can be difficult to cast very accurately owing to their increased shrinkage compared to noble alloys. Adequately compensating for this shrinkage can be challenging.

The following section will describe corrective techniques that may be employed.

Corrective techniques for cast metal bars

Generally, there are two techniques to unite metals together. *Soldering* is the act of uniting two pieces of metal by the proper alloy of metals (glossary).[4] It implies the use of a lower fusing metal to act as a solder. *Welding* implies the localized melting of the surfaces to be joined, with no additional material added.

Soldering non-passive bars

There are standard techniques available for sectioning, picking up and soldering misfitting cast metal frameworks that have been adapted from conventional fixed prosthodontic treatment with long span bridges. These techniques can be difficult to master for both dentist and technician, and require extremely high attention to detail in order to work well (Figure 10).

Laser welding

Recently, laser welding has been used for titanium alloys, in much the same way as soldering is used for noble alloys. The CrescoTi Precision method is a specific technique that uses laser welding.[9] It was introduced as a less expensive technique for producing passivity with cast titanium frameworks. It relies on cutting the joins between the body of the framework and the 'legs', which screw down on to the implant heads. All the cuts are made in a common plane. This is achieved with a special machine. Laser welding is then used to rejoin the framework to the 'legs'.

'Cast-to' technique

This involves sectioning a misfitting cast bar, establishing an index as per soldering, and flowing in a burnout resin material. The entire bar is then re-invested and the same gold alloy is flowed into the rejoined section.

Spark erosion (Secotec method)

This is the controlled removal of material on the fitting surface of the bar abutments. The technique involves the creation of a special working cast, with copper wire attached to the implant analogues.[10-11] The analogues therefore form one set of electrodes in series. The prosthetic metal framework is also connected to an electrical circuit, forming the second electrode. The cast and the metal framework are moved towards each other over a period of several minutes, causing electrical erosion of the protruding parts of the metal framework. This ultimately results in a passively fitting framework.

Figure 11. Impression showing copper wires attached to implant analogues.

Figure 12. Working cast showing copper wires embedded within cast attached to analogues.

Figure 13. Spark erosion process in action.

The process can be carried out on any type of metal bar, and the manufacturer claims compatibility with all major implant systems. It can also be used to produce passivity with cement-retained prostheses (Figures 11–13).

Other methods of making passive bars

Milling

Milled bars are made from a solid block of material, such as titanium, by a computer-aided design/computer-aided manufacture (CAD-CAM) process. Theoretically, there should be no problems of passivity, as there is no casting shrinkage to overcome. Expensive scanning and milling equipment is required for these techniques, but the milling can take place at a distant centre.

Prefabricated component bars

Bars can be made from prefabricated titanium alloy components that are cut to size and assembled together either chairside or in the laboratory, eg The SFI-Bar (Cendres et Métaux, Biel, Switzerland).[12] The bar itself is a tube of circular cross-section. The manufacturer supplies matching components for incorporation into an overdenture. The main advantage of this bar type is lower fabrication cost, with potentially the elimination of some laboratory stages. There is currently limited clinical evidence for this type of bar, however.

Conclusion

Implant-retained overdentures are a highly useful treatment modality for many patients. There is currently a variety of retention systems available, some involving linking implants together, some not. When selecting an appropriate system, the dentist and technician should consider the needs of the individual patient, lifespan, ease of maintenance, cost, prosthetic space, support requirements and expected force levels.

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