Precision Attachment Case Restoration With Implant Abutments: A Review With Case Reports

Edward Feinberg, DMD

Passively retained precision attachment partial dentures have been used successfully on natural tooth abutments since the 1920s. However, the dental profession has not advocated their use with implant abutments. When used in the passive manner that has proven successful on natural tooth abutments, precision attachment cases on implant abutments can be an excellent treatment option. This type of case has been used successfully for more than 17 years and offers tremendous advantages over the conventional overdenture approach to removal restorations on implant abutments.

Key Words: precision attachments, double tilt, implants

INTRODUCTION

Dr Per-Ingvar Branemark, the originator of the osseointegrated implant, has long recognized the need for finding new alternatives to restore the dental arches with implants. ''For those patients who have difficulties in accepting and functioning with a mechanically unstable prosthetic replacement for lost structure and function,'' he noted, ''solutions certainly still remain to be found. The decisive prerequisite is how to identify for each individual patient, an adequate, reliable and affordable therapeutic alternative that can be realistically provided in his or her entire life—present and future.''[1]

When fixed bridgework cannot be made on implants, most practitioners generally make overdentures on the implant abutments. In fact, the entire approach to making implant restorations has been adapted from denture procedures, rather than from crown and bridge procedures. Dentures on implants have shortcomings that can be circumvented with a solution adapted from crown and bridgework: the precision attachment case.

Precision attachment partial dentures can be combined with implants to ideally restore the upper and lower arches. The precision attachment case is also an excellent solution for difficult restorative problems that cannot be restored with fixed bridgework.

MATERIALS AND METHODS

Background: precision attachment cases on natural teeth

The precision attachment partial denture case has enjoyed a long track record of success on natural tooth abutments. Examination and follow-up of more than 1500 cases during a 50-year period by Drs Elliot

Westchester Academy of Restorative Dentistry, Scarsdale, NY.
Corresponding author, e-mail: edfberg@earthlink.net
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and Edward Feinberg overwhelmingly demonstrate that precision attachment cases offer one of the most successful approaches to removable partial denture therapy.[2] These cases were all created according to the same basic principles, even though the materials differed. The basic principles include full shoulder preparation of the abutment teeth, a 3-dimensional approach relating the preparations to the gingiva and the underlying bone, and a step-by-step protocol for the passive design and fabrication of the full-coverage restorations and the precision attachment partial denture.[3]

Cross-arch splinting of the anterior teeth that includes 2 strategic attachments best distributes the load of the precision attachment partial denture. The preferred arrangement is splinting the anterior segment from canine to canine, since the canines are the cornerstones of the arch and usually have the longest roots.[2] Auxiliary attachments may be added on posterior teeth for additional support and retention.

The importance of accurate impressions and models cannot be overemphasized. Precision attachments must be used in a precise manner. Great care must be taken to ensure precision at every step, as the entire chain can only be as strong as the weakest link. As George Klein remarked in 1951,[4] ''No amount of skill in one step of the work will overcome an error in a previous step.'' Precision attachment cases must fit with precision—the abutments must be stable and the frameworks must fit properly against the tissue without rock.

