WHITE PAPER

Definitions of Implant Dental Prostheses

The purpose of the following content is to define the parameters by which we describe restoration of edentulous patients and to develop a common nomenclature enabling dental specialists, general dentists, laboratory technicians, and patients to communicate more effectively. The evolution of endosseous implant-associated prostheses, since its introduction by Professor Per-Ingvar Brånemark, is a testament to the imagination and determination of the dental community to improve the lives of our patients.

With the support of Zest Dental Solutions, a group of 12 prosthodontists was assembled over a two-day period to examine the current definitions in use and to build a consensus of descriptions applicable to the current treatment modalities. The team included private practitioners and academicians, with experience in placing and restoring implants, performing laboratory work, and lecturing. In addition to the task force meeting, a survey of the members of the American College of Prosthodontists (ACP) was conducted to gauge whether prosthodontists used the same or similar terms to describe various types of implant prostheses.

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Introduction

The discovery of osseointegration had a tremendous impact on how dentists treat patients suffering from edentulism. In addition, it has significantly changed patients' expectations and improved their overall quality of life (Vogel *et al*. 2013, Bekler *et al*. 2015). Modern endosseous implants were initially introduced as a fixed, totally implant-supported prosthesis that eliminated the need for the edentulous patient to wear a removable prosthesis (Adell *et al*. 1981, Adell *et al*. 1990, Jemt 1994, Schwartz-Arad and Chaushu 1998). As success of surgically attaching a foreign artifact to bone capable of withstanding masticatory forces and surviving in the biologic matrix were proven, momentum in innovation began to appear in the prosthetic design. Initially, most variations followed a protocol that is based on the prototype of a splinted substructure; the bar-retained overdenture on implants was utilized as an alternative to the classic fixed prosthesis (Jennings 1992, Engquist *et al*. 1988, Glantz and Nilner 1997). These designs provided patients with opportunity for improved prosthetic performance requiring a fewer number of implants, thereby reducing the financial burden of implant-based treatment while allowing for prosthetic simplicity (Hooghe and Naert 1997). Patients were able to remove their prostheses at home, eliminating complications in hygiene while providing greater facial support than the original fixed design (Naert *et al*. 1988, Spiekermann *et al*. 1995). As success rates of implant osseointegration were maintained, adoption of solitary anchor implant restorations followed, further reducing the costs of treatment (Attard et. Al 2003). In addition, the implementation of fabrication techniques involving milling and computer-aided design/computer-aided manufacturing (CAD/CAM) allowed use of previously challenging alloys and brought about a wealth of new materials such as monolithic zirconia, milled monolithic acrylic, as well as new ceramics, polymers and hybrids (Ouzer 2015, Pozzi *et al*. 2008, Berthold *et al*. 2015).

With the evolution of technology, digital dentistry and material science, the variety of implant-assisted prostheses will continue to grow. Consequently, classic descriptions and definitions of such prostheses fail to adequately or correctly describe the prosthetic constructs employed. Indeed, while two-thirds (77.2%) of the respondents to the terminology survey acknowledged familiarity with the implant terminology used in the *Glossary of Prosthodontic Terms* (Glossary of Prosthodontic Terms Committee of the Academy of Prosthodontics 2017), when shown pictures of three prostheses and asked to describe them, no consensus was reached. For instance, the situation shown in Figure 1 was described by various respondents as, among other things, an implant-retained overdenture, an implant-retained removable overdenture, an implant-assisted overdenture, a full-arch implant-assisted removable prosthesis, a tissue-supported overdenture, and implant-supported overdenture.

It is important that the wide range of implant restorations be properly described, in order to improve communication amongst providers, technicians, patients, as well as insurance billing and coding.

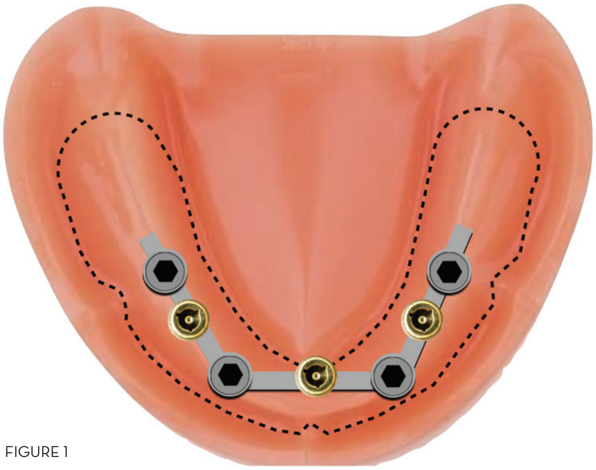

FIGURE 1

Current Terminology

A careful examination of the current definitions based on the *Glossary of Prosthodontic Terms* (Glossary of Prosthodontic Terms Committee of the Academy of Prosthodontics 2017) and other available current definitions was conducted by the group. It was determined that several commonly used descriptions listed in Table 1 are useful in properly defining a particular prosthesis:

