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Influence of Gingival Phenotype on Crestal Bone Stability around Implants: A Comprehensive Review

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Abstract

This review article explores the influence of gingival phenotype on crestal bone stability around dental implants. Gingival phenotypes are classified into thick and thin biotypes, each exhibiting distinct anatomical and histological characteristics that impact the stability and health of the surrounding bone. Thick gingival tissues provide better mechanical resistance, a robust biological seal, and reduced susceptibility to inflammation and recession, which collectively contribute to improved crestal bone preservation. In contrast, thin gingival tissues are more vulnerable to mechanical stress and microbial invasion, leading to an increased risk of peri-implantitis and subsequent bone loss. The article discusses the histopathological differences between these phenotypes and their clinical implications for implant therapy, including the importance of preoperative assessment, soft tissue management, and prosthetic design. Future research directions are suggested to enhance the understanding of this critical relationship. By considering gingival phenotype in treatment planning, clinicians can optimize implant outcomes and ensure long-term success.

Keywords: Gingival Phenotype, Dental Implants, Biotype, Soft Tissue Management, Peri-implantitis, Bone Resorption, Implant Therapy

Introduction

Dental implants have revolutionized restorative dentistry by providing patients with a reliable solution for replacing missing teeth. However, the success of dental

implants is influenced by various factors, with crestal bone stability being paramount for long-term outcomes. Crestal bone loss can jeopardize the stability of the implant, affect esthetics, and lead to complications that necessitate further intervention. Recent studies have emphasized the significance of the gingival phenotype in influencing crestal bone stability. This article aims to explore the intricate relationship between gingival phenotype and crestal bone stability around implants, examining biological, mechanical, histopathological, and clinical aspects. (1-3)

Understanding Gingival Phenotype

The gingival phenotype refers to the anatomical and histological characteristics of the gingival tissue surrounding the teeth or implants. It is primarily classified into two categories:

Thick Biotype (4,5)

Characteristics: The thick phenotype is characterized by a dense and fibrotic structure with abundant keratinization. Clinically, it presents as a broad band of attached gingiva that is resilient to trauma and inflammation.

Histopathology: Histologically, thick gingival tissues have a thicker epithelium, a greater number of collagen fibers, and a rich vascular supply. This structure contributes to a more robust biological barrier against external stimuli.

Thin Biotype (6,7)

Characteristics: The thin phenotype is more delicate, with less keratinized tissue and a narrower band of attached gingiva. This type is more susceptible to mechanical trauma, inflammation, and recession.

Histopathology: Thin gingival tissues exhibit a thinner epithelium, fewer collagen fibers, and reduced vascularity. These histological features contribute to a weaker biological seal around implants, increasing susceptibility to peri-implant diseases.

Mechanisms of Influence on Crestal Bone Stability

The gingival phenotype influences crestal bone stability through various biological and mechanical mechanisms:

Mechanical Resistance: (8,9)

Thick Phenotype: The robust nature of thick gingival tissues acts as a cushion that absorbs and dissipates mechanical forces during functional loading. The dense connective tissue provides better stability for the underlying bone, reducing the risk of resorption.

Thin Phenotype: Conversely, the thin phenotype offers less resistance to mechanical forces, making the underlying bone more vulnerable to resorption. The lack of adequate soft tissue protection can result in exposure of the implant surface, leading to an increased risk of bone loss.

Inflammatory Response (10,11)

Thick Phenotype: Thick gingival tissues create a more effective biological seal around implants, minimizing bacterial invasion and inflammatory responses. The keratinized epithelium and dense connective tissue act as barriers, limiting the spread of pathogens and inflammation to the crestal bone.

Thin Phenotype: Thin gingival tissues are less effective in preventing bacterial penetration, leading to a higher incidence of peri-implantitis. The inflammatory response may be more pronounced, resulting in faster and more extensive bone loss.

Gingival Recession: (12,13)

Thick Phenotype: A thick gingival biotype tends to maintain a stable gingival margin, thus preventing recession and preserving the soft tissue seal around the implant. This stability contributes to the maintenance of peri-implant bone levels.

Thin Phenotype: In contrast, thin biotypes are more prone to recession, exposing the implant collar and predisposing the area to plaque accumulation and inflammation. The resulting tissue breakdown can lead to crestal bone resorption.

