

Aesthetics in implantology: The pursuit of beauty and function

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ABSTRACT

Objectives: The pursuit of beauty and function in dental implantology has become increasingly important, with a shift in focus from solely achieving osseointegration to creating implant-borne restorations that harmonize with surrounding hard and soft tissues. This article highlights the significance of aesthetics in implantology, emphasizing the importance of precise implant placement, optimal restoration design, and comprehensive treatment planning. Various factors influence aesthetic outcomes, including tooth shape, root position, periodontal biotype, and bony anatomy. There is need for a team-oriented approach, involving collaboration between specialists from various disciplines.

Conclusion: A comprehensive evaluation of patient needs, integrated treatment planning, precise implant placement, and optimized restoration design are essential for predictable aesthetic outcomes. By embracing this paradigm shift and adopting a team-oriented philosophy, clinicians can elevate the standards of implant placement, ensuring that patients receive not only functional but also aesthetically pleasing restorations that enhance their overall quality of life.

KEYWORDS: dental implantology, implant aesthetics, implant placement, Aesthetic Outcomes.

INTRODUCTION: The quest to replace missing teeth has been a longstanding challenge, with attempts dating back to ancient civilizations. The concept of implants has undergone significant evolution since its earliest recorded use in Mayan skulls around 600 AD.¹ The modern era of implantology began with Per-Ingvar Brånemark's groundbreaking work in 1952, where he defined osseointegration as "a direct structural and functional connection between ordered living bone and the surface of a load-carrying implant".²

Today, dental implant therapy has become a fundamental aspect of modern dental practice even in developing countries like Nigeria.^{3,4}

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necessitating comprehensive knowledge of diagnostic and therapeutic options for dental practitioners.^{5,6} In recognition of its importance, dental implant therapy has been incorporated into undergraduate curricula in developed countries like Nigeria,⁷ utilizing various teaching methods to facilitate student learning.^{8,9} Osseointegrated implants have become a cornerstone of restorative dentistry, enabling patients with missing teeth to regain confidence and oral function. However, despite the numerous implant options available, each with unique benefits, achieving optimal aesthetics remains a challenge. Aesthetics, derived from the Greek word "aesthesis," encompasses the perception and evaluation of beauty, pleasantness, and harmony.

In the context of implantology, aesthetics plays a vital role in restoring not only function but also the natural appearance of the smile. Therefore, a deep understanding of aesthetics in implantology is crucial to achieve optimal

results, combining art and science to create natural-looking smiles that enhance patients' overall quality of life. The focus of implantology has shifted from solely achieving osseointegration to creating implant-borne restorations that harmonize with surrounding hard and soft tissues.^{10,11} This shift is driven by the high predictability of osseointegration, which now necessitates a more aesthetic approach to treatment planning. The importance of optimal implant placement cannot be overstated; as poor positioning can result in unsatisfactory aesthetic outcomes. Furthermore, increased patient awareness and expectations for aesthetically pleasing restorative treatments have raised the bar for implantologists. Meeting these new challenges, particularly in aesthetically critical zones, requires implantologists to prioritize aesthetic considerations.

Research indicates that predictability of aesthetic success is heavily influenced by the degree of edentulism.¹² Single-tooth implants tend to have better aesthetic outcomes than multiple-tooth implants. Understanding objective and subjective criteria related to hard and soft tissue aesthetics is crucial for achieving synergy. By developing a comprehensive understanding of the complex interplay between hard and soft tissues, implantologists can better meet the aesthetic demands of their patients.

Variables of Predictability of aesthetic outcome of an implant restoration

Patient factors: Patient selection and smile line are crucial considerations. Patients must understand the benefits of an implant, including what it entails, the length of time required for treatment, and associated costs.

Clinician's factors: Clinicians must understand patients' desire for aesthetic tooth replacement and ensure sound clinical concepts with clearly defined parameters for successful aesthetics and long-term tissue stability.

Aesthetic evaluation: A thorough aesthetic evaluation is essential, considering factors such as lip activity and length, smile line (average, low, or high), and previous photographs which can provide valuable insights.

Tooth Position: Tooth position should be evaluated in three planes of space: mesio-distal, bucco-lingual, and apico-coronal. Extractions can lead to apical migration and restorative

issues, such as long clinical crowns, if not carefully managed. Ideal margins should be prioritized to avoid complications. By carefully considering these variables, clinicians can enhance predictability and optimize aesthetic outcomes for implant restorations.