Implant-supported	Implant-assisted
Implant-retained	Patient-removable
Resilient-attachment-retained	Movement or no movement with function
Clinician-removable	Attachment-retained
Screw-retained	Restorative material
Cement-retained	Friction-retained

TABLE 1

The group found that these descriptions could be collated into specific criteria used in the definition process as shown in Table 2:

Tissue vs. implant support	Method of retention
Modifiers (retention types)	Fixed vs. removable
	Complete vs. partial

TABLE 2

Specific descriptions of the above-mentioned critical criteria are as follows.

Tissue Support vs. Implant Support

Dental implants can be placed in specific locations and of number to completely support a prosthesis. As a result, when loaded during function, the underlying tissue is not affected; this is defined as ***Implant-Supported***. Implant-supported restorations resist movement during loading unless a resilient attachment allows micromovement. If the mucoperiosteum is displaced during function, the design may be described as ***Implant-Assisted***, as support is shared by implants *and* soft tissues. These tissues displace under load, leading to movement. Attachments designed to retain these prostheses allow for a given degree of movement, whether by reliance of the connection or rotation. A variety of successful prosthetic designs that achieve support from either the underlying tissue, dental implants positioned in the arch, or a combination of both have been utilized.

The concept of rotational movement during function is derived from the design of partial removable dental prostheses (PRDPs), where there are teeth remaining in the arch, yet occlusal load could be shared by teeth and soft tissues. The development and acceptance of the Kennedy Classifications for partially edentulous patient was critical in describing the forces applied to both the tissues and supporting teeth. A PRDP can achieve support from the teeth only (Kennedy Class III) or a combination of teeth and adjacent tissues (Kennedy Class I or II). When the removable prosthesis is totally supported by the teeth there is no tissue support or displacement. However, if the prosthesis has an axis of rotation around a specific fulcrum line, the potential for tissue displacement occurs. The key point is whether or not a rotational axis exists and if the prosthesis moves when any direction of occlusal force is applied to it.

Most restorative dental clinicians have incorporated dental implant therapy into their practice as an additional modality of patient care. Hence, it is important to define, as simply as possible, what constitutes tissue support versus implant support for the prosthesis using endosseous dental implants. We found that the same criteria used to describe support and rotational movement of a tooth-tissue borne PRDP in the Kennedy classification apply to implant restorations in edentulous or partially edentulous patients where movement occurs, as the mechanics are similar in both situations even though teeth move slightly. According to the *Glossary of Prosthodontic Terms*, support is defined as "the foundation area on which a dental prosthesis rests." A *fulcrum line* (rotational line) is defined as "a theoretical line passing through a point around which a lever functions and at right angles to its path of movement." Finally, rotation is defined as "the action or process of rotating on a mechanical center or on an axis" (Glossary of Prosthodontic Terms Committee of the Academy of Prosthodontics 2017).

The use of endosseous implants in a completely or partially edentulous arch in and of itself does not dictate whether the prosthesis is tissue- or implant-supported. As stated above, ***the key in determining whether a prosthesis with natural teeth is tissue supported lies in whether a rotational line exists and whether there is tissue displacement during functional loading***. When defining tissue support or implant support for prostheses using dental implants, the same determining factors or questions apply and are shown in Figure 2:

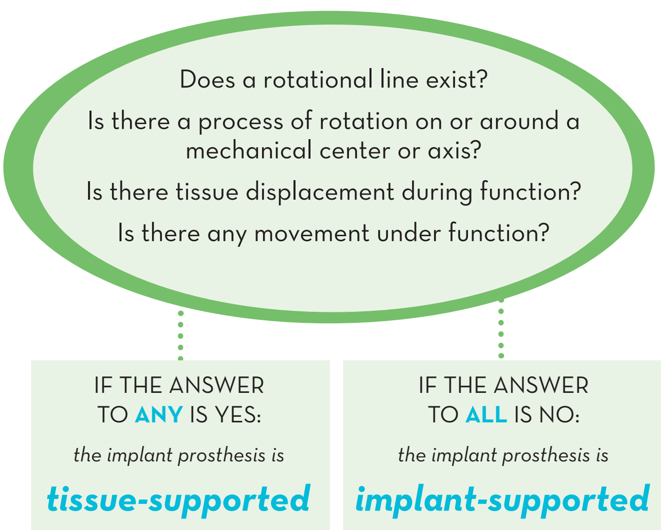

FIGURE 2

Summation of the elements that determine whether an implant prosthesis is tissue- or implant-supported include:

1) The number and location (A/P spread) of implants in the arch.
2) The retention mechanisms used (screws vs. resilient attachments).
3) The specific design of the prosthesis.