Advantages of the precision attachment case

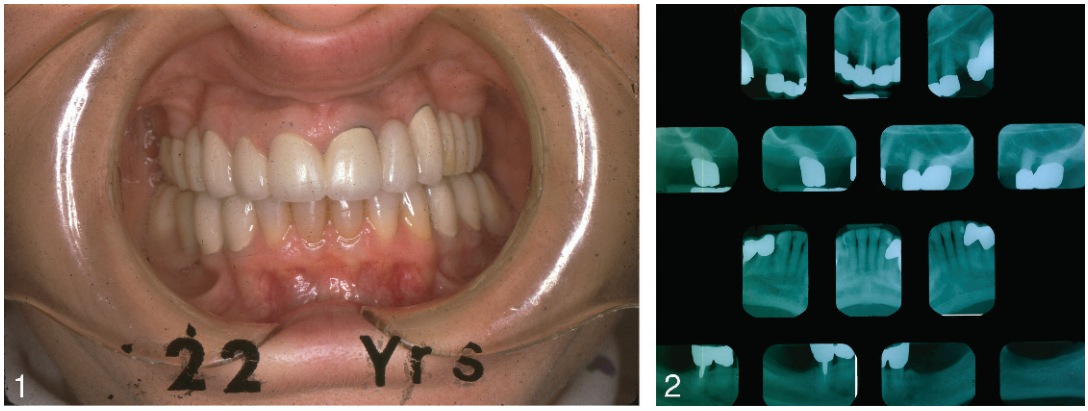
In addition to cosmetic appearance, maintainable periodontal health, longevity of abutment teeth, and patient comfort, precision attachments cases offer an advantage not possible with fixed bridgework: the ability to salvage questionable teeth without having these teeth jeopardize the success of the overall case. Practitioners have long been indoctrinated that fixed bridgework is always better for the patient. The prescription for fixed bridgework is often the rule—even for abutments with a questionable prognosis of longevity. ''Precision attachment partial dentures should be the *primary* treatment plan rather than long spans of fixed restorations,'' says Dr Elliot Feinberg.[5] ''After 30 years of clinical evaluation of over 1000 precision attachment cases,'' Dr Feinberg concluded in a 1982 article, ''my records indicate that the average age of an attachment-retained partial denture is between 15 and 20 years''[6] (Figures 1 and 2). One reason for this extraordinary success is—unlike fixed bridgework—questionable teeth can be included in a precision attachment case, without serving as primary abutments. This design provides a built-in contingency plan in the event that something happens to the weak abutment. When these teeth are lost, they are easily added to the partial denture without making anything over. Interestingly, weak abutments restored in this manner often last far longer than anticipated.

The free-moving attachment

There are numerous attachments available for partial denture therapy. These attachments are usually classified according to structural type (ie, intracoronal, extracoronal, anchor, ball and socket, etc). However, the Feinberg Classification for Precision Attachments[6] categorizes attachments on the basis of function rather than structure. According to this classification, attachments fall into 2 categories:

1. Rigid (mechanical locking action that includes clasps, lingual arms, springs, ball and sockets, clip-bars, etc)
2. Passive (free moving, stress-breaking action)

Despite the tremendous variation in design and application, almost all of the



Figures 1–2. In his 1982 article in *The New York State Dental Journal*, ''Diagnosing and Prescribing Therapeutic Attachment-Retained Partial Dentures,'' Dr Elliot Feinberg presents this case with questionable teeth that was originally made in 1975. This patient is still wearing this case after 35 years, and the questionable posterior abutments are still there! It is not likely that the upper left molar would have survived 35 years with fixed bridgework. Full-mouth X rays taken (Figure 8 shows 28-year X rays taken in 2003) over 3 decades reveal very little change in the periodontal bone. The precision attachment components have not been altered or replaced in 28 years.

precision attachments currently used in dentistry are of the rigid variety. They are designed to mechanically engage the abutment teeth so as to prevent muscular and gravitational forces from dislodging the denture during function. Unfortunately, rigid connectors apply lateral forces to the abutment teeth that are ultimately destructive through their torquing action. These attachments may be no less harmful to the abutment teeth than conventional clasps. Clasps exert forces on the abutments even when the partial is at rest.[7] A clasp partial denture is generally transitory to a full denture, as it usually necessitates moving the clasp to adjacent teeth as abutments are lost. The deleterious effects of rigid connectors are not confined to the abutment teeth. As Elliot Feinberg explains, ''the tissue may be subjected to constant pressure, resulting in ischemia, inflammation and resorption of the alveolar process.'' In addition, wear of the components of the attachment or erosion and caries of the enamel on the abutment teeth are common consequences of rigid partial denture connectors.[8]

By contrast, the passive, free-moving attachment dissipates destructive lateral forces, preventing their infliction on the abutment teeth. The forces in a free-moving attachment are vertically directed and easily tolerated by the abutment teeth. Thomas Forde, in *The Principles and Practice of Oral Dynamics*,[9] theorizes that vertically directed forces drive the hydraulic system of dentitional blood supply to the periodontal structures, whereas rocking or rotational forces disrupt the dentitional blood supply, causing ''force-induced mouth degeneration'' and loss of teeth. The tissue under a passive, free-moving attachment case is generally pink and healthy as a result of the vertically-directed physiologic stimulation during function. Passive, free-moving attachments also do not wear at a rapid rate. These attributes make it possible for free-moving precision attachment cases to succeed for decades, even on the weakest teeth imaginable.

