Factors to be considered when selecting an attachment type

Selection of an attachment system that is suitable for a specific clinical situation is sometimes difficult. A good knowledge of the different systems and their mechanical properties, and the way in which they distribute load, is important. For instance, when short implants are used resilient attachments should be applied to ensure a degree of relief on the supporting implants. This allows denture movements to occur and enables the edentulous ridge to absorb the masticatory forces. Consequently, a significant amount of masticatory force is dissipated by the edentulous ridge. Some factors that should be identified and considered in order to obtain the best treatment option with the use of RISOs include the following:

1. Quantity and quality of available residual ridge

When the alveolar residual ridge is severely resorbed, a bar attachment and a telescopic attachment provide better horizontal stability, and most occlusal loads are dissipated through the supporting implants as previously stated. However, the potential risk for mechanical failure of the implant or its components is a concern if an adequate number, size and length of the implants are not appreciated.

On the other hand, when bone resorption is minimal, individual attachments such as a Locator, ball or magnet can be used. In this case the denture is mainly tissue supported and the attachments may just be used to retain the denture.
2. Shape of the dental arch
When the residual alveolar ridge is narrow and has a v-shape, the use of two splinted implants is not recommended because the bar may encroach upon tongue space and interfere with function and speech (Figure 2). If the bar is placed more labially, it may interfere with the lower lip and also affect the denture stability, and may have a negative impact on the aesthetic outcome. Therefore, individual attachments are ideal for such clinical problems when an adequate space between the implants can be granted. Three splinted implants may also provide a good alternative (Figure 2B). With three splinted implants, biomechanical risk may be increased, particularly when the implants are short and narrow. In such a situation, the denture should be totally tissue supported whenever possible.

A U-shaped residual ridge with adequate bone permits placement of four implants that are connected with three bar segments (Figure 1). However, the inter-implant distances should be wide enough to accommodate the bar and the clips in order to avoid distortion and unsatisfactory retention. The distance between the most anterior implants and the most posterior implant (antero-posterior spread) dictates the cantilever extension if required.

3. Angle between implants
There is general agreement that when individual (non-splinted) attachments, such as a ball system, are used, implants should be installed parallel to each other to gain the best retention and to reduce the wear rate of the matrices. If this is not possible, other options such as the use of angled abutments or bars may provide an alternative solution. Furthermore, Locators and magnet attachments may also provide a solution when the implants are not parallel.

4. Amount of required retention
Bar attachments usually provide more retention than individual attachments. Thus, in patients who require maximum retention, bar attachments may fulfil this requirement and represent the most ideal option. A bar that has multiple segments can be combined with individual attachments in order to maximise the degree of retention, support and stability. Also, an FISO may be an alternative.

When a single bar is used with two implants, its length should be between 20 and 22mm to obtain good retention and stability. In this case, one or two clips can be used to gain the optimal retention. When the bar is too short, stability and retention are not achievable. If the bar is too long, it may bend when it is loaded and consequently is distorted and may be broken.

5. Restorative space
Restorative space is a three-dimensional space that is available to accommodate various parts of the overdenture and its attachment system. This space is surrounded bucco-lingually by cheek, lips and tongue, and vertically by the edentulous ridge and the occlusal plane of the prospective overdenture. Therefore, it should be appreciated in vertical and horizontal dimensions. Hence, room for the attachment, the superstructure, the acrylic and the teeth is required. If this room is not available, the outcome is negatively affected and, for example, mechanical failure of the denture is a possibility.

The aesthetic requirement of the final restoration (overdenture) is significantly influenced by the available restorative space, as well as by the used attachment system. As an example, when vertical space is limited, the use of a bar attachment may violate the inter-occlusal (free-way) space to accommodate the restoration, which results in an inferior aesthetic outcome of the overdenture, as well as possibly leading to other complications that arise as a result of this error. In such a case the attachments with a low profile are the best option; however, other factors should also be considered.

