INTERNATIONAL SEVEN JOURNAL OF MULTIDISCIPLINARY
ISSN: 2764-9547

ANGLED DENTAL IMPLANTS: IMPLICATIONS FOR CLINICAL PRACTICE AND BIOMECHANICAL CONSIDERATIONS

https://doi.org/10.56238/isevmjv3n1-026

Receipt of the originals: 02/01/2024 **Acceptance for publication:** 25/01/2024

Leonardo Dornelas Alves

ABSTRACT
Angled dental implants have emerged as an effective solution in clinical settings where the placement of straight implants is constrained by unfavorable bone positions or the presence of adjacent anatomical structures. The angulation of implants significantly influences stress distribution around the implant, impacting its stability and longevity. Research highlights that the direction of applied loads is critical, as angled implants can generate greater bending and shear forces compared to straight implants, potentially leading to stress concentrations in surrounding bone. Finite element analysis (FEA) is commonly used to model these conditions, offering insights into stress zones and predicting potential failure areas. Bone quality plays a vital role in how implants respond to applied forces, with denser bones effectively dissipating forces while more porous bones are at higher risk of resorption and integration failure. Studies indicate that excessive stresses on angled implants can lead to bone resorption, compromising long-term stability. Therefore, careful consideration of implant angulation, connection type, bone quality, and thorough surgical planning is essential. Recent studies, including those investigating the effects of implant design and bone density on stress distribution, have demonstrated that varying implant threads and angulated abutments affect the stresses experienced by surrounding bone and implants. The findings emphasize the need for appropriate implant selection and a detailed assessment of bone anatomy and patient-specific clinical conditions. By incorporating advanced technologies like FEA, clinicians can enhance their understanding of biomechanical interactions, ultimately leading to improved clinical outcomes and patient satisfaction. Continuous education and the implementation of best practices in dentistry remain vital for the successful application of angled dental implants.

Keywords: Angled Dental Implants. Stress Distribution. Bone Quality. Finite Element Analysis. Clinical Outcomes.

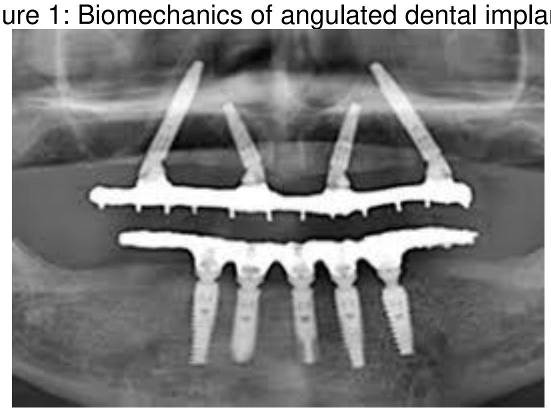
INTERNATIONAL SEVEN JOURNAL OF MULTIDISCIPLINARY
ISSN: 2764-9547

INTRODUCTION

Angled dental implants have stood out in clinical practice as an effective solution in situations where the placement of straight implants is limited due to unfavorable bone positions or the presence of adjacent anatomical structures, such as nerves or maxillary sinuses. The angulation of the implants can significantly impact the distribution of bone stress around the implant, influencing its stability and longevity. One of the main factors affecting bone stress in angled implants is the direction of the applied load. Under masticatory forces, an angled implant can generate greater bending and shear moments compared to a straight implant, as the load is not applied directly along the axis of the implant, which can result in stress concentrations in the surrounding bone regions. Finite element analysis (FEA) is often used to model and simulate these conditions, allowing visualization of stress zones and prediction of potential failure areas.

Moreover, the quality of the surrounding bone plays a crucial role in the implant's response to the applied forces. Denser bones tend to dissipate forces more effectively, while more porous bones present a higher risk of bone resorption and failure of integration. Research indicates that excessive stresses on angled implants can lead to bone resorption around the implant, compromising its stability and long-term viability. Therefore, the choice of angled implants should be made cautiously, considering factors such as angulation, connection type, bone quality, and appropriate surgical planning, with the aid of imaging technologies and computational simulations that ensure adequate implantological approaches for each patient.

Figure 1: Biomechanics of angulated dental implants.



Source: Periobasics.com (2022).

INTERNATIONAL SEVEN JOURNAL
OF MULTIDISCIPLINARY
ISSN: 2764-9547

A study conducted by Ikbal et al. (2022) investigated the influence of implant design, bone type, and abutment angulation on stress distribution around dental implants. Two implant designs with different thread configurations but of the same brand and length were used, and the three-dimensional geometry of the bone was simulated with four distinct bone types, considering two abutment angulations. An oblique load of 200 N was applied to the implant abutments, and the maximum and minimum principal stresses were calculated for the bone, while Von Mises stresses were obtained for the dental implants. The results showed that the load distribution was concentrated in the coronal portion of the bone and the implants, with higher stresses observed in the implant models in D4 type bone. Additionally, it was found that an increase in bone density and cortical bone thickness resulted in lower stress in the bone and implants, with a good distribution of forces for non-axial loads, although with higher stresses concentrated in the crested region of the bone-implant interface. The study concluded that the use of different implant threads and angled abutments affects stress in the surrounding bone and implants, highlighting the relationship between bone density, cortical thickness, and increased stress.