Histopathological Insights (14-17)

Understanding the histopathological differences between thick and thin gingival phenotypes is crucial for elucidating their influence on bone stability. Here are key histopathological findings:

Thick Phenotype Histology

Epithelial Layer: The epithelium in thick phenotypes exhibits a thicker keratinized layer, providing a strong barrier to microbial invasion. The keratinocytes contribute to the inflammatory response by producing antimicrobial peptides.

Connective Tissue Composition: The connective tissue is dense with a high density of collagen fibers arranged in a network that provides mechanical strength. Fibroblasts in thick tissues produce a greater amount of extracellular matrix components, promoting tissue stability.

Vascularization: Increased vascularization in thick gingival tissues enhances nutrient supply and facilitates healing processes, which is essential for maintaining bone health.

Thin Phenotype Histology

Epithelial Layer: The epithelium is thinner and less keratinized, making it more vulnerable to mechanical stress and bacterial invasion. The reduced keratinization may impair the epithelial barrier function.

Connective Tissue Composition: The connective tissue is characterized by fewer collagen fibers and a lower density of fibroblasts. This leads to a weaker attachment to the implant surface and a greater risk of tissue breakdown.

Vascularization: Thin gingival tissues tend to have less vascularization, which may compromise the healing response and increase the risk of complications following surgical interventions.

Clinical Implications (18-20)

The understanding of gingival phenotype and its impact on crestal bone stability has significant clinical implications for implant therapy. Here are key considerations for clinicians:

Preoperative Assessment

Phenotype Evaluation: Clinicians should assess the gingival phenotype during the preoperative examination using visual inspection and clinical measurements, such as the width of attached gingiva and tissue thickness. Tools like transgingival probing and periodontal probes can help determine tissue thickness.

Risk Assessment: Identifying patients with a thin phenotype allows clinicians to implement preventive strategies to enhance crestal bone stability.

Surgical Techniques

Soft Tissue Augmentation: For patients with a thin gingival phenotype, soft tissue grafting procedures can be performed to enhance tissue thickness and create a more favorable peri-implant environment. Techniques such as connective tissue grafts or free gingival grafts are effective in increasing soft tissue thickness.

Implant Positioning: Placing the implant subcrestally in patients with thin phenotypes can help create a more stable biological environment. Subcrestal positioning may allow for better adaptation of soft tissue and reduce exposure of the implant to bacterial challenges.

Prosthetic Design

Restorative Components: Prosthetic designs should minimize mechanical stress on the peri-implant tissues. Features such as platform switching, which involves using an abutment that is smaller in diameter than the

implant platform, can help preserve marginal bone levels. This technique redistributes the forces acting on the bone, reducing the likelihood of bone loss, especially in patients with thin phenotypes.

Maintenance Protocols

Regular Monitoring: Patients with thin gingival phenotypes require more frequent monitoring to assess for signs of inflammation or bone loss. Implementing a rigorous maintenance program that includes professional cleanings and patient education on oral hygiene can help mitigate the risk of complications.

Patient Education: Educating patients on the importance of maintaining proper oral hygiene practices is crucial for minimizing plaque accumulation and preventing peri-implant diseases. Patients should be encouraged to use soft-bristle toothbrushes, interdental brushes, and antimicrobial mouth rinses to maintain healthy peri-implant tissues.

Influence of Factors Beyond Gingival Phenotype (21,22)

While the gingival phenotype plays a significant role in crestal bone stability, other factors also contribute to the overall success of dental implants. These include:

Bone Quality and Quantity: The density and volume of the bone surrounding the implant significantly influence its stability. Bone quality can be classified as low, medium, or high density, with low-density bone being more susceptible to resorption.

Implant Design: The design of the implant itself can impact crestal bone stability. Factors such as implant diameter, length, surface treatment, and thread design can affect primary stability and osseointegration.

Loading Conditions: The amount and distribution of occlusal forces on the implant can influence bone remodeling. Implants subjected to excessive forces may experience greater bone loss, while those in a well-distributed loading scenario may show improved bone stability.