Figure 1: Tooth with temporary crown in situ.

The facio-lingual position of teeth plays a critical role in implant placement. When teeth are positioned too far labially or facially, it often indicates thin or non-existent labial bone, which can compromise implant stability and aesthetics. In such cases, augmentation procedures should be planned either prior to or concurrently with implant placement to ensure sufficient bone volume. Conversely, teeth positioned lingually or palatally typically have more facial bone, making them more favourable for implant placement, especially when extractions are necessary. This positioning also helps minimize free gingival margin discrepancy, leading to better aesthetic outcomes. Optimal facio-lingual positioning enables clinicians to achieve more predictable and successful implant restorations, both functionally and aesthetically.

The facio-lingual position of teeth significantly impacts implant placement outcomes. Teeth that are positioned too far labially or facially often have thin or non-existent labial bone, necessitating augmentation procedures either before or during implant placement. On the other hand, teeth positioned lingually or palatally typically have more facial bone, making them ideal candidates for implant placement prior to extractions. This favourable positioning also minimizes free gingival margin discrepancy, resulting in improved aesthetic outcomes.



Figure 2: Facio-lingual dimension

Proper evaluation of facio-lingual tooth position enables clinicians to plan and execute effective implant placement strategies, ensuring optimal, functional and aesthetic results. A thorough diagnostic workup for implant placement should include a periapical x-ray to assess root position and identify potential issues. This allows for identification of malposed teeth, enabling orthodontic correction to create sufficient inter radicular space. Teeth with inadequate interproximal bone pose a greater risk of lateral resorption, further decreasing vertical bone height after extraction or implant placement. Early identification of these factors enables clinicians to optimize orthodontic treatment planning and develop strategies to mitigate bone loss.

Root position: Key considerations in evaluating root position include inter root distance and morphology, interproximal bone width and density, root convergence or divergence, and adjacent tooth position and alignment. By integrating periapical x-rays into the diagnostic workup, clinicians can proactively address potential challenges and achieve more predictable and successful implant placements.

Soft tissues – periodontium: The biotype of the periodontium and tooth shape significantly influence the position of gingival tissue around a tooth, determined by the connective tissue attachment and bone level.¹³ The characteristics of soft tissues play a crucial role in the final planning for implant shoulder position. To achieve an optimal emergence profile, the implant shoulder should be positioned more palatally to prevent metal show. This consideration is vital for ensuring aesthetically pleasing results.

Research identifies two primary periodontal biotypes related to the morphology of the interdental papilla and osseous membrane.¹³ Understanding these biotypes is essential for predicting and achieving successful implant

outcomes. The periodontal biotypes are: The thick flat biotype, characterized by a robust interdental papilla and ample osseous membrane, allows for more flexibility in implant placement. The thin scalloped biotype, featuring a delicate interdental papilla and limited osseous membrane, requires more precise implant positioning to maintain aesthetics. By considering the periodontal biotype and soft tissue characteristics, clinicians can optimize implant placement and achieve predictable, aesthetically pleasing results. The thin scalloped periodontium is characterized by a delicate soft tissue curtain, reduced quality and quantity of keratinized gingiva, and a scalloped underlying osseous form with dehiscence and fenestrations. The interproximal tissues do not completely fill the space.



Figure 3: Centralization of Implant

between teeth. Teeth with this biotype typically have a triangular form with contact points towards the incisal, smaller facio-lingually and apico-coronally, and interdental bone thicker due to tapering root form. Challenges associated with this biotype include recession and inter-bone resorption resulting in soft tissue loss, compromising aesthetics. Patients with high lips and thin biotype are extremely difficult to treat and should be made aware of this.

In contrast, the thick flat periodontium is characterized by a denser fibrotic soft tissue curtain, increased quality and quantity of attached keratinized gingiva, and a flat, thicker underlying osseous form. Teeth with this biotype typically have a square form with wide contact areas facio-lingually and apico-coronally. This biotype reacts to insults by pocket formation.

For patients with thin scalloped periodontium, crown forms can be modified prosthetically to compensate for interproximal tooth loss. This can be achieved by positioning the contact area more cervically and reducing the volume of the

interdental space. Understanding the differences between these periodontal biotypes is crucial for predicting treatment outcomes and achieving optimal aesthetic results. Clinicians should inform patients with thin scalloped periodontium of the potential challenges and develop tailored treatment strategies to address these unique needs.