Another research conducted by Sivrikaya and Yılmaz (2022) focused on determining von Mises stress values in extra-maxillary implants anchored in the zygomatic bone, known as zygomatic implants, as well as stresses in the abutments, superstructures, and principal stress values in the bone under occlusal forces. The researchers compared these stress values with those from tilted implants and the sinus lift technique, hypothesizing that zygomatic implants would exhibit higher stress due to their more angled placement. Using finite element analysis (FEA), a force of 600 N was applied to a hybrid prosthesis in models representing three distinct concepts: zygomatic implants, tilted implants, and sinus lift, all situated in D2 bone. The results revealed that the von Mises stress values for the anterior and posterior zygomatic implants were lower than those of the other models under various loading conditions, indicating a favorable stress distribution. The highest von Mises stress was observed in the posterior implants of the tilted implant models under oblique load, while the principal stress values were also higher in the posterior implants of the sinus lift model. Overall, the study concluded that despite the angled placement of zygomatic implants, they exhibited lower stress values for both the bone and the implants compared to other techniques.

INTERNATIONAL SEVEN JOURNAL
OF MULTIDISCIPLINARY
ISSN: 2764-9547

The investigation conducted by Rito-Macedo et al. (2021) aimed to evaluate the impact of different angles and depths of implant insertion on the stresses experienced by the peri-implant bone tissue under axial and oblique loading conditions. Following the guidelines of the Checklist for Reporting In-vitro Studies (CRIS), the researchers positioned implants in the region of tooth 36, using different models: M1 (0 mm / 0°), M2 (0 mm / 17°), M3 (0 mm / 30°), M4 (2 mm / 0°), M5 (2 mm / 17°), and M6 (2 mm / 30°). Each model was subjected to a load intensity of 100 N, and the stress evaluation was conducted according to Mohr-Coulomb criteria through qualitative and quantitative analyses. The results indicated that angled implants positioned below the bone crest generated the highest stresses in the cortical bone, with axial loads leading to peak stress on the buccal side of the implants perpendicular to the bone crest. Regardless of the load type, the tilted implants exhibited the highest stress peaks on the lingual side of the cortical bone. The study concluded that implants installed perpendicular to the bone crest, with a prosthetic platform at the crest height, resulted in the lowest stresses in the peri-implant bone tissue, both under axial and oblique loading conditions.

The research conducted by Korkmaz and Kul (2021) aimed to clarify the most suitable material and design for abutment-implant connections in the aesthetic zone. Using finite element analysis (FEA), the researchers compared various abutment models to evaluate stress values in the implant components and deformation values in the simulated bone around an anterior maxillary implant. They created 3D FEA models of the left anterior maxillary segment, incorporating three contemporary implant models with angled abutments of 17 or 25 degrees, specifically a titanium base abutment (TIB), a zirconia abutment (ZIR), and a titanium abutment (TIT). The models were subjected to vertical and oblique load conditions of 100 N applied to the cingulum and incisor areas. The results revealed that the TIB model presented reduced stress conditions, particularly under oblique loads, evidenced by lower von Mises stresses in the screw, abutment, crown, and implant, compared to the ZIR and TIT models. Additionally, the deformation values in the simulated cortical and trabecular bones were lower in the TIB model. The study concluded that when standard implants are placed at elevated angles in the aesthetic zone, there are higher stress levels in the implants, abutments, and screws, suggesting that the use of a titanium base abutment can help mitigate stress. Furthermore, the contact surface area between the implant and the simulated cortical bone significantly influences stress and deformation outcomes.

Finally, the investigation by Sivrikaya and Omezli (2019) aimed to examine stress values associated with different bone densities, comparing the designs of conical and cylindrical implants. Using finite element analysis, the researchers applied a force of 100 N both vertically and at an angle of 30 degrees to cylindrical and conical implants within D1 and D4 bone densities in eight distinct models. The results showed that von Mises stress was lower in D1 bone densities under vertical loading conditions and was associated with conical implants. Regardless of the implant design, von Mises and principal stress values were consistently lower for D1 bone densities. The conical implant exhibited higher principal stress than the cylindrical one in both bone densities, while the cylindrical design demonstrated greater von Mises stress. Additionally, vertical loading resulted in less stress compared to loading at a 30-degree angle. The study concluded that the combination of D4 bone density and angled loading at 30 degrees significantly increased stress values, highlighting the need for careful selection of implants and treatment planning.

