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Fixed Detachable Prosthesis/Hybrid prosthesis: Literature Review

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Abstract

Background: The loss of teeth is a problem that frequently interferes with mastication, phonetics and esthetics. Patients frequently find their use of a removable partial denture (RPD) to be in sufficient from a functional and aesthetic standpoint. An alternative to fixed dentures (FD) for free-end saddles is a hybrid prosthesis that combines a RPD and FD using precision attachment.

Methods: The inability to consistently achieve a passive fit with screw-retained implant prostheses is well documented in the literature. This review is evidenced based literature describing current available data regarding the fabrication of fixed-detachable hybrid prosthesis.

Conclusions: Current and past literature regarding implant-retained frameworks for full-arch, hybrid restorations have been presented. Guidelines were proposed for use by clinicians and laboratory technicians in designing implant-retained frameworks. However further clinical and laboratory research continues to be warranted to test the efficacy of the proposed guidelines.

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Introduction

Edentulism is a very common problem among the elderly population. Rehabilitation with complete dentures was adequately the common line of treatment for such patients that would enable for speech, mastication, and carrying on many functions. Despite this fact, complete dentures have proven to be unstable, due to lack of retention especially in the lower arch, which made this treatment modality a point of controversy, and urged the need for alternative treatment options [1].

Implant retained overdentures can provide an effective treatment modality for edentulous patients and, in particular, those who have persistent problems in using conventional mandibular prosthesis. Installing implants tends to evolve into a less time-consuming, more aesthetic and less invasive techniques to restore lost dentition [2].

Patients have reported difficulties in managing implant overdentures; they have also reported functional concerns and higher expectations regarding removable implant overdentures. Some of the objectives of definitive fixed implant prosthodontic care include predictable, long-term prostheses, improved function, and maintenance of alveolar bone [2].

Implant-supported hybrid prostheses have been recommended for edentulous patients who could not adapt to long-term use of conventional complete dentures or suffered from removable implant overdentures [3].

WHAT IS HYBRID PROSTHESIS?

Hybrid prosthesis is a great innovation that provided thousands of patients with a fixed restoration. In the 1980's this was state of the art for fixed implant supported restorations [4].

For nearly thirty years the conventional screw retained denture or hybrid prosthesis has been the standard of care for many dentists and patients. And in many practices this is still a treatment of choice for converting denture patients to fixed implant retained restorations [5, 6].

A hybrid denture is one that is fabricated over a metal framework and retained by screws threaded into the implant abutments. The anterior part of a mandibular hybrid denture is fixed to implants while the posterior part of the denture is extended and cantilevered from implants [7, 8].

Hybrid prosthesis could be designed in one of the two ways where metal frameworks comprised the bulk of the prostheses, and artificial teeth and minimal denture bases were the only non-metallic components. Or implant fixed prostheses consisting mostly of acrylic resin denture bases and artificial teeth, with minimally sized metal frameworks (wraparound design) [5].

The commonly used terms in literature are fixed and removable options. The term fixed detachable and hybrid is not commonly used nowadays and the term fixed removable is actually a misnomer that shouldn't be used. Where the fixed restoration is a restoration that cannot be removed by the patient; fixed restorations are retained by cements, screws, or a combination of both [9].

HYBRID PROSTHESIS VERSUS REMOVABLE OVERDENTURES

Implant overdentures offer significantly improved stability, retention, bite force, chewing efficiency and oral health compared to conventional complete dentures 10. However, their removability may be considered disadvantageous by some patients. Occlusal forces from opposing natural teeth may cause fractures in implant overdentures and result in advanced bone loss [10].

Implant-supported overdenture without palatal coverage opposing a natural dentition may overload the implants [11]. With the presence of extreme gagging reflex, this treatment option may become more complicated [11]. Conversely, the palatal border of the maxillary implant-supported hybrid prosthesis can be finished shorter, yet more of the palate can be left totally open compared to implant overdenture, which in turn reduces or eliminates the gagging reflex of the patients [12]. Thus, Hybrid prostheses are the most predictable treatment option for improving patient satisfaction in terms of oral pain and chewing functionality when compared to implant overdentures [13].