Tooth shape: The shape of the presenting tooth significantly influences the shape of the implant restoration. To achieve optimal aesthetics, the restoration should mimic the contralateral tooth above the free gingival margin. However, apical to the free gingiva, the restoration should not be an exact replica. Instead, a delicate balance is required, providing adequate support for the gingival architecture without exerting undue pressure.

The facial contour of the restoration should be flatter than the contralateral tooth to minimize apical displacement of the free gingiva post-insertion, as emphasized by Phillips and Kois.¹⁴ This approach ensures preservation of gingival health, maintenance of aesthetic symmetry, and optimal emergence profile. By understanding the importance of tooth shape in implant restoration, clinicians can create restorations that harmonize with the surrounding dentition, ensuring predictable and aesthetically pleasing outcomes. The goal is to achieve a natural-looking restoration that blends seamlessly with the adjacent teeth, considering factors such as tooth morphology, gingival contours, and overall dental aesthetics. Effective planning and execution of implant restorations require careful attention to these details.

Bony anatomy of the implant site: Optimal implant placement and success require accurate angulation and positioning to achieve functionally satisfying results.¹⁵ Furthermore, the site should have a three-dimensional housing configuration, as emphasized by Daddona and Nowzari.¹⁶ This configuration ensures adequate support and stability for the implant. If the site lacks this configuration, a bone graft may be necessary to enhance the site. In such cases, it is essential to clearly communicate the reasons for the graft to the patient. The choice of graft material depends on the specific reason for grafting, including the extent of the deficiency, desired outcome, and patient's overall health.

Beyond aesthetics, precise surgical execution is crucial for a successful outcome.¹⁷ In complex cases, collaboration with a maxillofacial surgeon may be necessary.

Pre-placement analysis is critical to ensure optimal results. This includes a diagnostic wax-up to identify tissue deficiencies and determine final tooth position, as well as an assessment of the required amount of augmentation, if any. A CT scan is also performed to evaluate facio-lingual ridge anatomy for implant housing. The apico-coronal dimension is particularly critical, as it is challenging to graft. Accurate evaluation and planning are essential to achieve a successful outcome. Comprehensive evaluation and planning enable clinicians to identify potential challenges, develop tailored treatment strategies, ensure optimal implant placement and stability, and achieve predictable aesthetic and functional results. By prioritizing precise planning and execution, clinicians can maximize the success of implant placements and provide patients with optimal outcomes. Effective communication and collaboration with specialists, when necessary, are also vital to achieving these goals.

Implant Position: Aesthetic implant placement is guided by a restorative and biological philosophy, emphasizing both pleasing aesthetics and maintenance of hard and soft



Figure 4: Occlusal Clearance.

architecture.¹² The required precision varies depending on individual case presentation. In edentulous cases, the facio-lingual dimension is crucial, whereas partially edentulous cases demand increased precision due to the presence of adjacent and opposing teeth. However, the apico-coronal dimension remains the most critical factor. The apico-coronal dimension refers to the vertical discrepancy between the occlusal surface of the implant and the septa

proximal to the adjacent teeth. Minimal discrepancies in this dimension are essential for optimal aesthetics. Cases requiring complex grafting are considered high-risk due to the increased potential for complications. However, thorough planning using diagnostic tools such as wax-ups can mitigate these risks.

Effective implant placement requires careful consideration of restorative goals, biological compatibility, facio-lingual and apico-coronal dimensions, adjacent and opposing tooth relationships, and soft tissue architecture. By prioritizing precision and thorough planning, clinicians can achieve optimal aesthetic and functional outcomes, minimize complications, and ensure long-term success of implant placements. Jivraj and Chee¹² emphasize the importance of careful planning and precision in aesthetic implant placement to achieve predictable and successful outcomes. Thorough evaluation and planning enable clinicians to identify potential challenges and develop



Figure 5: Apico-coronal showing comparative margin and facial plane in relation to contralateral tooth.



Figure 6: Palato-Incisal Relationship of Maxillary to Mandibular teeth.

Errors in apicocoronal placement of dental implants result in serious aesthetic and biomechanical implications. If the implant is placed too coronally, the restorations may appear short in comparison to adjacent teeth.

