Original Article

STRESS TRANSFER IN IMPLANT-SUPPORTED DENTURES: A 3D FINITE ELEMENT ANALYSIS

Muntathar Muhsen Abusanna[1], Farah Nabeel Mohammed Tahir AlKhayyat[2], Nagham Bahjat Kamil[2]*

[1]*College of Dentistry, University of Al-Ameed, Karbala, Iraq.*
[2]*Department of Prosthodontics, College of Dentistry, Mustansiriyah University, Baghdad, Iraq. farahnabel@uomustansiriyah.edu.iq*

Received: 27 November 2025; **Revised:** 19 February 2026; **Accepted:** 24 February 2026 *https://doi.org/10.51847/CnZFN4OEaC*

ABSTRACT

Prostheses supported by implants directly transmit the occlusion loads to the adjacent peri-implant bone, and this can result in complicated patterns of stress distribution affecting long-term implant stability. The biomechanics of stress transfer to the dental implants during complete denture loading and the effects on long-term stability of the implants through the use of a finite element analysis technique. A 3D finite element model of an edentulous mandible provided with an implant-supported complete denture of 30 dental implants was developed. Vertical and oblique conditions of static loading were used to simulate functional masticatory forces. Stress distribution and peri-implant bone strain criteria of von Mises stress and maximum principal strain. Oblique loading induced a general increase in the values of peak stress and strain, with the highest degrees of concentration in crestal cortical bone around the posterior implants. Although the high number of implants led to an improvement in global load distribution, the localized stress magnification under applied oblique loads was observed. Cortical bone was invariably subjected to more stress than cancellous (41%), as in all cases it was associated with increased disposition to biomechanical overload. A simple rise in the number of implants is not the solution to biomechanical risk, and indicates that optimized loading direction and distribution of implants are necessary; also, it notes the design of the prostheses as one of the major determinants of long-term clinical outcomes.

Key words: Dental implants, Complete denture, Biomechanical stress, Finite element analysis, Implant stability, Load transfer.

Introduction

Dental implants have emerged as an essential part of a modern-day prosthodontic rehabilitation of patients who have lost all of their teeth [1, 2]. Implant-supported complete dentures have proven to be much more stable, retentive, masticatory, and satisfactory to the patients in comparison to the traditional removable dentures over the past decades [3]. Such benefits are crucial, especially in patients who present with severe alveolar ridge resorption, in which the conventional methods of prostheses often offer insufficient functional performance or stability [4]. Consequently, there is a growing view that implant-supported prosthetic systems have a superior role to play in the restoration of oral functions among edentulous individuals [5].

Implant-supported complete dentures, although clinically successful, are biomechanically complicated systems with multiple structural elements that transmit the occlusal forces, such as the prosthetic superstructure, elements of attachment, dentimplants, and the surrounding peri-implant bone [6, 7]. These forces and their distribution and size are significant in sustaining implant stability as well as the peri-implant bone during the long-term [8]. Unfavorable and excessive stress concentration at the bone-implant interface has long been considered to be one of the main biomechanical causes of marginal bone erosion, implant overload, and long-term implant failure [9].

The variables that affect biomechanical load transfer of implant-supported prostheses are the number of implants, distribution of implants, prosthetic design, strength of bone, and direction of occlusal loading [8]. In mastication, the forces that occur during mastication are seldom purely axial, but often include oblique or lateral components that result from functional chewing actions and parafunctional behavior [10]. Experimental and computational studies conducted in the past have shown that the loading conditions involving oblique can generate considerably high degrees of stress concentration along the implant neck and inside the crestal cortical bone when compared to that produced by vertical loading alone [11, 12]. This can enhance the potential of building up of microdamage in peri-implant bone and can lead to progressive bone remodeling or implant instability later in life [13].

When considering implant-supported complete dentures, more factors complicate the biomechanical environment, including denture base deformation, mucosal resiliency, load sharing of implants and soft tissues, and cantilever effects that occur during loading of the back [3, 14]. These aspects can have a major change in the stress distribution pattern within the supporting bone structures and can affect the long-term success of implant rehabilitation [11, 13]. As a result, the biomechanical behavior of implant-supported complete dentures under varying loading conditions is an important part of the factors to maximize the design of prosthetics and enhance patient outcomes [15].

