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REVIEW ARTICLE **OPEN ACCESS**

Critical Review of Materials Used to Fabricate Implant Supported Fixed Prosthesis

Diksha Singh, [1]*Reshu Sanan,[2]Omkar Shetty[3], Bhupender Yadav[4],Pankaj Ritwal[5]Jaiveer Yadav[6]
*Department of Prosthodontics, Faculty of Dental Sciences, SGT University, Gurugram
*Email: diksha_fdsc@sgtuniversity.org

ABSTRACT
Implantology has rehashed to offer a long lasting, predictable, successful treatment with biological and mechanical advantages as compared to previous conventional treatments. It has evolved from implant placed surgically with respect to bone available for placing implants with the help of guides. The surgical and handling routine is severely constrained by the need for a dental implant to fully address a variety of physical and biological issues. Although metallic dental implants have been effectively utilised for many years, they have significant drawbacks linked to their bony union and the fact that they do not have the same mechanical characteristics as bone. The material's physical and mechanical qualities should be able to endure functional stress as well as the demanding oral environment. The method of fabrication must be affordable and practical for the technician and dentist. It ought to improve the aesthetic results of prostheses. The fit should be passive to avoid wear at the prosthesis implant interface. The material should be such that the proper oral hygiene is maintained. The material should be reparable. The article reviews prosthetic materials which are available and describes their use in different situations accordingly.
Keywords: PEEK, G-CAM, Zirconia, Surgical guides

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INTRODUCTION
Implantology has rehashed to offer a long lasting, predictable, successful treatment with biological and mechanical advantages as compared to previous conventional treatments which were available. It has evolved from the placement of implants surgically with respect to bone available to placing implants with the help of guides. Due to this progression, there are now a wider variety of prosthetic materials that can be used to replace missing teeth in edentulous jaws [1]. The following qualities are excellent for dental implant abutments and superstructures to have: The patient or the operator shouldn't be exposed to any hazardous or allergic effects from the substance. The material's physical and mechanical qualities should be able to endure functional stress as well as the demanding oral environment. The method of fabrication must be affordable and practical for the technician and dentist. It ought to improve the aesthetic results of prostheses [2-3]. The fit should be passive to avoid wear at the prosthesis implant interface. The material should be such that the proper oral hygiene is maintained. The material should be reparable. The article reviews prosthetic materials which are available and describes their use in different situations accordingly [4-5].

DATA COLLECTION
The literature search covered the following databases:
Medline via PubMed, Science direct, Wiley online library. The articles were shortlisted with similar research parameters like the uses, indications, contraindications, advantages, and disadvantages of certain prosthetic materials used for implant supported fixed prostheses. Around 50 articles were shortlisted, and 30 articles were then included in the review [6].

MATERIALS FOR FRAMEWORK
Commercially pure titanium and Titanium Alloy – Grade 4
Dental implants, abutments, and prostheses have often been made of Ti and titanium alloys. The crucial properties of titanium are its biocompatibility, resistance to corrosion, and durability. To create stock and customised abutments/frameworks to hold or support dental prostheses, grade 4 commercially pure titanium and titanium alloys (particularly Ti-6Al-4V) are utilised. Özcan *et al* [7] concluded that Ti and

titanium alloys, is suitable for dental implants and prostheses, based on their biological, physical, chemical properties. Titanium and its alloys are now used and can be regarded as the material of preference to produce end osseous implant devices.

According to research by Bhola *et al* [8], the alloying components that cause the surface of metallic titanium dental implants and prostheses to create a continuous, stable TiO2 passive coating are what give them their biocompatibility. When metal ions seep into biological tissues, bad things happen. The results of studies may not always consider all of the host defence mechanisms and physiological factors present in the actual implant environment in the oral cavity. Corrosion will occur, and it may have extremely bad consequences. The frequency of implant failures in the oral physiological environment under corrosion and its adverse events has been significantly reduced by our current research standards, laws governing biocompatibility testing, material and design understanding, composition of metals and its alloys suitable for use in implants, and design of materials

COBALT CHROMIUM ALLOYS

In a restricted prosthetic area, a CNC milled, single-piece Co-Framework with porcelain vennering are used. It benefits from being a digitally made answer for a single piece of metal framework and from the successful history of metal-ceramic prosthesis. The effects of accumulated distortion and porosity, as well as the high labour costs and structural hardness that make finishing difficult, are some of the major drawbacks of casting processes. To make it easier to fabricate big frameworks with more precision and fit accuracy, subtractive and additive technologies were introduced, which reduced the majority of these drawbacks. Frameworks made using additive technology (SLM) are more rigid and durable as compared to that made using milling or casting. In comparison to CAD/CAM milled Co-Cr, milled wax with lost-wax technique, or traditional lost-wax casting, it also exhibits improved framework fit.

