# 4
# Principles of Attachment Selection

*Hamid Shafie*

One of the most confusing issues for dentists is choosing the appropriate attachment assembly for implant overdenture cases. They usually ask themselves many questions when it comes to selecting the right attachment assembly. First, which attachment should one use? Would a bar or stud attachments be best? Depending on the answers to those questions, more considerations follow. For instance, which bar or stud would be best for this particular case?

Learning about the mechanical properties and the load distribution characteristics of different attachments is the easiest way to determine which one to use. Most available attachments demonstrate different levels of resiliency. Attachment resiliency is associated with the movement between the abutment and the prosthesis in a predetermined direction or directions. The more directions or planes in which the prosthesis can move, the less stress is placed on the implant, in turn transferring more forces to the residual ridge. That being said, the attachment is more resilient.

**Various Movements Allowed by Resilient Attachments**

- *Vertical Movement*: The prosthesis is allowed to move bodily toward the tissue. This type of movement results in even loading and support from the entire anterior-posterior length of the residual ridge. Typically, movement is stopped by the supporting structure of the residual ridge, meaning as soon as the prosthesis comes into contact with the residual ridge and passes the resiliency of the soft tissue, it stops.
- *Hinge Movement*: Hinge movement is that in which the prosthesis revolves around an axis that has been formed by the most posterior attachments on each side of the arch.
- *Rotation Movement*: Rotation movement allows the prosthesis to rotate around an axis that runs anterior-posteriorly. Anytime masticatory forces are applied to one side of the prosthesis, it rotates around the crest of the ridge, and the opposite side rotates up and across the arch.
- *Translation and Spinning or Fishtailing*: In this type of movement, the prosthesis moves in an anterior-posterior movement, or a bucco-lingual direction, without any

rotation. The prosthesis, in turn, revolves around a vertical axis.
- *Combination of the Above Movements*

# TYPES OF ATTACHMENTS BASED ON RESILIENCY

## Rigid Non-Resilient Attachments

No movement occurs between the abutment and the implant. When utilizing a rigid non-resilient attachment assembly, the implant receives 100 percent of the chewing forces, providing no relief to the supporting implants.

This type of attachment is recommended when a sufficient number of implants are available. A screw-retained hybrid overdenture is an example of a rigid non-resilient attachment.

## Restricted Vertical Resilient Attachments

This type of attachment provides 5–10 percent load relief to the supporting implants, and the prosthesis can move up and down with no lateral, tipping, or rotary movement. In other words, the attachment resists any lateral tipping or rotary movements.

## Hinge Resilient Attachments

This type of attachment resists any lateral tipping, rotational, and skidding forces. Hinge resilient attachments provide almost 30–35 percent load relief to the supporting implant. Each time one utilizes an attachment that provides hinge resiliency, the vertical components of the masticatory forces are shared between the attachments and the posterior portions of the residual ridge—the buccal shelf and retro molar pad. A Hader bar or any other kind of round bar can provide hinge resiliency. (Refer to Figures 6.23 through 6.27.)

## Combination Resilient Attachments

Attachments of this type allow unrestricted vertical and hinge movements. This attachment uniformly transfers the vertical component of masticatory forces to the entire length of the residual ridge. Anytime we utilize this type of attachment, we increase the tissue support of the prosthesis during mastication. No matter where the masticatory load is applied to the overdenture, the ridge receives the vertical component of the forces. This type of attachment offers 45–55 percent load relief to the supporting implants. The Dolder bar joint (egg shaped) is a combination resilient attachment (Figure 6.30).

## Rotary Resilient Attachments

This type of attachment provides vertical hinge and rotation movements. We utilize these attachments so that the prosthesis can move vertically and hinge-wise and rotate around the sagittal plane. Rotary resilient attachments transfer both the vertical and horizontal components of masticatory forces to the residual ridge. Movements of the prosthesis are determined by the location, direction, and magnitude of the forces that have been applied to the prosthesis. Usually this type of attachment provides 75–85 percent load relief to the supporting implants. Some of the stud attachments (prefabricated individual attachments) provide rotary resiliency. (Refer to Chapter 5.)

## Universal Resilient Attachments

These attachments provide vertical, hinge, translation, and rotation movements. Basically, you see all types of movement; the attachment provides resistance only to movements away from the tissue. This type of attachment offers 95 percent load relief to the supporting implants. Magnetic attachments are the best example of the universal resilient attachments.