A minimum of 12mm of vertical restorative space from the crest of the ridge to the incisal edge is usually required with the bar system. This distance consists of 4mm for the bar, at least 1mm for the space between the inferior surface of the bar and the ridge, and 7mm for the teeth, the acrylic and the clip. A space between the bar and the tissue is required to facilitate oral hygiene, and reduce the possibility of plaque and calculus deposition. When the Locator attachment is used, a minimum of 8.5mm is required, while the ball attachment requires 10-12mm.

The horizontal restorative space in the bucco-lingual direction should also be considered, and the attachment should be placed on the crest of the ridge to achieve the best biomechanical advantages of the attachment. As well as this, the horizontal space in the mesio-distal direction should also be considered. Thus, a good distance between the adjacent implants, which provides a good biomechanical advantage and facilitates oral hygiene, should be considered.

6. Treatment costs
Treatment and repair costs should be considered when the treatment plan is made, and the patient should be made aware of these costs. For instance, a bar or telescopic attachment is more expensive when compared with other attachment systems. Furthermore, when bar repair or replacement is required, they cannot be carried out clinically and, therefore, laboratory work will be needed. This is a lengthy and expensive process. Also, the denture will be held for some time and the patient may have to leave without the denture. Also, when an implant tissue-supported overdenture is considered, bone resorption of the tissue-borne regions will continue. Therefore, relining and occlusal adjustments are needed on a regular basis.

The cost of treatment and its inter-relationship with other factors should be investigated and considered. However, the treatment cost may compromise and interfere with providing the best treatment option.

7. Other factors
Factors such as the patient’s expectations of the prosthetic, personal choice, and knowledge and skills of the dentist and laboratory technicians, as well as opposing (maxillary) arch, may play a role in the selection of a specific attachment system and type of overdenture. All of these factors are interrelated, and their individual and combined effects should be considered and appreciated when the treatment plan is made.

The anterior region of the mandible is an ideal site for implants
There is strong evidence indicating that implant success is highly reliant on the volume and quality of the peri-implant bone. Bone quality in the anterior area of the mandible is much better than that in the posterior region, and implant failure rate in this site is lower than in any other site in the mandible, as well as in the maxilla. Implant placement in the inter-foraminal area is less critical than in other areas of the mandible, and a success rate of ≥95% was reported for implants placed in this region. Furthermore, after tooth extraction, bone resorption in this area is usually less than that in the posterior region, which gives an opportunity for installing the implants without the need for other surgical methods such as ridge augmentation and the use of graft materials.
Therefore, the mandibular anterior area represents an ideal site for placement of dental implants in the edentulous mandible with a high success rate.

**Two-implant RISOs as a first choice standard of care for the edentulous mandible**

The decision on the number of implants that suits a particular clinical situation is to some extent subjective and depends on the clinician’s knowledge and experience, as well as on many other factors. However, two consensus statements on the number of implants to be used with RISOs were published in 2002 and 2009, respectively. Both consensus statements recommended that RISOs with two implants should be considered as the first-choice standard of care for an edentulous mandible.

A more recent survey was carried out by an expert panel of 16 representatives of academic prosthodontists to investigate if there was agreement on the gold standard for an edentulous mandible between the two-implant-supported mandibular overdentures and a conventional mandibular complete denture. The survey results concurred with the two consensus statements of 2002 and 2009.

Even though the RISO with two implants is a reliable clinical decision and is considered as the minimum standard that should be appropriate for most patients, it does not suit all patients and the abovementioned factors should be taken into account when planning for mandibular RISOs.

As a general guide, two implants of 4mm diameter and a minimum of 8mm length are sufficient in order to obtain satisfactory retention and stability. The two implants are preferably located in the lateral incisor areas and not in the canine region. This location is regarded as the best site for installation of the implants for several reasons. For instance, if a removable RISO is supported by two implants that are placed in the canine regions, and the RISO then needs to be altered into a fixed one where five implants are considered essential, placement of three additional implants between the two existing implants may not be possible as the space would be insufficient. Additionally, it has been suggested that the anterior mandibular area should be divided into five equal spaces, in which prospective implants may be positioned. By this strategy, more implants may be installed if the overdenture needs to be changed from a two-implant-supported overdenture to a four-implant-supported overdenture.