Fixed implant hybrid prostheses supplies functional and psychological advantages, as hybrid prostheses are fixed for the patients. Nevertheless, mucositis, periimplantitis and fracture of the acrylic may occur [14].

HYBRID PROSTHESIS VERSUS FIXED METAL CERAMIC RESTORATIONS

Metal–ceramic fixed implant restorations are recommended when there is minimum loss of bone and a sufficient number of implants may be distributed along the edentulous arch; they may negatively affect the aesthetics, implants' axial load, occlusal stability, and resistance of the veneering material around the screw access holes [15].

Fixed-detachable hybrid prostheses represent the treatment of choice in the absence of osteomucosal support. In the atrophic maxilla, hybrid prosthesis has been reported to be superior to fixed metal ceramic restorations in providing lip support, phonetics, and esthetics. It is considered an alternative method to treat a case with severe maxillary atrophy by the use of angled implants instead of complicated augmentation procedures [16]. Cement retained restorations are indicated when the crown height space (CHS) is between 8-15 mm. With lower CHS there is not enough abutment height for cement retention. With more than 15 CHS the size of the metal casting is a problem; too much metal is fabricated to support 2mm of porcelain, it acts as heat sink, resulting in porosities as well as risk of fracture of porcelain. The weight is also quite considerable so screw retained hybrid prosthesis is the treatment of choice for these cases [8].

However, it was reported that Hybrid prosthesis is contraindicated in maxilla due to Speech/hygiene dilemma; Functional demands for maxillary hybrid implant prostheses are complicated in that phonetics may be affected by hybrid designs and contours as a hygienic space may disturbs speech and closed designs may compromise hygiene [4]. Hybrid overdenture is more affordable than an implant supported fixed bridge however maintenance cost is very high compared to full arch fixed bridge [17, 18].

NUMBER OF IMPLANTS AND LOCATION USED FOR HYBRID PROSTHESES

It was also reported that higher bending moments may develop on the implants, in order to distribute the masticatory load, an increase in the number of implants was recommended in the edentulous maxilla to prevent the bending moments that may cause bone loss [19, 20]. For the maxillary arch a minimum of six-eight implants with minimum of two cm A-P spread is recommended. Distal implant must be at least 10 mm in length and placed in teeth positions. For mandibular arch four- six implants anterior to mental foramen are recommended due to mandibular dynamics with occlusion at 1st molar and distal cantilever to 15 mm [19].

In 12 studies that included follow-ups of up to five years it was suggested that despite worries that mandibular root-form implants would be overloaded if only two were used to retain a hybrid overdenture, the survival rate of loaded osseointegrated root-form implants under mandibular hybrid overdentures varied from 97 to 100% [21].

HYBRID PROSTHESES FRAMEWORKS

Frameworks are designed to splint implants together; they also provide retention and support for the functional and esthetic portions of the fixed hybrid prostheses. One of the keys to long-term clinical success is the design and fabrication of metal frameworks that support implant prostheses [21]. Multiple, diverse methods have been reported regarding framework design and materials in implant prosthodontics. Among the factors, clinicians may consider in fabricating fixed implant frameworks are: biocompatibility/type of alloy/type of ceramic, CAD/CAM (digital/copy mill), lost-wax technique, and expense [21].

Different materials have been used, including, but not limited to cast noble alloys; gold, palladium, silver, and platinum, cast base metal alloys; nickel and chromium, cobalt/chromium and iron-based alloys, milled titanium frameworks; Ti and Ti alloys, milled zirconium frameworks; yttria tetragonal zirconia polycrystal (Y-TZP) which is characterized by high biocompatibility, low bacterial surface adhesion, and favorable chemical properties [22].