The precision attachment of choice

Attachment designs exist that offer stress-breaking action, but they are generally prone to breakage. Wetherell and Smalles found that 82% of partial dentures with attachments of stress-breaking design failed within 6 years.[10] To compensate for this tendency toward breakage, some attachments, such as

the ERA, include plastic or vinyl snap-on sleeves. Unfortunately, these components usually require frequent replacement.

Most free-moving, precision attachment cases during the past 50 years were fabricated with the Sterngold #7 attachment (no longer on the market). The #7 attachment was patented in 1921 by Isadore Stern. Experience with thousands of Sterngold #7 cases over a 50-year period has shown that it is rare to replace the male component of the attachment, even after decades of continuous function.[8]

However, precision attachment partial denture cases have been just as successful with the Whaledent International P3.4 attachment and with the Sterngold Latch Attachment. These attachments are similar in design to the Sterngold #7. They are all essentially keys (males) that fit with machined precision into receptacles (females). Any male out of the box will perfectly fit any given female. Success with these attachments is a function not just of the attachment but also how the attachment is used.

The Sterngold Latch attachment is similar in design to the #7 attachment, except that it is 1 mm shorter and contains a depression in the male component of the attachment that engages a ball in the internal face of the female component of the attachment (the latch). This ball can be quickly (and carefully) wiped away from the female component with a one-fourth inverted cone bur in a high-speed handpiece so that it cannot engage the male. However, removal of this ball is usually not necessary since in actual practice it ceases to function as a retentive mechanism almost immediately.

The path of insertion mechanism of retention

The path of insertion can be used as a retentive mechanism—one that functions as a true stress breaker, reduces wear of the attachments, and eliminates the need for retention adjustment and eventual replacement of the attachment apparatus. The retention of the partial denture results from creating an unconventional path of insertion that is different from the pull of the muscles, the action of the tongue, and gravity. "The path of insertion is unlike virtually any oral movement such as the patient's tongue habits," says Dr Elliot Feinberg, "so it is unlikely that normal flexing of the musculature will dislodge the prosthesis."[8] When a stress is applied to the partial denture during function, it can move slightly to release the stress, but it cannot be dislodged. The result is physiologic stimulation of the abutment teeth and the edentulous ridges. Because the path of insertion technique does not rely on the flexing of metal components for retention, there is very little wear on the attachment components. Many patients wear these precision attachment partials for decades without replacing the male or female components of the attachment. When the partial gets loose, all that is required to make it tight is a reline. Nothing is ever done to male or female components of the attachment to improve the fit.

The path of insertion technique was refined by Dr I. Franklin Miller but has not achieved mainstream popularity because few practitioners are making precision attachment partial dentures. Precision techniques are required for their fabrication, and there is a perception that the prosthesis is too complex for patients with limited manual dexterity.[8]

"Original concern over the difficulty of insertion appears to be unsupported by clinical experience," explains Dr Elliot Feinberg. "In teaching patients how to insert more than 1000 double-tilt cases … just one patient … could not master the path of insertion with 15 minutes of practice."[8] Precision attachment partial dentures have been successfully used by patients with arthritis, Parkinson disease, and other diseases that affect manual dexterity.

The double-tilt path of insertion

Traditionally, intracoronal attachments are paralleled on the surveyor perpendicular to the occlusal plane—the same line of insertion as the vector of gravity and line of occlusion.[8] This method of surveying contributes to dislodging the partial denture, thereby necessitating locking mechanisms such as lingual arms to retain the partial denture.

The double-tilt method of surveying is simple to accomplish the following:

1. The master model is secured to the surveyor table of the parallelometer. The model is placed with the occlusal plane approximately parallel to the table with the anterior teeth facing forward.
2. The heel of the model (posterior) is raised between 10° and 15° to provide an anterior-posterior tilt.
3. The left or right side of the model is subsequently raised approximately 10° to 15° to provide a mesio-distal tilt. Whether the left or right side is chosen depends on anatomy. The idea is to create a tilt that will allow the use of the fullest length of the attachments possible. The female attachments should be placed as close to the shoulder as possible and as close to the axial walls of the preparation as possible (Figure 3).