Success of treatment may depend on appropriate application of these factors and the distribution of occlusal forces.

It was the consensus of the group that the first term in describing an implant prosthesis should be whether it is ***tissue-supported*** or ***implant-supported***.

Method of Retention

The second criterion to describe the prosthesis should be the method of retention. Retention as described in the *Glossary of Prosthodontic Terms* is described as "that quality inherent in the dental prosthesis acting to resist the forces of dislodgment along the path of placement" (Glossary of Prosthodontic Terms Committee of the Academy of Prosthodontics 2017). When introduced to North America, implant restorations used screws for fixed retention, implying that a patient could not remove the prosthesis. As the opportunity for removable prosthetics in conjunction with dental implants emerged, available attachment mechanisms intended for dental structures were adapted and used. Initially, using experience from teeth and concern for implant stability, supporting bars with attachment mechanisms were advocated. Eventually, improving confidence in osseointegration emboldened clinicians to rely on solitary implants, simplifying treatment and reducing costs. (Vogel *et al.* 2013) This opened the way to new designs of direct-attachment abutments that provided retention and stability. By incorporating a resilient

component or by allowing for slight rotation, these attachment mechanisms reduced the strain on the implant complex during loading. The most popular attachments allowed for easy replacement of the retentive element, as prosthesis movement increases the potential for wear of the attachment mechanism (Alsabeeha *et al.* 2009).

Currently, retention devices are subdivided into fixed or patient-removable options. For fixed restorations, the common methods used to retain a prosthesis are as follows:

- Screw retention
- Cement to abutment retention
- Combination/mixed retention (screws, cement, and attachments)
- Attachment retained (example, Locator F-Tx, Rodo nitinol abutment)

In the patient-removable category, technologies allow a prosthesis to function without movement but can be removed by the patient. These include friction-fit cap on abutment, telescopic bar systems that prevent tilting or depressing of the prostheses in function, as well as various bar/superstructure prostheses that have locking latches. When disengaged by the patient, these components allow prostheses removal. All of these designs pertain to implant-supported prostheses and require appropriate distribution of an adequate number of implants in the arch.

Current common patient-removable implant-supported designs include:

- Resilient attachment on an implant
- Non-resilient attachment on an implant
- Frictional bar retention
- Frictional abutment/attachment retention
- Locking bar-in-bar designs

As stated above, retention mechanisms employed in tissue-supported implant restorations must allow for rotation about an axis. These mechanisms are thus designed to allow a degree of movement about the axis without disengagement of the retention components.

Current examples of attachments used in tissue-supported designs include:

- Locator, Magnets, Locator R-Tx, O-Ring Attachments
- Resilient matrix/patrix combination
- Non-resilient, pivoting, or rotating design

In summary, the second criterion of description is the method of retention. Examples of descriptions of a prosthesis might include: ***implant-supported screw-retained*** or ***tissue-supported resilient-attachment-retained***.

Removable vs. Fixed Prosthesis

As previously stated, the group discussed the method by which a prosthesis is removed and by whom. Hence, the third descriptive agreed upon by the group is whether the prosthesis is fixed or removable. Again, referencing the *Glossary of Prosthodontic Terms* (Glossary of Prosthodontic Terms Committee of the Academy of Prosthodontics 2017), the definition of a fixed dental prosthesis is as follows: "the general term for any prosthesis that is securely fixed to a natural tooth or teeth, or to one or more dental implants/implant abutments; it cannot be removed by the patient". On the other hand, a removable dental prosthesis is described as "a removable complete or partial denture, overdenture, or maxillofacial prosthesis that replaces some or all missing teeth; the dental prosthesis can be readily inserted and removed by the patient". Simply stated, the question to ask is: ***Can the prosthesis be removed by the patient or not?*** Providers prescribe one type of prosthesis over another based on many factors such as ease of

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hygiene, facial support, patient dexterity, and implant position. Although there are many advantages and disadvantages related to these variations, the purpose of this paper is only to describe the prosthesis in simple terms. Thus, this descriptive will simply state whether or not the patient can remove and correctly re-seat the prosthesis.

By adding this discussion to the support and retention criteria, we might describe a prosthesis as ***implant-supported, attachment-retained, removable***.

Complete vs. Partial

In an effort to maintain a degree of proprioception for the patient, the decision may be made to maintain some natural teeth and supplement them with dental implants, in order to improve support and/or retention. Implants may also be used to eliminate or minimize the use of clasps in a PRDP to improve esthetics and reduce strain on abutment teeth. Examples of inclusion of this descriptive were given previously.