Finite element analysis (FEA) has become an effective computer model to explore biomechanical interactions of complex implantation in the dental system [16]. This technique allows the three-dimensional simulation of stress and strain distribution of implants and the surrounding bone structures under controlled load conditions [15]. Finite element modeling can be used to offer high-resolution visualization of patterns of stress concentration to supply useful information about biomechanical risk factors that can threaten the stability of implants or lead to peri-implant bone loss [11]. Moreover, FEA enables researchers to check the impact of using implants configuration, prosthetic designs, and loading directions with no exposure of patients to the experimentation risks [15].

Even though the force distribution in the area of dental implants has been studied with the use of finite element modeling, few studies have been conducted on the biomechanical behavior of implant-aided complete denture systems and their behavior under various loading positions as well as challenging occlusal situations [17-19]. Specifically, the correlation between loading direction and implant distribution is not fully comprehended in full-arch designs of implant-supported prosthetics. These biomechanical processes require a further insight into how to enhance the implant placement strategies and the design of prosthesis to e. Thus, the objective of the current research was to explore biomechanical behavior of implant-assisted complete dentures in terms of three-dimensional finite element analysis with specific focus on how the distribution of implants and the direction of loading of the dental prosthetics affect the concentration of stress in peri-implant bone.

Materials and Methods

Study design

The current study used a computational biomechanical model that applies three-dimensional finite element analysis (FEA) to examine the pattern of stress transfer to dental implants that had to support a complete denture. The choice of finite element modeling could be explained by the fact that this type of modeling allows to simulate accurately complex biomechanical interactions under specified loading conditions between prosthetic components, implants, and bone structures around them. The analysis aimed at assessing the effect of loading direction on the stress and strain distribution in the implants and peri-implant bone, with special attention to the cortical bone surrounding the implant neck ensure long-term stability of the implants.

Three-dimensional geometric modeling

An edentulous mandible three dimensional computer model was developed using the average anatomical measurements documented in the literature of adult edentulous patients. To replicate the biomechanical properties of mandibular bone, the mandibular structure was made up of an outer cortical bone layer and an inner cancellous bone core. The thickness of the cortical bone was normalised with the generally reported anatomical values to maintain physiologically realistic values in the model.

To emulate clinically applicable treatment regimens, three implant designs were implemented into the edentulous mandible, consisting of four, six, and eight implants, spacing the mandibular arch. These designs are the common clinical practices in full-arch implant-supported prosthetic rehabilitation.

The pattern of placing the implants was a symmetrical distribution in order to reduce the geometric variability and have the same amount of load on the simulated prosthetic system. The standardized angulation and spacing, and depth of insertion of the implants were used to reproduce controlled conditions of the clinical settings. In the model, complete implant to bone osseointegration was presumed in order to model a fully integrated and clinically stable implant niche.

Prosthetic configuration

An edentulous mandibular arch was modeled with a digital prosthetic that was a mandibular implant-supported complete denture. The implants were attached to the prosthetic superstructure with standardized attachment components that were meant to disperse the occlusal forces throughout the implant system. The denture base was designed with appropriate thickness and structural properties in order to reproduce realistic deformation behavior during functional loading. In addition, a simulated mucosal layer was incorporated beneath the denture base to represent soft tissue compliance and to allow partial load absorption during mastication. This configuration allowed the model to represent both implant-borne and tissue-supported components of the prosthetic system.

Material properties

All the materials used in the model, such as cortical bone, cancellous bone, dental implants, denture base material, attachment components, and mucosal tissue, were characterized as homogeneous, isotropic, and linearly elastic materials. Even though mathematical models of tissue biomechanics suggest that more complicated mechanical behavior is characteristic of biological tissues, these approximations are broadly used in finite element computations to simplify computational analysis without sacrificing biomechanical significance.

The values of elastic modulus and Poisson ratios in each material were provided based on the available biomechanical investigations carried out in the past on implant-supported prosthetic systems. These parameters allowed the model to provide realistic mechanical behaviour of both hard and soft tissues when they were subjected to functional loading conditions.

Finite element meshing

The geometrical models were then modeled as a large number of three-dimensional tetrahedra, turned into finite elements used in the computation mesh in the numerical analysis. Mesh refinement was done in areas of special biomechanical concerns, particularly around the neck of the implant and the peri-implant cortical bone, where stress concentrations are commonly found.

To provide stability and reliability of the results, a mesh convergence test was applied. Up to a certain stage, the finest mesh density was continuously increased, so that any further increase in the number of elements produced insignificant alterations in the calculated stress values, and the solution was said to be converged.