Cast metal frameworks are subjected to expansion and contraction that may result in porosity and/or distortion of individual castings. Conversely, CAD/CAM frameworks are more precise. They utilize computer software which designs the restoration framework virtually after scanning the patient model and the trial setup and after the acceptance on the design the superstructure is milled precisely by the CAM machine into titanium or zirconia [23]. The results of a 10-year clinical study, noted that the frequency of prosthetic complications was low, with similar clinical and radiographic results for CAD/CAM milled and cast gold alloy frameworks. They noted more maintenance appointments were needed for casted frameworks [24].

CAD CAM frameworks may be less expensive for clinicians than cast metal frameworks, as they do not contain noble metals. However, they may be waxed to certain specifications by dental technicians, scanned, and then milled in a procedure called "copy milling." These frameworks generally will not result in the decreased costs associated with CAD frameworks designed in CAD, as significant labor costs will be incurred in developing the wax/resin framework patterns [21].

FRAMEWORK DESIGN

Framework fracture may be avoided with optimal, mechanically designed frameworks. Implant framework designs are either (L, I, elliptical, and oval) [25]. It was reported that each of these designs could be viable clinically [26]. I-beam designs have been proven to strengthen cantilevered portions of frameworks, deflect less and experience the smallest maximum normal stress of all designs, also this design can maximize resistance to occlusal loading and minimize permanent deformation under stress as well as provide rigidity and strength to frameworks with minimal increased bulk and weight [27].

CAD implant framework with a modified I-bar design and elliptical designs has been also proposed. The apical buccal and lingual portions of the framework are designed for use as finish lines for the denture base portion of the hybrid prosthesis [25]. Likewise, CAD/CAM milled framework with the L-beam design was reported. Teeth are supported apically by the horizontal component of the L-beam design. The framework is designed to provide adequate support for the artificial teeth and denture base to minimize the risks of denture tooth/base fracture [23].

The authors speculated that L-beam with extended vertical wall height lingually provided increased resistance to cantilever stress and would resist fracture better than frameworks designed as I-beams; this design was consistent with desirable physical properties, was readily maintainable by patients, and could be produced with available methods and materials. However, required significantly more alloy and would be significantly more expensive than frameworks fabricated with I-beam designs. Unfortunately, the authors did not provide scientific evidence that the L-beam design resulted in more successful implant frameworks [21].

Strategic thinning of implant frameworks is recommended to allow for retention of acrylic resin denture teeth and denture bases. Thickness is also

necessary to minimize the potential fracture of the acrylic resin base material surrounding metal frameworks [28]. However strategic thinning shouldn't compromise the bulk. Cast alloy frameworks must have at least three mm of vertical bulk to provide (sufficient rigidity) to frameworks . Unfortunately Implant frameworks are vulnerable to fracture, especially at the junctions between distal abutments and cantilevered segments [28].

Adequate access for oral hygiene is needed and minimal display of metal on the facial and occlusal surfaces is recommended. Also using casting alloys with higher yield and tensile strengths is advisable and cantilevered segments shouldn't exceed 20 mm [29]. Frameworks with cantilevered, freestanding segments have areas of high stress at or distal to the posterior abutments, and may compromise the structural integrity of inadequately designed frameworks. However framework fracture may be avoided with optimal, mechanically designed frameworks [5].

Cantilever length and A-P spread are essential factors regarding distribution of occlusal loads. Although there was a trend of increasing CL with increasing AP spread, indiscriminate use of a single CL:AP ratio as an indication for cantilevers may not be prudent because CL is also a function of the number of implants and the distribution of implants between the most anterior and posterior implants. Some authors have suggested that cantilever lengths of 1.5 and A/P spreads of two are guides for maximum allowable cantilever lengths. A cantilever length/A/P spread ratio of two was determined to be optimal by choosing implant forces equal to twice the applied loads as the failure criteria [30].