It is advisable to survey the double tilt when creating the wax-ups so that the boxes for the attachments will be correct after the castings have been soldered.

Case Reports

Three cases demonstrate how precision attachment partial dentures can be used effectively with implant abutments. The cases were fabricated in exactly the same manner than has proven successful with natural tooth abutments:

Lower implant precision attachment case

In 1996, 3 implants were placed in the anterior region of the mandible. During this era, abutment connectors were screwed into the implants in the manner originally advocated by Dr Branemark. The fixed bridgework wax subsequently screwed into place with 3-mm screws. Generally, it is much better to create restorations that are screwed retained directly into the implant rather than into an abutment. The 3-mm screws have a tendency to loosen compared with the longer and wider screws used to retain bridgework at the level of the implant. However, in this case, the fixed bridge was removed only once in 13 years.

The precision attachment partial denture was custom designed so that it is difficult to tell where the fixed bridgework ends and the pontic teeth begin. The patient wears the partial 24 hours a day and removes the partial only for hygiene. One of the best features about the precision attachment case is that the partial can be altered to compensate for any changes that occur in the tissue or the occlusion. In 2006, the partial was relined and the teeth were replaced (chairside) and customized with Biolon-processed acrylic cured in a pressure pot at 190°F and 30 psi. When a precision attachment partial denture gets loose, all that is necessary to tighten it is a reline. Nothing was ever done to the male or female attachments (Figures 4–6).

Upper precision attachment case

This patient had upper and lower attachment cases on weak teeth prone to periodontal problems (Figures 7–11). The cases lasted more than 30 years. The original lower attachment case is nearing its 40th year in the mouth on teeth that have short conical roots with periodontal bone loss.

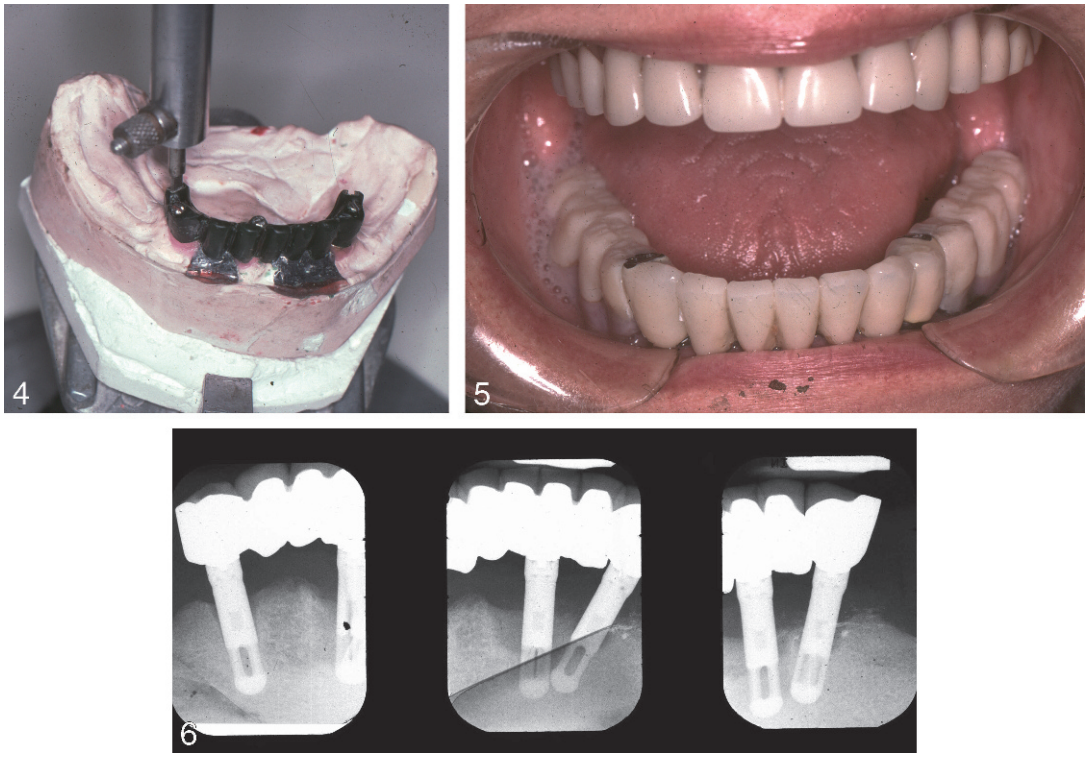
About 10 years ago, some upper teeth fractured and the upper attachment case was lost. The original attachment case was converted chairside to a denture with acrylic and Triad composite. This approach is far