Boundary conditions and loading protocol

Boundary conditions were imposed on the mandibular model by fixation of the inferior border to avoid rigid body movement while allowing the bone structures to deform physiologically around the mandibular model. A simulation of two loading scenarios was done to recreate clinically relevant conditions of occlusion.

Vertical loading was employed to reflect the axial occlusal forces that are passed along the long axis of the implants during normal mastication. Moreover, oblique loading was done to represent non-axial forces that occur during functional chewing movements and parafunctional activities. These oblique forces are clinically significant loading conditions that can cause higher levels of biomechanical stress in the implant system.

The applied forces were spread out to the anterior and posterior parts of the prosthetic denture to replicate the realistic occlusal patterns of contact that occur during the implant-supported complete denture operation.

Outcome measures

The biomechanical performance of the implant system was determined by measuring stress and strain values in the implants and peri-implant bone. Von Mises stress in the implants, the distribution of stress in the cortical and cancellous bone, and the level of strain in the peri-implant bone structures were the key outcome variables.

Stress concentrations at the crestal bone around the neck of the implant were of particular interest due to the fact that this area is reputedly biomechanically important and often linked to marginal bone remodeling and implant overload. Anterior and posterior implant regions were also compared to establish the possible differences in stress distribution patterns in various loading conditions.

Computational analysis

Calculations were done on all finite element simulations with special computational analysis software for biomechanical modeling. The results of the simulation were compared to discuss the stress and strain distributions obtained in the case of vertical and oblique loading. The outcomes were compared based on the generally accepted biomechanical thresholds relating to the peri-implant bone remodeling and overloading.

Results and Discussion

The biomechanical analysis of the result showed that there are definite stress and strain distributions in the dynamics of the implant-supported complete denture system in varied loading conditions. The loading direction proved to be a determinant of the degree and mode of stress transfer between the prosthetic superstructure and the implants and adjacent bone. Overall, Oblique loading generated considerably more stress and strain levels than vertical loading, which points to a great biomechanical impact of non-axial forces on the implant bone interface **(Table 1 and Figure 1)**.

Distribution of the stresses within the implant system under vertical loading conditions was comparatively homogenous, and moderate stress levels were observed at the cervical part of the implants. The von Mises stress at the implant-neck had a mean stress of 22.8±4.1 MPa, indicating that the conditions of axial loading would yield a comparatively constant biomechanical response in the implant-bone complex. Conversely, oblique loading greatly augmented the level of stress within the implant system, with the highest von Mises stress of 46.9±6.8 MPa, showing the great impact of the components of lateral forces in the implant biomechanics **(Table 2)** [20-24].

The bone structures around them were analyzed, and it was found that in both cases of loading, cortical bone always had a greater amount of stress than cancellous bone. Cortical bone stress in vertical loading was 39.6±5.7 Mpa, and cancellous bone had lower values of stress of 13.4±2.6 Mpa. The cortical bone stress rose significantly to an average of 81.3±9.4 MPa when the oblique loading was simulated, and cancellous bone stress rose to 24.1±3.9 MPa. These results prove that the role of cortical bone in the process of implantation of mechanical forces on the skeletal structures is dominant **(Table 3)**.

Peri-implant strain analysis also indicated the biomechanical effect of loading direction. Mean cortical bone strain around the implants during vertical loading was 980±140 microstrain, which fell within the physiological range that is normally related to normal bone remodelling activities. But strain levels rose significantly when subjected to oblique loading to 1825±260 microstrain, especially in the posterior areas of implants. These strain values border on levels that are gained with the possibility of accumulating micro-damages and greater biomechanical stress of peri-implant bone.

The distribution of stresses was analyzed regionally, and it was observed that there are distinct differences between the anterior and posterior positions of the implant. The posterior implants always showed increased stress concentration as compared with the anterior implants, irrespective of the direction of loading. The anterior-to- posterior stress ratio was found as 1.32 when vertical loading was applied, and as 1.78 when oblique loading was applied, which means that the posterior part of the prosthetic system is exposed to enhanced biomechanical forces. This trend probably concerns posterior occlusal loading, lever-arm loading, and rotational propensity of the denture base in the process of mastication.