Systemic Health Factors: Conditions such as diabetes, osteoporosis, and smoking can negatively impact bone healing and stability. Patients with systemic health issues may require additional interventions and monitoring to maintain peri-implant health.

Microbial Factors: The presence of specific bacterial profiles in the peri-implant sulcus can contribute to the development of peri-implant diseases. Maintaining a healthy microbiome through proper oral hygiene and professional cleanings is vital for implant success.

Future Directions (23)

Future research should focus on the following areas to enhance our understanding of the relationship between gingival phenotype and crestal bone stability:

Longitudinal Studies: Long-term studies examining the impact of different gingival phenotypes on implant success rates and bone stability are essential to establish clear correlations and inform clinical practice.

Biomarkers of Inflammation: Identifying biomarkers that correlate with gingival phenotype and peri-implant inflammation could provide valuable insights into the underlying mechanisms of bone loss around implants.

Advanced Imaging Techniques: Utilizing advanced imaging technologies, such as cone-beam computed tomography (CBCT), can help assess bone morphology and soft tissue characteristics in a non-invasive manner, providing a comprehensive view of the peri-implant environment.

Innovative Surgical Techniques: Researching and developing new surgical techniques and materials for soft tissue augmentation could improve outcomes for patients with thin gingival phenotypes.

Interdisciplinary Approaches: Collaborations between periodontists, oral surgeons, and restorative dentists can

lead to improved treatment protocols that account for gingival phenotype, systemic health, and implant design to optimize outcomes for patients.

Conclusion

The gingival phenotype is a critical factor influencing the stability of crestal bone around dental implants. Thick gingival biotypes provide enhanced protection against mechanical stress, bacterial invasion, and inflammation, ultimately leading to better crestal bone preservation compared to thin biotypes. Understanding the distinct histopathological characteristics of these phenotypes informs clinical decision-making and allows for tailored treatment strategies.

For clinicians, recognizing the importance of the gingival phenotype during preoperative assessments can significantly impact implant success rates. Implementing appropriate surgical interventions, such as soft tissue grafting and optimizing implant positioning, can mitigate the risks associated with thin phenotypes. Additionally, careful prosthetic design and regular maintenance protocols are essential in maintaining peri-implant health.

As research in this field continues to evolve, future studies should focus on long-term outcomes, the identification of inflammatory biomarkers, and innovative surgical techniques to further enhance the management of crestal bone stability around implants. By adopting an interdisciplinary approach and considering various factors that influence implant success, dental professionals can improve treatment outcomes and patient satisfaction in implant therapy.

References

1. Oh TJ, Yoon J, Misch CE, Wang HL. The causes of early implant bone loss: myth or science? J Periodontol. 2002;73:32233. 10.1902/jop.2002. 73.3.322.10.1902/jop.2002 - DOI - PubMed
2. Schwarz F, Derks J, Monje A, Wang HL, Peri-implantitis. J Clin Periodontol. 2018;45(Suppl 20):246–66. 10.1111/jcpe.12954.10.1111/jcpe.12954 - DOI - PubMed
3. Albrektsson T, Chrcanovic B, Östman PO, Sennerby L. Initial and long-term crestal bone responses to modern dental implants. Periodontology. 2017;73:41–50. 10.1111/prd.12176.10.1111/prd.12176 - DOI - PubMed
4. Wennström JL, Derks J. Is there a need for keratinized mucosa around implants to maintain health and tissue stability? Clin Oral Implant Res. 2012;23(Suppl 6):136–46. 10.1111/j.1600-0501.2012.02540.10.1111/j.1600-0501.2012.02540 - DOI - PubMed
5. Lin GH, Chan HL, Wang HL. The significance of keratinized mucosa on implant health: a systematic review. J Periodontol. 2013;84(12):1755–67. 10.1902/jop.-2013.120688. 10.1902/jop.-2013.120688 - DOI - PubMed
6. Del Suárez-López AF, Lin GH, Monje A, Galindo-Moreno P, Wang HL. Influence of soft tissue thickness on Peri-implant marginal bone loss: a systematic review and Meta-analysis. J Periodontol. 2016;87(6):690–99. 10.1902/jop.2016.150571. 10.1902/jop.2016.150571 - DOI - PubMed
7. Akcalı A, Trullenque-Eriksson A, Sun C, Petrie A, Nibali L, Donos N. What is the effect of soft tissue thickness on crestal bone loss around dental implants? A systematic review. Clin Oral Implants Res. 2017;9:1046–53.
8. Cortellini P, Bissada NF. Mucogingival conditions in the natural dentition: narrative review, case definitions, and diagnostic considerations. J Periodontol. 2018;89(Suppl 1):204–13.