Figure 3. The double tilt. Dual path. Anteroposterior tilt 10°–15°. Lateral tilt 10°–15°. Elimination of all locking mechanisms. Free movement of the attachment.

superior to making an immediate denture because it is an easier transition and ensures that the patient maintains the same esthetics and vertical dimension. Although the transitional denture fit well, the patient did not like wearing it and wanted to have implants. A guide stent was made by duplicating her denture with the Lang Denture Duplicator, alginate, and clear orthodontic acrylic.

Despite the guide stent, the surgeon placed the implants too far labially. Angled abutments were screwed into the implants to change the path of screwhole access.

The patient is extremely comfortable and quite happy. She is thrilled to have her attachment case back! Nine-year X rays show well-placed, long implants and precision fit of the bridgework. There has been no discern-



Figures 4–6. Case I: lower implant attachment case. **Figure 4.** Three implants with screw-retained abutments were placed in the anterior region of the mandible in 1995. The wax-ups are surveyed to create the double-tilt path of insertion for the boxes that will house the female attachments. **Figure 5.** The finished case, 1996. **Figure 6.** Thirteen-year X rays (2009).

Figures 7–11. Case II: upper precision attachment case. **Figure 7.** The denture was duplicated using the Lang Denture Duplicator and alginate to create a stent out of clear acrylic to guide implant placement. **Figure 8.** Three implants were placed and fitted with angled abutments. **Figures 9–10.** The finished case. The teeth appear longer than the original attachment case because of resorption and remodeling of the bone after the extractions. The vertical dimension has not been altered, and the patient shows the same length of the anterior teeth when she smiles as she did with her denture. **Figure 11.** Nine-year X rays (2009).

able change in the X rays since the case was fabricated.

Salvaging a fixed bridgework case with precision attachments; connecting natural teeth and implants with precision attachments

Implants are wonderful restorations where they can be done properly, but they are certainly no panacea. This patient had a long-span fixed bridge on her lower left that failed after many years of service, as well as periodontally involved lower anterior teeth. She did not want to wear removable bridgework and opted to have implants. Implants were placed several times by a highly competent surgeon on the lower left quadrant, but the patient ended up in the hospital with a massive infections. The lower left first and second molar implants that survived are short in length and may not have been adequate to support fixed bridgework.

Precision attachments provide the best option for salvaging this restorative nightmare. The precision partial ties all the remaining teeth and implants together. It is

acceptable to tie natural teeth abutments and implant abutments because the precision attachment partial denture is not rigidly connected to them. A special housing with 2 female attachments was made for the anterior implant. On the lower left, a 2-unit bridge was made with a female attachment. On the lower right, the existing fixed bridgework was modified to support the precision attachment partial denture. The porcelain was removed from the lower right first bicuspid, and a porcelain-to-metal overlay with a female attachment was permanently cemented to the bridge with acrylic.

The precision attachment partial denture contains 4 male attachments that fit into the 4 female attachments. The major advantage of 4 attachments is that the partial denture is entirely supported by abutments, imparting tremendous stability. The precision attachment partial denture is as close to fixed bridgework as possible for this patient. She can bite into anything and eat anything.

The main drawback of using 4 attachments in a precision attachment case is the extreme attention to accuracy and detail that is required. The importance of accurate impressions and models cannot be overemphasized. All of the attachments must be exactly parallel, as alteration of the males to compensate for an error in parallelism will compromise the end result.