Modifiers

The group agreed that there needed to be further descriptions to address various applications of the factors presented above. Several specific terms are necessary to completely describe a given prosthesis. These include splinted vs. solitary anchor concepts, type of abutment (stock or custom fabrication), resilient and non-resilient attachments, as well as retrievable or non-retrievable prosthetic design. Examples of these are listed below:

- Solitary anchor (non-splinted implant), resilient (i.e., O-Ring Attachments, Locator, Ball Attachments, Locator R-Tx). It is always associated with tissue support and removable designs.
- Bars with various attachment mechanisms. If the bar has a rotational axis and the prosthesis moves under function, it is considered tissue-supported. If sufficient implant support exists, such that the prosthesis does not rotate or move, then it is implant/bar-supported. A wide variety of attachment mechanisms such as O-Rings, Locators, ball attachments, distal attachments, Hader clips, friction fit [spark erosion], and patient activated clips can be used or adapted to a bar design. Therefore, attachments that are applicable to movement designs may be used in a fully implant-supported concept, if movement is eliminated by appropriate support.
- Non-resilient solitary anchors (i.e., Conus [no movement but removable]).
- Fixed/screw-retained.
- Fixed/cement-retained.
- Fixed attachment-retained (i.e., Locator F-Tx, Rodo Nitenol).
- Fixed screw/cement combination. This concept is a hybrid of traditional techniques that allows for the "grouting action" of cement, yet renders the prosthesis removable, as a screw access hole is present.

There may also be a modifier for the type of material. For instance, an implant-supported, fixed, complete prosthesis made from monolithic zirconia is distinctly different in cost and performance from an acrylic/titanium "hybrid" (Abdulmajeed *et al*. 2016, Bidra et al. 2017, Bidra *et al*. 2018). As more innovation occurs, these types of additional modifiers will be needed to completely describe the prosthesis. As accelerating technical innovation makes material science a dynamic feature, we have attempted to describe the behavior of the prosthesis in function as well as the ability of the patient to place and remove as pertinent, rather than relying on the materials used.

Use of these modifiers would be optional and placed in parentheses at the end of the description. For instance, the 2-implant overdenture would be ***tissue- supported, attachment-retained, removable complete dental prosthesis (resilient attachments)***. Another example might be ***implant-supported, screw-retained complete dental prosthesis (monolithic zirconia)***.

Overall Comments

The task force debated the use of the word "denture" in descriptions and generally agreed that when talking to patients, the use of "denture' is interpreted by patients as a removable construct. As a result, patients are often embarrassed about wearing dentures or may perceive a diminished value of their investment. Replacing the word "denture" with "prosthesis" when addressing patients may improve acceptance of the recommended treatment, particularly in the case of modern multifactoral designs as described above.

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Multiple factors vary from one prosthesis to another. Criteria such as the number of implants employed, and the engineering of the construct are of great importance. However, these criteria have no purpose when defining the prosthesis, and are simply immaterial in the description. Similarly, the type of restorative material, such as acrylic, occlusal metal, and zirconia is critical in the fabrication of the prosthesis. Nonetheless, this specification is not required in the general description and may be used as a modifier.

It is the responsibility of the dentist or prosthodontist to fully understand the various forces applied to a particular planned design, and to play a central role in the diagnosis and treatment planning of these prostheses when communicating with colleagues and laboratory technicians. Proper communication and mutual understanding of the above terminology will be helpful in achieving successful results.

With regards to the general consensus, there are currently excessive inconsistencies in the terminology of implant prostheses among manufacturers, dental schools, private practitioners, technicians, and patients. The task force understands that brevity in everyday communication is essential, and that slang terms will continue to be used in discussions with patients. Nevertheless, many terms have become ubiquitous in implant therapy, in spite of the fact that their use may be historic or poorly descriptive of the modern prosthesis. The mandate of the task force was to propose a system of terminology in a logical order that could be used to universally describe the great variations available today. The system must also be adaptable as emerging technologies come on line, such that its methodology can be used well into the future. Table 3 details the system suggested by this paper. Our overall goal was to create a consensus of simple descriptions that can be easily applied to any type of implant prosthesis.

Definition of Implant-Assisted Dental Prosthesis

TYPE OF PROSTHESIS SUPPORT	METHOD OF PROSTHESIS RETENTION	PATIENT'S ABILITY TO REMOVE PROSTHESIS	EXTENT OF PROSTHESIS	(MODIFIERS)
Implant	Screw	Fixed	Partial	Splinted vs un-splinted
Tissue	Cement	Removable	Complete	Resilient vs non-resilient attachment
	Attachment			Custom vs. stock abutment
	Combination of above			Material
	Other			Other

TABLE 3

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