Furthermore, if four implants were installed with an equal distance between each, placement of an additional implant when it is required is not possible, as there will be insufficient space to accommodate the fifth implant.

**Splinted versus non-splinted implants**

In general, when two or more implants are used to retain an RISO, two basic techniques are described and widely used: connecting the implants to each other (splinted); or, using them individually (non-splinted) (Figures 1, 2 and 3). For example, two implants may be joined together with a straight bar that has an ovoid/circle cross-section, which permits denture movement vertically; thus, the implants as well as the mucosa will be involved in the dissipation of the occlusal force. Two implants can also be used individually in a non-splinted fashion with a ball, Locator, magnetic or telescopic attachment (see later). However, patient satisfaction regarding retention and stability of the RISO declined significantly with the use of the two non-splinted ball attachments, while patient satisfaction with single-bar and triple-bar (two and four implants) attachments did not change with time.

When two implants are used in the construction of the RISO and to reduce mechanical failures of the prosthesis and/or implants, the overdenture should have a single axis of rotation during function. This rotation will allow the alveolar ridge to take part in dissipation of the occlusal loadings. This design requires that the denture base be extended in a similar fashion, as in the case of a conventional complete denture. This allows a maximum area of tissue to support the denture. However, when a bar with multiple axes is used, the denture is exposed to torque that consequently leads to damage of the attachment and the denture, in addition to overloading of the implants.

**Single-implant-retained RISOs**

In an attempt to simplify the technique while still maintaining denture stability, retention, and patient comfort and satisfaction, a single implant mandibular complete overdenture can be used. In this case only one implant was installed in the midline of the mandible with a ball, a Locator or a magnet attachment. However, because of a limited number of well-controlled clinical studies, it is difficult to draw a sound conclusion regarding the viability of one-implant-supported overdentures.

**Use of mini-implants in RISOs**

Mini dental implants (MDIs) are one-piece implants with a diameter of less than 3mm (range from 1.8mm to 3mm). They may be used as an alternative option when a conventional implant is not possible, as when the alveolar ridge is severely resorbed or in systemically compromised patients. The advantages of using mini-implants include relatively low cost, simplicity of placement, minimally invasive surgery and significantly shorter healing periods than those for conventional implants. However, mini-implants have a reduced diameter and surface area; therefore, they are subjected to greater occlusal loading, which may lead to mechanical failure, such as deformation and fracture. Nevertheless, when four mini-implants were used to support and retain the RISO for three years, high survival rates were reported irrespective of whether mini-implants were immediately or early loaded (91.7% and 96.7%, respectively). Nevertheless, well-controlled randomised clinical studies are required.

**Complications and attachment failure**

RISO failure is most commonly of a mechanical nature. Types of failure include: fracture of the acrylic base, teeth and retentive clip; reduction of retention as a result of wear of the retentive elements or loosening of matrices and screws; fracture or wear of the clip and matrix; fracture of solder joints; and, dislodgement of the attachments. Complications as a result of plaque...
TABLE 3: A summary of the results of several laboratory studies on attachment systems.

| 1. Irrespective of the material used (with the exception of magnetic attachments), the majority of attachment systems show a degree of wear with use. |
| 2. As a result of the wearing process, a decrease or complete loss of retention is usually seen after use, the exception is telescopic systems. |
| 3. The telescopic crown attachment system shows an increase in retention with use, which is explained as a result of wear. This leads to an increase in the mechanical adaptation between the matrix and the patrix. |
| 4. The magnetic system shows the lowest retention capacity but the least wear. |
| 5. The magnetic system shows a low percentage of retention loss after use. |
| 6. A high percentage of retention loss was seen with ball, Locator and Extra-coronal Resilient Attachment (ERA) systems. |
| 7. When one attachment element is made of plastic and the other is made of metal, such as in the Locator and ERA systems, the decrease in retention seen is a result of distortion of the plastic patrix, as insignificant wear was detected in the metal matrix. |
| 8. The decrease in retention that is seen with the other attachment systems is believed to be due to wear of the matrix or patrix, or both attachment parts. |
| 9. Clinical performance of the Locators and ERAs are similar, as both consist of plastic patrices and metal matrices. |

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References