# ATTACHMENT SELECTION CRITERIA

- Available bone
- Patient's prosthetic expectations
- Financial ability of the patient to cover treatment costs
- Personal choice and clinical expertise of the dentist
- Experience and technical knowledge of the lab technicians

Patients with advanced resorption of the alveolar ridge are good candidates for bar or telescopic attachment assemblies. These attachments offer a considerable amount of horizontal stability.

Patients with minimum alveolar ridge resorption are good candidates for studs or magnetic attachments assemblies. Magnets provide the least amount of retention compared to the other attachments, and they lose their initial retention capacity very soon. Studs are ideal for patients with a narrow ridge, because in these cases the bar would interfere with the tongue space.

## DIFFERENT ATTACHMENT ASSEMBLIES

- Clips and bars
- Studs
- Magnets
- Telescopic copings (rigid or non-rigid)

Rigid telescopic copings transfer most of the masticatory forces to the supporting implants. This increases the risk for implant fatigue and eventual fracture of the implant or its components. Rigid or minimally resilient attachment assemblies transfer the minimum load to the posterior alveolar ridge; therefore, the patient experiences the least alveolar bone resorption.

## FACTORS INFLUENCING THE DESIGN AND RESILIENCY LEVEL OF THE ATTACHMENT ASSEMBLY

- Shape of the arch
- Distribution of the implants in the arch
- Length of the implants and degree of implant bone interface
- Distance between the most anterior and the most posterior implants

## BIOMECHANICAL CONSIDERATIONS

One hypothesis suggested that the bar connecting the implants should be parallel to the hinge axis; this rule was followed by many clinicians, but no studies have supported this claim. One long-term study (5–15 years) analyzed the influence of placing the bar parallel to the hinge axis on peri-implant parameters, including the clinical attachment level. The outcome of the type of retention, splinted versus unsplinted, was also assessed. No significant correlations were found. (Refer to Chapter 6.)

## DISTAL EXTENSION TO THE BAR

Distal extensions provide a high level of stability against lateral forces, particularly in the mandible, and may protect the susceptible denture-bearing tissue from load forces. They should not extend beyond the position of first premolar of the mandibular prosthesis, and they cannot compensate for a short central segment. When distal extensions are used, the splinting effects of implants for better force distribution disappear. In this situation, the force patterns are similar to those that occur with unsplinted implants.

## LOAD DISTRIBATION OF STUD VS. BAR ATTACHMENTS

The in vivo study by Menicucci and colleagues showed that ball anchors are preferred, because they provide better load distribution on the posterior mandibular bone.

Stern and colleagues, through a series of three-dimensional force measurements with two infraforaminal Strauman implants in fully edentulous patients, showed no significant differences among different attachment assemblies and retention mechanisms.

## BIOMECHANICS OF MAXILLARY OVERDENTURE

A pilot study by Stern and colleagues compared repeated in-vivo measurements of maxillary implants supporting either a fixed denture or an overdenture with a rigid bar connection. Comparable force magnitudes and patterns were found. This suggests that a rigid bar with a connected overdenture performs in a similar way as a fixed prosthesis under loading condition.

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# 8
# Treatment Success with Implant Overdenture

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## IMPLANT SURVIVAL

Most studies available on mandibular overdentures report a success rate of 90 to 100 percent. Neither the number of supporting implants nor the type of attachment assembly has been found to affect the rate of survival.

In contrast, the results of implants placed in the edentulous maxilla, particularly in conjunction with overdentures, are less favorable. Multiple studies have shown a higher failure rate for implants placed in the edentulous maxilla. If a distinction between the degree of atrophy in the maxilla and the bone quality is made, the results show that failure in the maxilla is a result of short implants, poor bone quality, and an inadequate number of implants.

Although bone grafting is often recommended for patients with advanced atrophy, this surgical procedure typically results in a high percentage of implant losses and increased bone resorption.

## PROSTHETIC SUCCESS

Evaluation of prosthetic success can be challenging, since a clear distinction among normal maintenance, repairs, and adjustment of the prosthesis is not made. Maintenance due to normal wear can become excessive and a biased criteria for assessment of success. Complications can vary widely from requiring a simple adjustment to a remake of the entire prosthesis.