9. Tang P, Meng Z, Song X, Huang J, Su C, Li L. Influence of different mucosal phenotype on early and long-term marginal bone loss around implants: a systematic review and meta-analysis. Clin Oral Investig. 2023;27:1391–407. 10.1007/s00784-023-04902-w. 10.1007/s00784-023-04902-w - DOI - PubMed
10. Swierkot K, Lottholz P, Flores-de-Jacoby L, Mengel R. Mucositis, peri-implantitis, implant success, and survival of implants in patients with treated generalized aggressive periodontitis: 3- to 16-year results of a prospective long-term cohort study. J Periodontol. 2012;83(10):1213–25.
11. Lekholm U, Zarb G. Patient selection and preparation. In. Tissue-integrated prosthesis: Osseointegration in clinical dentistry, editors Brånemark PI, Zarb GA, Albrektsson B. Chicago: Quintessence Publ. Co. 1985:199–209.
12. Mengel R, Wendt J, Peleska B. Prosthodontic treatment outcomes in periodontally compromised patients: a 6- to 20-year long-term cohort study. Int J Prosthodont. 2019;32:–153. 10.11607/ijp.5917. - PubMed
13. Löe H, Silness J. Periodontal disease in pregnancy I. Prevalence and severity. Acta Odontol Scand. 1963;21(6):533–51.
14. Silness J, Löe H. Periodontal Disease in pregnancy. II. Correlation between oral hygiene and periodontal condition. Acta Odontol Scand. 1964;22:121–35. 10.1097/-jpn.0b013e31821072e4. 10.1097/-jpn.0b013e31821072e4 - DOI - PubMed
15. Olsson M, Lindhe J, Marinello CP. On the relationship between crown form and clinical features of the gingiva in adolescents. J Clin Periodontol. 1993;20(8):570–7. 10.1111/j.1600-051X.1993.tb00773.x.10.1111/j.1600051X.1993.tb00773.x - DOI - PubMed
16. Thoma DS, Mühlemann S, Jung RE. Critical soft-tissue dimensions with dental implants and treatment concepts. Periodontol 2000. 2014;66(1):106. 10.1111/-prd.12045. 10.1111/-prd.12045 - DOI - PubMed
17. Puisys A, Linkevicius T. The influence of mucosal tissue thickening on crestal bone stability around bone-level implants. A prospective controlled clinical trial. Clin Oral Implant Res. 2015;26(2):123–29.
18. Garaicoa-Pazmino C, Mendonça G, Ou A, Chan HL, Mailoa J, Del Suárez-López AF, Wang HL. Impact of mucosal phenotype on marginal bone levels around tissue level implants: A prospective controlled trial. J Periodontol. 2021;92(6):771–83.
19. Müller HP, Eger T. Gingival phenotypes in young male adults. J Clin Periodontol. 1997;24:65–71. 10.1111/j.1600-051x.1997.tb01186.x. Müller HP, Heinecke A, Schaller N, Eger T. Masticatory mucosa in subjects with different periodontal phenotypes. J Clin Periodontol. 2000;27:621 – 26 10.1034/j.1600-051x.2000.027009621.x . - PubMed
20. Goaslind GD, Robertson PB, Mahan CJ, Morrison WW, Olson JV. Thickness of facial gingiva. J Periodontol. 1977; 48:768 – 71.
21. Lee SA, Kim AC, Prusa LA Jr., Kao RT. Characterization of dental anatomy and gingival biotype in Asian populations. J Calif Dent Assoc. 2013;41:36–9.
22. Chan HL, Sinjab K, Li J, Chen Z, Wang HY, Kripfgans OD. Ultrasonography for nonivasive and real-time evaluation of peri-implant tissue dimensions. J Clin Periodontol. 2018;45:986 – 95. 10.1111/jcpe.12918. - PubMed