

# RATIONALE FOR CHOICES OF OCCLUSAL SCHEMES FOR COMPLETE DENTURES SUPPORTED BY IMPLANTS

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## KEY WORDS

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This review of occlusal considerations for implant-supported complete dentures reflects the majority opinion of authors according to clinical observations and research-documented evidence. Occlusal concepts are presented for the implant-supported complete dentures regarding analysis of loads applied to dental implants, location and number of implants, occlusal materials, and occlusal scheme.

## INTRODUCTION

It is known that natural teeth have periodontal ligament receptors that protect the teeth and periodontium from excessive occlusal forces, which can cause trauma to supporting tissues and bone. Although many factors are involved in the neuromuscular reflex actions in natural teeth, there are no specific defense mechanisms against occlusal forces in implant-supported complete dentures.<sup>1</sup> Complications (prosthetic or bony support) reported in follow-up studies underline occlusion as a determining factor for success or failure.<sup>2</sup>

For implant placement and fabrication of implant-supported complete dentures, several factors are important: the number and position of implants, the available implant surfaces for load transmission on the jaw bone, the relation of the length of the superstructure to the implant body, and

the establishment of correct occlusion.<sup>3</sup> The choice of an occlusal scheme for implant-supported complete dentures is often controversial. Almost all guidelines are based on those developed with natural teeth, and there are no published clinical studies comparing the occlusal theories.

This study reviews the occlusal concept choices for implant-supported complete dentures regarding analysis of loads applied to dental implants, location and number of implants, occlusal materials, and occlusal scheme.

## ANALYSIS OF LOADS APPLIED TO DENTAL IMPLANTS

A dental implant is subjected to mechanical forces because of the loading placed on the prosthesis. Forces are described as compressive, tensile, and shear. Compressive forces tend to maintain the integrity of an implant. In general, the implant-supported

complete dentures best accommodate compressive forces, whereas shear and tensile forces tend to distract or disrupt an implant interface.<sup>4</sup>

The manner in which a force is distributed over a surface is referred to as mechanical stress.<sup>5</sup> The magnitude of stress is dependent on 2 variables: force magnitude and cross-sectional area. A dentist can control the force magnitude, which depends on cantilever length and offset loads. The cross-sectional area is defined as the surface that participates significantly in load bearing and stress dissipation. It can be optimized by (1) increasing the number of implants for the edentulous area and (2) selecting an implant geometry that has been carefully designed to maximize the functional cross-sectional area.<sup>5</sup>

Two main types of loading should be considered: axial force and bending force. The axial force is more favorable because it distributes the stress throughout the implant. Posterior implant-supported complete dentures are subjected to bending moments, which are generated by functional and parafunctional movement patterns of the mandible.

According to the theoretical studies that have been reported by some authors, bending moments lead to higher stress levels in implant components and the supporting bone than do compressive and tensile forces.<sup>6-9</sup> Under lateral loads, all implants exhibit very high levels of stress in the head and neck region with compressive stress on one side and tensile on the other. They are gradually diminished in apical and lateral directions.<sup>10-14</sup> For better function of implant-supported complete dentures, it has been suggested that the implants should have the following construction:

- Root-shaped implants, because of their cylindrical shape, minimize transmission of stresses to supporting bone better than blade-shaped implants.
- Implant necks should be enlarged. Implants with narrow or constricted necks should be avoided.<sup>15,16</sup>

#### LOCATION AND NUMBER OF IMPLANTS

There are basically 2 types of implant-supported overdentures: tissue borne and implant borne. The tissue-borne overdenture is attached to implants that are placed in the anterior area of the maxillary and mandibular arch. At least 2 implants are required for this overdenture. In the mandible, the bar and clip are the most commonly used types of attachments. These attachments not only provide support and retention of the denture in the anterior area, but also allow stress breaking when the area of the denture is loaded. In the maxilla, bars and clips are not generally used. These attachments prevent complete seating of the prosthesis onto tissues in the area where the implants are placed, impede the achievement of seal around the periphery of the denture, and result in loss of retention of dentures. This overdenture design is dependent on soft tissue support.<sup>17,18</sup>

The width of the arch plays a role in determining the position of the implants and the distance between the implants.<sup>19</sup> Patients with a tapered mandibular arch are not considered good candidates for a 2-implant bar and clip system because the bar will occupy the tongue space. If the bone is of good quality and implants are of sufficient length, attachments can be placed over

individual implants without the use of a splinting bar.<sup>20</sup> The occlusion for this type of overdenture should include contacts in centric relation and in eccentric positions.<sup>20</sup>

An implant-borne overdenture relies on the implants to bear the full occlusal loading. This prosthesis requires the use of a sufficient number of implants to accommodate the load that is placed on the prosthesis.<sup>20</sup> The minimum number of implants required is 4 in the mandible and 6 to 8 in the maxilla.