Clinically, the overdenture is simpler, and its initial treatment is less expensive compare to fixed prosthesis. However, since overdenture has more components (abutments, clips, bars, anchors, and female retainers), it carries a higher chance of complication.

A five-year longitudinal study comparing two resilient attachment assemblies showed more complications with bars than with ball attachments. Another study compared rigid and resilient attachment assemblies for mandibular overdentures supported by two implants during 5–15 year periods. This study showed no significant difference between the incidents of complications between the two groups. However, replacement of the entire attachment assembly was more common with stud attachments and round bars than with rigid bars.

## PATIENT RELATED FACTORS

Treatment success should not be evaluated only on the implant and prosthesis survival and success. The psychological and physiological impacts of overdenture treatment on a patient's quality of life should be considered as well. The treatment cost and financial status of the patient are also important factors in deciding a treatment strategy. The average person may accept implant overdentures supported by two or four implants over the fixed prosthesis because they are less expensive.

## BIOMECHANICAL RISK FACTORS FOR UPPER IMPLANT OVERDENTURE

- An upper implant overdenture attachment assembly design is an ideal solution that has minimum biomechanical risk. One clip/rider should be used for each bar (Figure 8.1).

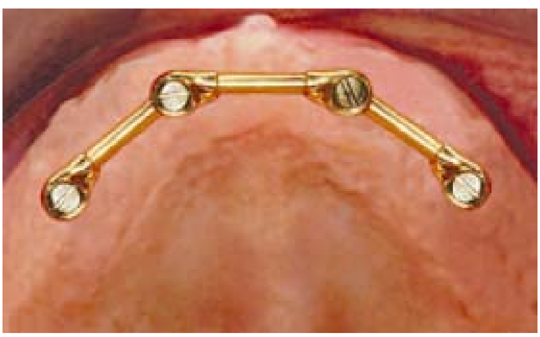

**FIGURE 8.1.**

- This design is mechanically less favorable than previous designs since the lateral forces will not distribute among all four implants. However, this design provides a better anterior aesthetic compared to previous designs (Figure 8.2).

**FIGURE 8.2.**

- This design has a higher biomechanical risk compare to the previous two designs. This design is a completely non-resilient attachment assembly with cantilever components. It is very important to consider the Anterior–Posterior spread in this design. Generally, the distal cantilever should not exceed half of the Anterior–Posterior spread (Figure 8.3).

**FIGURE 8.3.**

- This design represents a moderate biomechanical risk when the supporting implants are not parallel (Figure 8.4).
- This design creates a high biomechanical risk, especially if the palatal coverage has been eliminated and the flanges are reduced. This design should only be used with an upper complete denture and maximum tissue coverage in cases in which the patient has severe bone loss, but there is still enough bone quantity to place two implants in the canine areas. If the patient is willing to consider a bone

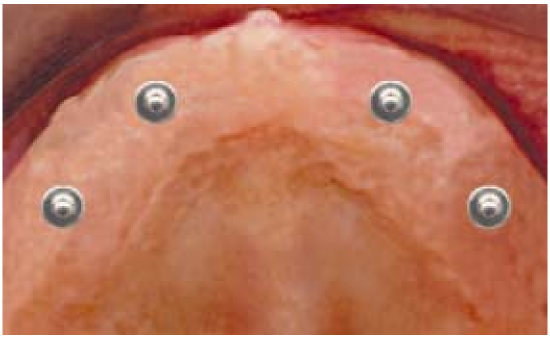

**FIGURE 8.4.**

graft procedure, then this treatment option should be avoided (Figure 8.5).

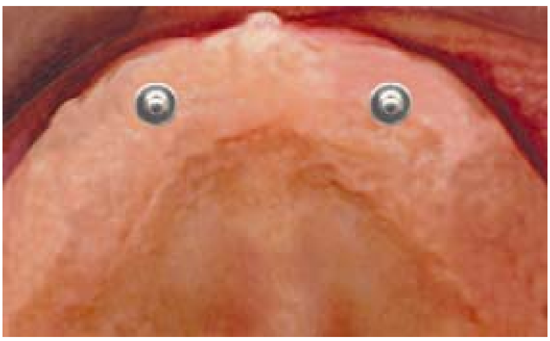

**FIGURE 8.5.**

From experimental points of view, maxillary overdentures are best supported by multiple implants connected by a rigid bar and reinforced with a metal framework to enhance rigidity of the superstructure.