This issue can potentially be rectified with a ridge lap design. However, if the implant is placed too apically, with excessive countersinking, it can lead to circumferential bone loss affecting both proximal and facial bone. This can result in several complications, including limited or no access for instrumentation, collapse of soft tissues, and tissue impingement when attempting to locate the implant head. Additionally, seating is difficult to assess, particularly for external hex systems. Due to these challenges, screw-retained restorations are often the preferred choice in such cases.

The consequences of apicocoronal placement errors underscore the importance of precise planning and execution in implant placement. Clinicians must carefully evaluate the implant site and consider factors such as bone density, soft tissue architecture, and restorative requirements to ensure optimal outcomes. Apicocoronal placement errors can compromise the long-term success and aesthetics of implant restorations. Meticulous pre-operative planning, accurate surgical execution, proper implant selection, and a thorough understanding of biomechanical and aesthetic principles are essential to minimize errors.

By prioritizing precision and thorough planning, clinicians can optimize implant outcomes, ensure patient satisfaction, and reduce the risk of complications. Effective implant placement requires a comprehensive approach, considering both aesthetic and biomechanical factors to achieve successful and long-lasting results.

Poor mesio-distal placement of dental implants can significantly impact the generation of interproximal papillary support and the osseous crest of the adjacent tooth. Optimal placement should be 1.5-2mm from the adjacent tooth to preserve interproximal bone and ensure papilla maintenance. Deviations from this guideline can lead to poor embrasure forms and emergence profiles, resulting in restorations with long contacts and compromised aesthetics. Consequences of poor mesio-distal placement include inadequate interproximal papillary support and unfavourable osseous crest formation, making restoration design challenging.

To mitigate these issues, clinicians may resort to prosthetic strategies, such as using pontics to support tissues and create the illusion of papilla, and customizing restoration designs to compensate for placement errors. However, these workarounds may not fully meet patient expectations. To avoid mesio-distal placement errors, it is crucial to follow principles of thorough diagnosis, comprehensive treatment planning, diagnostic wax-up, and surgical guide fabrication. Adhering to these guidelines ensures accurate implant placement, optimizing aesthetic and functional outcomes.

Prosthetic strategies can help manage placement errors, but ideal results are achieved when implants are placed with precision, considering mesio-distal dimensions and adjacent tooth relationships. By prioritizing accurate placement, clinicians can ensure predictable and successful implant restorations. Effective implant placement requires careful planning and execution, taking into account the complex interplay between implant position, bone architecture, and soft tissue aesthetics. By doing so, clinicians can achieve optimal outcomes, meet patient expectations, and ensure long-term success of implant restorations.

Over two decades ago, the developed world, having mastered the technical aspects of implant placement, began focusing on the aesthetics of implant placements.¹⁸ This shift marked a significant turning point in the evolution of dental implantology.

This serves as a wake-up call, highlighting the need for a paradigm shift towards prioritizing aesthetic considerations in implant placement. This new approach recognizes that successful implant placement extends beyond functional success to encompass harmonious integration with surrounding tissues and overall dental aesthetics. Achieving this goal requires a collaborative team approach, bringing together experts from various disciplines, including surgery, prosthodontics, and periodontics. By working together, implant placements can be meticulously planned and executed, considering both functional and aesthetic requirements.

Figure 7 to Figure 10: Depicts finished implant in prosthetic porcelain crown.



Figure 7: Apico coronal view showing comparative margin and facial view in relation to contralateral tooth. Note pink porcelain making up for excessive marginal depth.



Figure 8: showing facial level in comparison to contralateral tooth as well as pink porcelain making up for gum height.



Figure 9: Palatal-incisal view in relation to contralateral tooth, also note mesiodistal dimensions of both teeth.



Figure 10: Tooth in relation to other teeth in arch.

Conclusion

A comprehensive evaluation of patient needs, integrated treatment planning, precise implant placement, and optimized restoration design are essential for predictable aesthetic outcomes.

By embracing this paradigm shift and adopting a team-oriented philosophy, the standards of implant placement can be elevated, ensuring that patients receive not only functional but also aesthetically pleasing restorations that enhance their overall quality of life. The collaboration between specialists enables a holistic approach, leading to improved patient satisfaction and successful implant placement outcomes. Effective communication and mutual understanding among team members are critical to achieving these goals.

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