The number and the location of implants reflect the quality and quantity of bone. It is important to avoid cantilevers on the maxillary arch. Symmetric placement of implants in the tuberosity, canine, and incisor regions is required,<sup>21</sup> and the type of occlusal scheme should be balanced and lingualized. The implants carry all the occlusal loading.<sup>22</sup>

#### OCCUSAL MATERIALS

The materials that are used for the occlusal surface of the prosthesis affect the transmission of forces and maintenance of occlusal contacts. Occlusal materials may be determined by aesthetics, impact force, chewing efficiency, wear, fracture, and interarch space.<sup>23-25</sup> Occlusal loading of osseointegrated implants is believed to be an important factor in the long-term success of implant-supported complete dentures.<sup>26</sup>

Branemark and his associates<sup>27</sup> proposed a protocol for occlusal development based on physics and clinical results. Acrylic resin was the material of choice for the occlusal surfaces. The resiliency of acrylic resin was suggested as a safeguard against stress and microfracture of the implants.<sup>28,29</sup> In contrast with the

foregoing studies, Ismail and his associates<sup>30</sup> revealed that the function of the resin teeth as a shock absorber was not valid.

It has been suggested that metal occlusal surfaces may be preferred in order to minimize wear and prolong the accuracy and longevity of occlusal schemes.<sup>5</sup> Porcelain teeth in both arches is the material most often selected when there are parafunctional habits and marginal interarch space.<sup>31,32</sup> Improved composite resin materials are available that wear less than acrylic and are very similar to enamel; however, the long-term fracture potential of these materials on implants has not yet been established.<sup>33</sup>

#### OCCLUSAL SCHEME

The goal of any prosthetic procedure must include the establishment of a functional occlusion.<sup>34</sup> Many authors have developed guidelines for occlusion over dental implants. Although all authors appear to agree on a balanced occlusion, there are no clinical experimental data to support these assumptions.<sup>35-37</sup> Balanced occlusion in natural dentition is not needed because the periodontal ligament supports each tooth independently. Numerous articles have described occlusal schemes for edentulous patients.

Parr and Loft<sup>38</sup> reviewed the various occlusal schemes, which range from full anatomic balanced to neutrocentric occlusion. These different occlusal schemes were developed to function on unstable denture bases. Occlusion and articulation of implant-supported complete dentures must reduce stress on the implants.<sup>39</sup>

The occlusion should distribute the forces evenly among the implants. The vertical dimension

of occlusion should be made compatible with a patient's free space and evaluated carefully. Adequate interarch space is needed to accommodate the prosthesis and allow for adequate hygiene.<sup>40,41</sup>

For tissue-supported overdentures, balanced occlusion is suggested with simultaneous contact of the artificial teeth. In edentulous patients, there is more leeway in control of the incisal guidance. The role of condylar guidance also varies with the type of developed occlusion. If a balanced occlusion is desired, a 3-point contact balance between the working and nonworking sides is achieved. No attempt should be made to obtain a full balanced occlusion.<sup>20</sup>

A full balanced scheme of occlusion can be developed with any of the various cusp types of artificial teeth with a compensating curve.<sup>42</sup> If there is mandibular resorption, a flat plane type of occlusion should be developed. This is accomplished by the use of 0° teeth in the opposing arches.<sup>20</sup> A lingualized type of occlusion is preferred in order to eliminate or reduce lateral stress. The teeth with the greater cusp degree are placed in the maxillary arch, allowing for the lingual cusps of the maxillary posterior teeth to glide from central fosse and onto the buccal and lingual inclines of the buccal and lingual cusps of the mandibular teeth. This occlusal scheme is based on the use of the maxillary lingual cusp as the "stamp cusp," which occludes with a shallow mandibular central fosse. A lingualized occlusion can also be accomplished by the use of cusped teeth in the maxillary arch and 0° teeth in the mandible.<sup>43,44</sup>

The occlusion chosen for implant-supported complete dentures should be a balanced occlu-

sion ensuring that there is no interference with jaw movements into eccentric positions.<sup>45</sup> A lingualized occlusion provides an excellent alternative to a fully balanced scheme.<sup>46</sup>

#### DISCUSSION

In addressing the subject of dental implants, a dentist must consider not only the surgical phase of placing the implants, but also the entire treatment sequence, especially the prosthodontic rehabilitative procedures. Many implant failures can be attributed to improper occlusal design, which can concentrate stresses in the bone and lead to rapid bone resorption.<sup>47</sup> Certain rules are recommended to establish proper occlusal design: (1) cusp designs should be made so that the stress is directed along the long axis of the implant, (2) lateral stresses should be avoided, (3) the width of the occlusal table should be no wider than the width of the implant root, and (4) cusp height should be minimized in order to decrease lateral stress. Sometimes the occlusal table should be flat, providing only centric function.<sup>15,48</sup>

Lingualized occlusion can be preferred in tissue-borne and implant-borne overdentures. The advantages of this occlusion are that the penetration of the bolus of the food is accomplished with less occlusal force and that the opposing incline surfaces of the tooth provide buccolingual stability and eliminate the potential for lateral interferences in excursive movements.<sup>44,49</sup>

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