## BIOMECHANICAL RISK FACTORS FOR LOWER IMPLANT OVERDENTURE

- The lower implant overdenture is an ideal design in regard to biomechanical aspects. The bar should provide at lease hinge resiliency for the prosthesis. More resilient bars will provide more load relief on the supporting implants (Figure 8.6).
- This design is very simple and practical and will provide significant biomechanical advantages to the supporting implants. A more resilient stud attachment provides more load relief for the implants (Figure 8.7).

**FIGURE 8.6.**

**FIGURE 8.7.**

- This design represents a significant biomechanical risk to the supporting implants. It carries a high risk of fracture and bending mode of failure for the cantilever distal extensions (Figure 8.8).

**FIGURE 8.8.**

- This design provides less biomechanical risk compared to previous designs. However, it is very important to design the distal extension cantilevers based on the Anterior–Posterior spread measurement (Figure 8.9).

**FIGURE 8.9.**

- This design presents a significant biomechanical risk when the implants are short, narrow, and do not have enhanced surface characteristics. With this design, the attachment assembly does not provide any resiliency for the prosthesis or load relief to the supporting implants. The prosthesis is fully implant borne and not enough implants are available to support a fully implant-borne prosthesis (Figure 8.10).

**FIGURE 8.10.**

- The attachment assembly in this design is rigid non-resilient. This assembly creates a significant biomechanical risk if the supporting implants are not parallel. However, if the supporting implants are long and wide and have been placed in a perfect parallel position, this design can be predictable (Figure 8.11).

**FIGURE 8.11.**

The key purpose of the implants in the mainly tissue supported implant overdenture is to improve the retention of the denture, not support all of the chewing forces. In order to reduce the amount of load transfer to the supporting implants, the prosthesis should be made like a conventional complete denture with respect to support and stabilization criteria.

## SHAPE OF THE MANDIBLE AND ITS EFFECT ON THE LOADING OF THE SUPPORTING IMPLANTS

Shape of the mandible has a significant influence on the location of the supporting implants and biomechanical properties of the overdenture. If the anterior mandible is ovoid, a relatively high resistance to the lever arm will exist (Figure 8.12).

If the anterior mandible has a square shape, it will create an unfavorable biomechanical situation, because there is a minimum resistance to the lever arm (Figure 8.13).

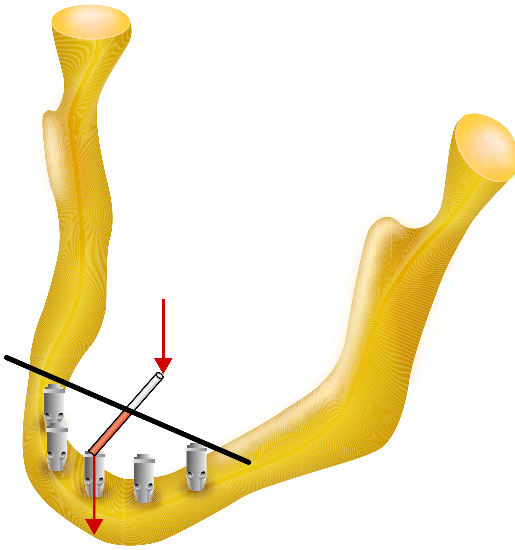

**FIGURE 8.12.**

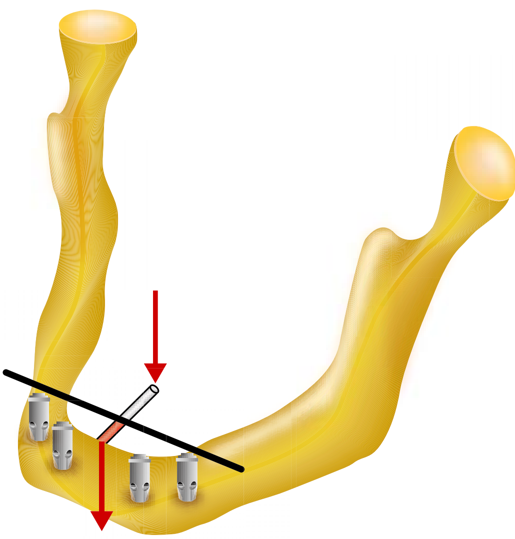

**FIGURE 8.13.**

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