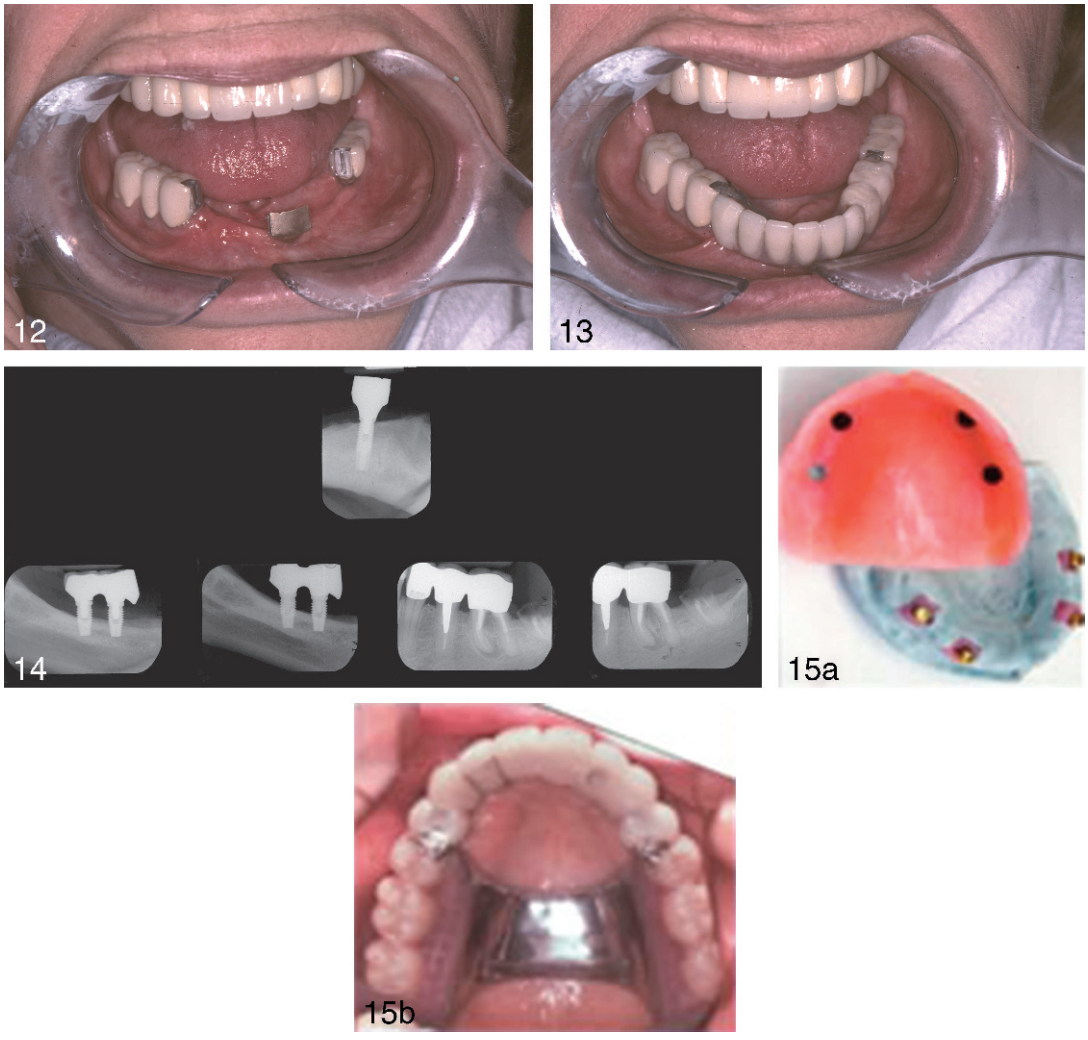
The partial denture also extends around the natural tooth bridgework on the lower right. The extension is not retentive and serves only as a contingency plan in the event that the lower right bridgework is lost. If the bridgework is lost, the extension will serve as a housing for the bridgework, which will be added to the partial denture with acrylic or composite to form a free-end saddle (Figures 12–14).

Discussion

Unlike natural teeth, which are connected to the bone by the periodontal ligament, implants are fused to the bone. These feats of engineering are quite strong—far stronger than the weak natural tooth abutments that have supported precision attachment dentures successfully for decades. Precision attachment cases easily succeed on strong implant abutments.

There is no question that osseointegrated implants have enjoyed a high degree of success with fixed bridgework. However, this success is far from 100%. All engineering feats can be successful only if they are designed to withstand the forces to which they will be subjected. Colossal failures of engineering feats like the 1948 Tacoma Narrows Bridge disaster bear witness to this fact. ''If a designer overlooks just one way his structure may fail,'' notes engineering expert Henri Petroski, ''all may be for naught.''[11] As engineering feats, osseointegrated implants are no exception. ''Together with infections, the most common reasons for the loss of implant retention in bone are believed to be of a biomechanical nature,'' say John Brunski, Per-Olaf, J. Glantz, Jill Helms, and Antonio Nanci in Per-Ingvar Branemark's *Osseiointegration Book*.[1] ''Surveys of the literature also reveal numerous reports on mechanical failures in the prosthetic superstructures supported by titanium implants.''