PEEK

Instead of using metal, the thermoplastic resin polyether-ether-ketone (PEEK) was developed for use as a frame for fixed and detachable prosthetics. This material is equivalent to metal and ceramic materials in terms of low absorption qualities, corrosion resistance, radiolucency, reduced wear, biocompatibility, and lack of allergic reaction. It also has a lower modulus of elasticity. Additionally, it offers good shock absorbing qualities, high wear resistance, and low creep. Either milling or thermo-pressing can be used to build the material frames for prosthetics. In a study to determine the results of rehabilitation of full arch using a fixed implant-supported hybrid prosthesis (PEEK) in conjunction with the All-on-4 concept. Maloand Hammerle [9] concluded that the full-arch hybrid PEEK-acrylic resin fixed rehabilitation method was successful.

G-CAM

G-CAM is a thermostable acrylic with a polymethylmethacrylate resin base that has been doped with graphene (allotropic form of carbon). The CAD/CAM system recommends milling with the disc format. It uses a milling technique like PMMA without irrigation.G-CAM is a product designed for the CAD/CAM system used in the production of dental prostheses. It comes in disc formats of 98.5 mm (universal anchoring) or 95 mm (Zirkonzahn anchorage).

Given that the G-CAM disc is utilised dry, it will be necessary to suction any drilling-related debris. If the wrong tools are used, the drills could break. Although graphene aids in cooling down materials, using the wrong approach could lead to the material overheating and deforming.

MATERIALS FOR ABUTMENTS

The most typical implant abutment are follows:

1. Temporary
    - Resin
    - PEEK
    - Stainless steel surgical grade
    - Casted gold
2. Permanent
    - Titanium
    - Zirconia

Ti alloy

Titanium has strength, light weight, and biocompatibility in addition to being very strong and durable. Grade 5 Ti is another name for titanium alloy. Aluminum, vanadium, oxygen, and a maximum of 0.25 percent iron make up the majority of the titanium alloy, which is composed primarily of titanium. Better in terms of tensile strength and fracture resistance than commercially pure titanium is the Ti-6Al-4V alloy. Due to its exceptional biocompatibility, titanium is the perfect material to create implants. However, using titanium abutments with thin gingival biotypes results in the surrounding soft tissues taking on a

greyish tint. As a result, many implant abutment materials that mimic natural tooth colour have been offered in the past [10].
Zirconia and heavily sintered alumina are examples of these. 6 Reports of metal fragments from titanium prosthesis wear have been made in response to the possible dangers of TiO2 buildup in the body. The production of inflammatory mediators that impact the tissues around the prosthesis and lead to osteolysis may be triggered by debris particles of worn Ti-Al-V. Human monocytes generated more inflammatory mediators as a result of titanium alloys containing vanadium and niobium than those containing titanium, aluminium, and niobium, according to research by Rogers et al (Ti-Al-Nb). According to the authors, metal fragments may cause bone loss around the prosthesis.
In spin-echo sequences using a 0.35T MR equipment used to obtain the pictures, which is believed to have a usually limited diagnostic efficacy, research from 1988 revealed that titanium exhibited no significant metal artefacts. In contrast, some writers claimed in 1998 that titanium alloys caused spin-echo sequence artefacts of a high- to moderate-magnitude. The T1 FSE approach, which is the least sensitive to metal artefacts, shows moderate-magnitude artefacts from commercially pure titanium and titanium alloys, according to Shafiei's study. On MR scans, base metal alloys may show artefacts of various sizes. The majority of the time, high-noble alloys and commercially pure titanium materials do not exhibit artefacts.

Stainless Steel

SS is robust, corrosion-resistant, and simple to clean. Implant abutments are occasionally made of alloys of nickel, chromium, and molybdenum, however nickel sensitivity is a drawback. Although, it can be used for temporary implant abutments, surgical grade stainless steel is not the best material for a permanent implant abutment.

Cast Gold

After seeing the shortcomings in stock abutments, the UCLA abutment—a castable abutment was created. The components of this abutment include a plastic sleeve that can be changed with wax before being cast in gold and a gold alloy base machined fit that fits over the implant. To provide implant-level, custom-made restorations with margins subgingivally for aesthetics, a lowered height for occlusal clearance vertically, cast gold abutments were used. In the 1980s and 1990s, cast gold abutments were widely used, but when more advanced prefabricated abutments and milled abutments became available, their use declined.
Abrahamsson *et al* [11] contrasted the use of gold and porcelain with those of titanium and aluminium:The dental implants were made on five beagle dogs. Each dog received two implants made of commercially pure titanium, two made of aluminium oxide, one made of titanium with porcelain which is fused to gold connected, and one made of gold. A JE measuring 2 mm in height and a piece of CT measuring 1-1.5 mm in height had grown on the titanium and aluminium oxide abutments after six months. The porcelain abutments and gold abutments had no connection at the abutment level after six months. The bone had resorbed, and the soft tissue margin had shrunk. It was determined that aluminium oxide and titanium abutments respond better to soft tissue than gold or porcelain ones.
Study by Vigolo *et al* [12] on soft tissue reaction due to gold and titanium. The trial included 20 individuals with bilateral single-tooth edentulous conditions (using 40 implants). A gold abutment was used to rebuild one side of the arch, while a titanium abutment was used to rebuild the other side. Bilateral sites were checked for supragingival plaque, gingival irritation, bleeding during probing, the amount of keratinized gingiva, and probing depth four years following prosthetic restoration. The soft tissue responses and the marginal bone levels around the implant did not differ considerably.