The analysis of the implications of angled dental implants in clinical practice reveals the importance of a careful and evidence-based approach in the selection and planning of these devices. The discussed studies demonstrate that the angulation of implants, the quality of the surrounding bone, and the direction of the applied forces are crucial factors that affect stress distribution and, consequently, the stability and longevity of the implants. Research shows that utilizing different implant designs and considering bone characteristics are fundamental to optimizing implant performance while minimizing the risk of failure. Thus, the integration of advanced technologies, such as finite element analysis, allows for a better understanding of biomechanical interactions and provides a solid foundation for surgical planning. Therefore, the success of angled implants depends not only on the appropriate selection of implant type and angulation but also on a detailed assessment of the bone anatomy and the individual clinical conditions of each patient. Ultimately, advancements in research and technology in this field can lead to better clinical outcomes and patient satisfaction, highlighting the importance of continuous education and the rigorous application of best practices in dentistry.

REFERENCES

1. Ikbal, L., Kerem, K., Burak, B., & Ahmet, K. (2022). Finite element analysis of the stress distribution associated with different implant designs for different bone densities. *Journal of Prosthodontics: Official Journal of the American College of Prosthodontists*. https://doi.org/10.1111/jopr.13539

2. Korkmaz, I., & Kul, E. (2021). Investigation of the type of angled abutment for anterior maxillary implants: A finite element analysis. *Journal of Prosthodontics: Official Journal of the American College of Prosthodontists*. https://doi.org/10.1111/jopr.13462

3. Rito-Macedo, F., Barroso-Oliveira, M., Paranhos, L., Rodrigues-Brum, J., Pereira-Lima, I., Gomes-França, F., & Brito-Junior, R. (2021). Implant insertion angle and depth: Peri-implant bone stress analysis by the finite element method. *Journal of Clinical and Experimental Dentistry, 13*, e1167-e1173. https://doi.org/10.4317/jced.58930

4. Singh, N., Chalapathy, S., Thota, R., Chakravarthula, K., Tirnati, R., & Yenugupalli, K. (2018). Evaluation of stress distribution among two different pre-angled abutments of implants in two different densities of bone at different levels along the implant: *In vitro study*. *The Journal of Contemporary Dental Practice, 19*(11), 1370-1375. https://doi.org/10.5005/jp-journals-10024-2434

5. Sivrikaya, E., & Omezli, M. (2019). The effect of tapered and cylindrical implants on stress distribution in different bone qualities: A finite element analysis. *The International Journal of Oral & Maxillofacial Implants*. https://doi.org/10.11607/jomi.7513

6. Sivrikaya, E., & Yılmaz, O. (2022). Comparison of extramaxillary anchored implants, tilted implants, or sinus elevation concepts on stress distribution in atrophic maxilla: A finite element analysis. *The International Journal of Oral & Maxillofacial Implants, 37*(3), 563-570. https://doi.org/10.11607/jomi.9631

7. Pessoa, E. G. (2024). Pavimentos permeáveis uma solução sustentável. *Revista Sistemática, 14*(3), 594-599. https://doi.org/10.56238/rcsv14n3-012

8. Bonon, M. R. C. D. (2024). Polidesoxirribonucleotídeo (PDRN): Inovações e potencial na regeneração e cicatrização tecidual. *International Seven Journal of Multidisciplinary, 1*(1). https://doi.org/10.56238/isevmjv1n1-011

9. Silva, S. C. R. (2024). O papel vital da saúde periodontal no controle do diabetes. *International Seven Journal of Multidisciplinary, 1*(1). https://doi.org/10.56238/isevmjv1n1-012

10. Pessoa, E. G., Feitosa, L. M., Pereira, A. G., & Padua, V. P. (2023). Efeitos de espécies de Al na eficiência de coagulação, Al - residual e propriedade dos flocos no tratamento de águas superficiais. *Brazilian Journal of Health Review, 6*(5), 24814-24826. https://doi.org/10.34119/bjhrv6n5-523

11. Pessoa, E. G., Feitosa, L. M., Padua, V. P., & Pereira, A. G. (2023). Estudo dos recalques primários em um aterro executado sobre a argila mole do Sarapuí. *Brazilian Journal of Development, 9*(10), 28352-28375. https://doi.org/10.34117/bjdv9n10-059

12. Lopes, A. R. (2024). Previsibilidade em implantes dentários na área estética. *Revista Sistemática, 14*(5), 1355-1364. https://doi.org/10.56238/rcsv14n5-025

13. Lopes, A. R. (2024). Cirurgia tradicional e cirurgia guiada: Uma abordagem comparativa. *International Seven Journal of Multidisciplinary, 2*(6). https://doi.org/10.56238/isevmjv2n6-020