It is therefore important to recognize the limitations of fixed bridgework on osseointegrated fixtures. Anatomical deficiencies may be impossible to correct with bone grafts so that implants of adequate length can be placed. The patient may not even be a good candidate for extensive implant surgery—for systemic reasons, financial reasons, or lack of patience for prolonged treatment. Branemark's studies have demonstrated that poor anatomy in the posterior region can be circumvented with 4 or 5 anterior implants and fixed bridgework with posterior bicuspid cantilevers.[1,12] However, a cantilevered fixed bridge may be the wrong choice if anatomical deficiencies prevent the placement of adequate-length implants; if



Figures 12–15. Case III: salvaging a fixed bridgework case with precision attachments; connecting natural teeth and implants with precision attachments. **Figures 12–13.** This case was made with 4 male-female attachments that connect natural teeth with implants. When the partial is in place, no one can tell she has removable bridgework. **Figure 14.** Five-year X rays (2009). **Figure 15.** The implant overdenture vs the implant precision attachment case. (a) Implants were used to retain a full denture. (b) Implants were used to create fixed bridgework in the front and a precision attachment partial denture in the back.

bicuspid occlusion is inadequate for neuromuscular comfort, esthetics, or function; or if the patient wore a precision attachment case successfully in the past.

When implants cannot support fixed bridgework, the traditional restorative solution has been an implant-supported overdenture. A denture that rests on tissue can exert only 10% to 15% of the force of natural teeth.[13] Although the placement of implants may improve the retention of a denture, patients who choose to go through the surgery, time, and expense of implants would really like to be rid of the denture. The patient who has worn a precision attachment case prior to wearing a denture (as in case 2) knows the difference between the two and is thrilled that a new precision attachment case can be made with the placement of only 3 implants.

An implant-supported precision attachment partial denture is superior to an implant-supported overdenture for the following reasons (Figure 15):

1. Superior comfort and self-esteem. The ideal precision attachment case is made with an anterior fixed bridge that does

not come out—unlike the overdenture. The patient does not feel old or freakish looking in the mirror when the partial denture is removed for hygiene.

2. Superior function. Unlike a denture, precision attachment cases do not have anterior-posterior tipping forces. Patients with implant-supported precision attachment cases can bite into anything. An upper precision attachment case also does not cover the entire palate as do most overdentures. A thin, posterior bar does not interfere with tongue movements and speech, and it allows taste buds on the anterior palate to function.
3. Less surgery is required. As few as 3 implants can restore an entire arch of teeth. The implants are placed in the anterior region of the mouth, avoiding much of the poor-quality bone, the sinuses, and the mandibular nerve.
4. Increased longevity. A precision attachment case does not place lateral forces on implants, which can be destructive to implants as well as natural teeth.
5. Implant abutments can be combined with natural tooth abutments. It is not a good idea to make fixed bridgework on both natural tooth and implant abutments. This arrangement stresses the periodontal ligament of the natural tooth abutments, since the implant abutments are not resilient. W. Chee and S. Jivraj surveyed the literature on this topic and concluded that ''there is no doubt that the free standing option where teeth are not connected to implants is the preferred method of restoring missing teeth.''[14] The precision attachment case can link natural tooth and implant abutments (as in case 3) because these abutments are not rigidly connected.

Summary

The passive precision attachment case has been used successfully on natural tooth abutments for more than 70 years. This record of success can be applied to implant abutments as long as there is adherence to basic principles of engineering. The implant-precision attachment case offers the advantage of minimal implant surgery and avoidance of areas (usually posterior) in which there is poor bone quality or interfering anatomical structures. The precision attachment case also offers several advantages over the conventional implant overdenture, such as no anteroposterior tipping forces, the ability to bite into any food, increased self-esteem, and less tissue coverage for greater comfort. To realize these advantages, attention to step-by-step detail is essential.

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