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THE EMERGING ROLE OF OSSEOPERCEPTION IN PROSTHODONTICS & ORAL IMPLANTOLOGY

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ABSTRACT

The rehabilitation of missing teeth has been revolutionized by osseointegrated dental implants. However, unlike natural teeth, implants lack a periodontal ligament (PDL), which plays a crucial role in proprioception. This absence initially raised concerns regarding tactile sensibility and functional precision. Emerging evidence, however, supports the concept of osseoperception, a neurophysiological phenomenon that enables sensory perception through implants. This editorial explores the mechanisms underlying osseoperception, including peripheral mechanoreception and central neural plasticity, and highlights its clinical implications in prosthodontics and implantology. Implant-supported prostheses demonstrate superior tactile sensibility and masticatory efficiency compared to conventional dentures, although still inferior to natural dentition. Factors such as implant design, loading protocols, and prosthetic configuration influence osseoperception. Despite promising findings, variability among individuals and the lack of standardized assessment methods remain challenges. Future research integrating neuroimaging and bioengineered sensory-enhanced implants may further optimize functional outcomes. Osseoperception represents a significant advancement, transforming implants from passive replacements into dynamic contributors to oral sensorimotor function.

Keywords: Bone mechanoreceptors; Cortical plasticity; Dental implants; Masticatory efficiency; Neuroplasticity; Osseointegration; Osseoperception; Prosthodontics; Sensory feedback; Tactile sensibility.

INTRODUCTION

The restoration of missing teeth has undergone a transformative evolution with the advent of osseointegrated implants. Unlike natural teeth, which are supported by the periodontal ligament (PDL), implants are directly ankylosed to bone. Consequently, they lack the intrinsic proprioceptive mechanism provided by the PDL. This limitation initially raised concerns regarding tactile sensibility and functional precision.

However, growing evidence supports the concept of osseoperception. This phenomenon enables tactile and proprioceptive feedback through osseointegrated implants, partially compensating for the absence of the PDL.

Osseoperception is defined as the ability to perceive mechanical stimuli via implants through mechanoreceptors located in peri-implant bone, soft tissues, and associated structures, along with central neural adaptations ^[1,2]. Although implants lack a PDL, they effectively transmit occlusal forces. These forces are detected by receptors in the periosteum, mucosa, muscles, and temporomandibular joint ^[3,4]. The resulting afferent signals contribute to motor coordination and protective reflexes.

Following tooth loss, neural pathways associated with the PDL undergo reorganization. Experimental and clinical studies demonstrate significant cortical plasticity, where adjacent neural pathways adapt to process new sensory inputs from implants [5,6]. Mechanoreceptors in the mucoperiosteum and masticatory muscles play a compensatory role. Functional MRI studies further confirm that the brain integrates implant-mediated sensory input into existing neural networks ^[7].

In prosthodontics, particularly in complete edentulism, osseoperception provides clear functional benefits. Implant-supported overdentures and fixed prostheses offer improved sensory perception compared to conventional dentures ^[8]. Patients demonstrate better bite force discrimination, enhanced masticatory efficiency, and fewer prosthesis-related injuries such as mucosal trauma ^[9,10].

Osseoperception also facilitates neuromuscular adaptation. It enhances motor learning and improves coordination during mastication and speech ^[11]. Comparative studies indicate that while natural dentition exhibits the highest tactile sensitivity, implant-supported prostheses outperform conventional dentures ^[12].

Jacobs and van Steenberghe demonstrated that patients with implant-supported prostheses could detect minimal occlusal discrepancies, highlighting functional sensory integration ^[1]. Similarly, Grieznis et al. reported improved masticatory performance in elderly patients rehabilitated with implant-retained overdentures ^[2].

From an implantology perspective, several factors influence osseoperception. Implant design plays a crucial role, as surface characteristics and geometry affect load transmission to surrounding tissues ^[13]. Loading protocols also contribute; immediate loading may accelerate neurosensory adaptation compared to delayed approaches ^[14]. Additionally, fixed prostheses provide more consistent sensory feedback than removable prostheses due to rigid implant coupling ^[15].

Despite these advancements, challenges remain. There is considerable inter-individual variability in osseoperception. Standardized methods for its assessment are lacking, and subjective sensory perception is difficult to quantify. Recent research has begun exploring advanced neuroimaging techniques and computational modeling to better understand these mechanisms ^[16,17]. Furthermore, the development of bioengineered implants with integrated sensory feedback systems represents a promising future direction ^[18].

CONCLUSION

For the technique, atraumatic removal of the coronal portion is performed by sectioning in the mesiodistal and buccolingual directions. The alveolar crest can be used as a support wall for elevators, thereby avoiding contact with the roots. Ostectomy may be necessary in some situations; however, it is recommended that it not be extended below the cemento-enamel junction. By observing these details, stress on the roots is significantly reduced, as is the risk of technique failure and root mobilization during the procedure.²⁶ According to Monaco et al.,¹⁰ the amount of bone to be removed must be compatible with the depth of inclusion and type of impaction observed. For vertical impactions or distoangular inclusions where 50% of the third molar crown is above the cemento-enamel junction (CEJ) of the second molar, odontosection can be performed without ostectomy. However, if the crown is 50% or more below the CEJ of the second molar, ostectomy becomes necessary. For mesial or horizontal inclusions, ostectomy is more often required and should be performed until complete crown visualization is achieved. Regarding suturing, most studies indicate that suturing stabilizes the clot and improves postoperative healing. Suturing should provide tension-free healing, and interrupted simple stitches should be placed until the incision is completely closed, as depicted in Figure 7. Then, coronectomy is a valid surgical option for managing mandibular third molars. With adequate knowledge and attention to technique, the chances of success are high, and the incidence of potential complications is reduced. Proper surgical planning and mastery of the method are essential for the steps to be performed correctly and for success to be achieved.

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