Also Cantilever lengths of 1.5 times the A/P spread were determined empirically for prostheses supported by five implants after considering clinical conditions that might biomechanically compromise the biologic and/or prosthetic outcomes of clinical cases. Likewise, a minimum of six implants with an A/P spread of at least 20 mm was reported [31]. Clinical cantilever length variables included: number and distribution of implants, arch placement, and clinically optimal cantilevers [29]. It has been suggested that the extension from the midpoint of the most distal implant must not exceed 15 mm in the mandible. Others believe that the distal extension must not go beyond the first molars. Therefore, the hybrid denture often has fewer posterior teeth than a conventional complete denture [31].

Passive fit is difficult to detect especially if minor. The screw driven force has the ability to distort the framework (within its elastic range) giving a false full seating appearance.it can only be detected using single screw test and radiographically [32]. A perfect passive framework is impossible to achieve and considered arguably, and unnecessary. Although research regarding framework misfit as a cause of peri-implant bone loss is difficult to prove, others have described the value of excellent framework fit for optimal screw mechanics [33].

Prosthetic complications reported with non-passive fit after occlusal loading included Screw loosening, Screw fracture, Prosthesis fracture, Crestal bone loss around implants, and Implant loss [34]. Thus if clinical passive fit was not obtained, frameworks should be sectioned, an intraoral index made, and then the segments should be soldered [33].

THE ESTHETIC MATERIAL USED UPON METAL FRAMEWORKS

Acrylic denture teeth were used for hybrid prosthesis. Over the span of many years, occlusal surfaces of the denture teeth in the hybrid prostheses exhibited signs of occlusal abrasion and wear, sometimes completely abrading the teeth and denture bases, resulting in framework exposures. Ultimately, this resulted in decreased chewing efficiency and loss of vertical facial height [21]. Conventional acrylic resin denture teeth have a life expectancy of approximately seven to nine years prior to needing replacement. Micro-ceramic composites are alternatives to other materials because of their improved wear resistance, water absorption, polymerization shrinkage, and high fracture strength [35].

ADING PROTOCOLS AND OCCLUSION OF HYBRID PROSTHESIS

One-stage surgery and early or immediate loading, have demonstrated promising results. Yet the possibility of damaging the surgical site and the possibility of irritation and bleeding of the freshly sutured mucosa with the impression materials during clinical procedures may be concerns for the immediate loading protocol [36].

The Branemark Novum method is one of the immediate loading protocols available. The clinical protocol involves rigid connection of the implants at the time of surgery, a prefabricated titanium framework, elimination of the traditional impression procedure, and delivery of a permanent fixed prosthesis on the day of implant placement [6, 37]. The advantages of the Novum system include: one-day teeth, reduced cost of surgery and prosthetics compared to other types of fixed cases, one surgical procedure, immediate positive psychological reinforcement for the patient, no extended treatment, no casting, and no impressions. The disadvantages are inability to use for Class II Division I patients, lack of additional implants if one implant fails, patient selection limited by mandibular height, width, shape, size, and density and mental foramina position [37].

An alternative method including a no final impression

procedure developed in response to some of the difficulties presented with a prefabricated metal framework. The method consists of an adjustable acrylic resin framework allowing maximum adaptability for each mandible arch size and shape to accelerate the fabrication of the metal framework of the final prosthesis. Thus, final early load mandibular hybrid prosthesis can be fabricated in four days [37].

Regarding the occlusion of hybrid prosthesis, a balanced occlusal concept has been recommended for implant-retained mandibular hybrid prostheses opposing maxillary overdenture to preserve maxillary bone and if anterior contact is noticed during the annual recall examination, the occlusion should be adjusted to relieve the pressure from the anterior maxilla [38].