Zirconia

Zirconium dioxide (ZrO_2), also referred to as zirconia (and not to be confused with zircon), is a zirconium oxide that is white and crystalline in nature.Zirconia with a high strength and biocompatibility that can be utilised in biomedical devices and implant abutments has been produced thanks to advancements in bio material science and ceramic manufacturing technology[13]. These developments included the introducti on of powder injection moulding (PIM), hot isostatic pressing (HIP), and yettria partly stabilised tetragon al zirconia polycrystals (Y-TZP).
Other advancements, such the usage of ceriadoped zirconia and zirconia that has been hardened by zircon ia to reduce the occurrence and slow the course of zirconia ageing, are also seen as crucial stages in the ris ing use of zirconia as a bioceramic.Zirconia is used when high loads and aesthetic considerations are required because of its material characteristics and strength (e.g., aesthetic zone cases, posterior fixed prosthesis frameworks, implant abutments, and multi-unit implant restorations). Zirconia has a Young's modulus that is comparable to steel's, strong bending strength, and fracture toughness. The major benefit of ZrO_2 is its superior tissue integration, which is in addition to its strength. Zirconia abutments also

reduce plaque and bacterial adhesion and soft tissue inflammation. For dentists and dental professionals, adjustment and grinding might be difficult due to its physical characteristics. Zirconia component post-sintering modification considerably increases the likelihood of micro-cracks, which may ultimately lead to failure under clinical function [14-15].Zirconium dioxide (ZrO_2) dental ceramics were found to have negligible radionuclide activity, which can be regarded as being lower than many hazardous radioactive appliances in our environment.

Polyether Ether Ketone

PEEK is commonly used for making temporary abutments. It is a semi-crystalline thermoplastic organic polymer with a beige or white tint and outstanding qualities. The tensile strength is 90–100 MPa, and 3.6GPa is Young's modulus. PEEK melts at a temperature of approx 343°C (662°F) and has a GTT of about 143°C. It has a high level of resistance to attacks from organic elements, damp conditions, and heat deterioration. Due to its sturdiness, PEEK is the perfect material for interim abutment. Its properties include the capacity for sterilization without causing mechanical or biocompatible characteristics to deteriorate. Without creating artefacts, X-ray, MRI, and CT imaging compatible. Excellent mechanical qualities include rigidity and longevity. High compressive resistance. proven biocompatibility with both hard and soft tissues. For good aesthetics, natural colour. Ion exchange in the mouth is eliminated by metal-free solutions. simplicity of dentists' chairside adjustments and preparation[15].

MATERIALS USED FOR THE SURGICAL GUIDES

Inadequate diagnosis, treatment planning, surgical technique, and implant placement frequently result in unintended implant problems. By employing surgical guidance for implant location, this can be avoided. Even when using routinely constructed surgical guides, the clinical outcome is frequently uncertain. Additionally, even when implants are inserted correctly, their placement and deviation may not fulfil the ideal prosthodontic standards. Securing a high success rate without iatrogenic harm requires excellent accuracy in surgical operation design and execution. CT, image-guided template fabrication methods, 3d implant software and computer-assisted surgery can help.

Adrian *et al* [16] created a radiographic cum surgical template using auto polymerizing acrylic resin. The maxillary and mandibular incisors were covered in lead foil, and he employed a lateral cephalogram to cross-check the relevant values. To cover the duplicate denture, a radioopaque marker in the demonstration of acrylic resin provisional fixed restorations. In situations when a temporary fixed repair spans the implant site in place of a removable radiologic template, this is particularly helpful as an option. Vacuum-formed thermoplastic matrix was utilised to modify the diagnostic model. Minoretti *et al* [17] employed thermoplastic matrix (vacuum formed) or self-cure resin to construct templates and Sicilia *et al* used orthodontic wires and self-cure resin.

CAD-CAM Guides

Computer-generated surgical templates have evolved to address the drawbacks of traditional radiography surgical templates. Utilizing information from a CT scan, computer-aided design and computer-assisted manufacturing technology plans implant recovery. The Computed Topography images are transformed into data that a CT imaging and planning programme can recognize. Using stereo-lithographic drill guides, software transports presurgical plan to the surgical site. With the use of cutting-edge scanning, CAD/CAM manufacturing technology, the dentist can create customised dental restorations with a high degree of accuracy and fit. According to the original Branemark procedure, an implant's Osseo-integration took between 3-6 months, depending on the position of implant and the type of the bone, before it was ready for restoration and loading. Surgical guides built with CAD/CAM have various benefits.

It has been demonstrated that dental implant planning using CAD/CAM technology is accurate and that the presurgical plan is reliably transferred to the surgical site. A more recent development in dentistry, stereo-lithography, enables the creation of guides from 3D computer-generated models for precisely placing the implants. This method creates surgical templates with pre-programmed depth and angulation of the implant.

CONCLUSION

Innovations in implant dental prosthesis materials have made it possible to restore complex instances and have found solutions to issues without sacrificing the outcome's functionality or aesthetics.

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