HYBRID PROSTHESIS FOR LIMITED MOUTH OPENING PATIENTS

Fixed hybrid prosthesis is considered the treatment of choice for patients suffering from limited mouth opening post tumor resection [39]. In light of the young aged sarcoma patients, a maxillary detachable prosthesis is preferred owing to the reduced number of maxillary implants needed. The presence of oral tumors may lead to long-term edentulism without the use of a prosthesis which may cause phonetic difficulties following denture insertion. Therefore, the use of a fixed maxillary restoration giving palatal freedom is highly advantageous for these patients. Moreover, early loss of teeth in these patients can result in esthetic and functional disorders for the patient, who may suffer from psychosocial problems. Reduction or elimination of palatal coverage with maxillary implant-supported prostheses may be perceived as advantageous to patients in providing greater comfort through reduction of tissue coverage [39].

The use of removable implant prosthesis is not considered the treatment of choice for these patients as in the future; daily removal of the prosthesis will present a significant challenge due to the limited mouth opening. Also additional concerns regarding reduced salivary flow weighs against a definitive removable restoration. However, it is important to ascertain the maximum mouth opening the patient has prior to the tumor resection. An understanding of what the patient has gone through and acknowledgement of their apprehension and concerns about examination and treatment is essential. Frequent recalls with appropriate oral hygiene reinforcement and home care programs are essential [39].

Care should be taken when carrying out implant placement for these patients to ensure that the patient is positioned comfortably enough to tolerate the procedure, as distress caused at this stage can generate anxiety and limited co-operation. Standard short drills and the screwdriver supplied by the manufacturer are sufficient for implant insertion. Open-tray impression copings can be used with a polyether impression material by insertion of the tray sections separately. Transfer posts should be strengthened with the use of a pattern resin to avoid dislocation during unscrewing of the posts. Hybrid prosthesis provides for patients suffering from limited mouth opening post tumor resection; biomechanical stability, esthetics, palatal freedom, phonetics as well as self-confidence and comfort [39].

COMPUTER AIDED ENGINEERING IN FABRICATION OF HYBRID PROSTHESIS

A unique prosthetically driven protocol has been developed that uses computer-aided engineering (CAE) to develop sophisticated, scientific algorithms that guide the fabrication of a conversion denture using established digital complete denture fabrication technology [40]. The process begins by acquiring clinical records for fabrication of conventional AvaDent digital dentures. The data obtained from scans of these clinical records are used to fabricate provisional complete dentures along with radiographic template of the arch that will receive an implant fixed complete denture (hybrid prosthesis). This new protocol makes it easier and more time efficient to convert a denture at the time of surgical implant placement and enhances the accuracy of the process and the resulting occlusal relationships due to use of the same digital data throughout the planning and conversion denture process [40].

MAINTENANCE OF HYBRID PROSTHESES

Maintenance of hybrid prostheses is an important part of clinical practice. Implant survival rate of 96.3% and a prosthesis survival rate of 85.4% were reported for hybrid prostheses. Prostheses demonstrated higher failure rates than implants. Denture tooth occlusal wear results in the need to replace denture teeth in the fixed prostheses. It appears to be prudent to minimize the costs associated with remaking the occlusal surfaces of these prostheses by reusing, if possible, the original frameworks; however, this is a time intensive effort and generally requires that edentulous patients to go without the original prostheses while the new denture teeth and bases are applied to the frameworks [17].

CONCLUSIONS

Proper diagnosis and treatment plan are important but cannot be all-inclusive. A comprehensive examination, including a thorough medical and dental history, orofacial and dental clinical examination, dental radiographs, impressions, and jaw relation records for mounting casts

are important steps leading to a successful oral rehabilitation. Dentists must consider the advantages and disadvantages of the available implant prosthetic options and match them to patient's expectations. Guidelines were proposed for use by clinicians and laboratory technicians in designing implant-retained frameworks. However further clinical and laboratory research continues to be warranted to test the efficacy of the proposed guidelines.

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