Though the number of implants was high, which led to the redistribution of loads effectively in the global system of the prosthetic, yet localized stress concentrations were noticeable around the crestal cortical bone in the vicinity of the posterior implants. The simulated mucosal layer under the denture base gave some stress attenuation, but that was not enough to suppress stress amplification produced under the oblique loading condition [25-30]. In general, the finite element simulations revealed that loading direction is still one of the major factors affecting biomechanical stress transfer in implant-supported complete denture systems [31-36].

Table 1. Biomechanical response of the implant-supported system under vertical and oblique loading

Parameter	Vertical Loading	Oblique Loading
Peak von Mises stress at implant neck (MPa)	22.8±4.1	46.9±6.8
Cortical bone stress (MPa)	39.6±5.7	81.3±9.4
Cancellous bone stress (MPa)	13.4±2.6	24.1±3.9
Peri-implant cortical bone strain (με)	980±140	1825±260
Posterior-to-anterior stress ratio	1.32	1.78

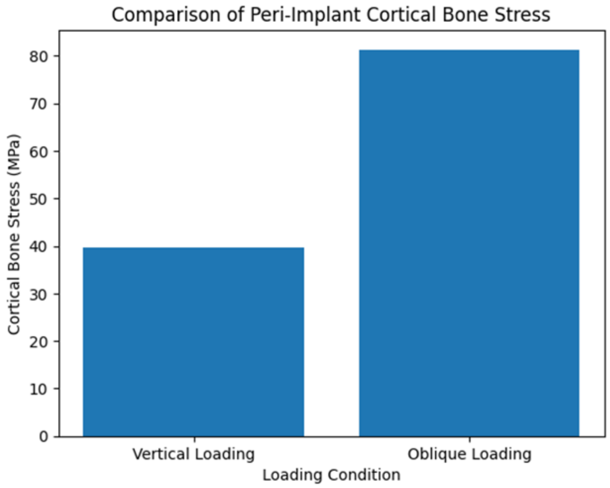

Figure1. Peri-implant cortical bone stress comparison with vertical and oblique complete denture load

Table 2. Regional stress distribution in anterior and posterior implants under different loading conditions

Implant Region	Vertical Loading Stress (MPa)	Oblique Loading Stress (MPa)	Relative Increase (%)
Anterior implants	18.7±3.5	31.6±5.1	68.9
Posterior implants	24.6±4.3	56.3±7.4	128.9
Overall implant system	22.8±4.1	46.9±6.8	105.7

Table 3. Comparison of stress distribution in peri-implant bone structures

Bone Structure	Vertical Loading Stress (MPa)	Oblique Loading Stress (MPa)	Stress Increase (%)
Cortical bone	39.6±5.7	81.3±9.4	105.3
Cancellous bone	13.4±2.6	24.1±3.9	79.8
Cortical/Cancellous Stress Ratio	2.95	3.37	—

Current finite element analysis examined the biomechanical behavior of implant-supported complete dentures in varying loading conditions, which the patterns of stress transfer in implants and in the peri-implant bone structures. The findings indicated that loading direction is an important factor that influences the magnitude and distribution of biomechanical stress. Precisely, oblique loading produced significantly higher values of stress in implants and the bone around them than vertical loading. This observation indicates the strong role of non-axial forces on implant biomechanics and proposes that implant systems used to support complete dentures could be especially susceptible to lateral loading conditions when eating and performing parafunctional tasks [13].

It was also found in the present study that the concentration of stress was majorly localized in the crestal cortical bone around the implant neck [37-46]. This fact is in line with the earlier biomechanical studies, which report that the most common load-bearing part of the cortical bone is the most important part that transfers the occlusal forces of the implants to the skeletal structure around them [17, 47]. Since cortical bone has a higher elastic modulus than cancellous bone, it is likely to accumulate greater stress, which can lead to marginal bone remodeling and premature peri-implant bone loss when exposed to too much mechanical loading [15].

The other significant conclusion of the current analysis was the significant dissimilarity between the stress distribution on anterior and posterior implants. When using posterior implants, the stress values were always greater than those recorded under both loading conditions, especially when the oblique loading was done [48, 49]. This may be explained by the augmented occlusal forces that would be produced in the back of the dental arch and lever-arm effects during rotational denture base under functional loading. These biomechanical patterns have been found to mirror past finite element analyses of implant-supported overdenture systems, in which posterior implants were found to be areas of heightened biomechanical danger [13].

Even though adding more implants helped to evenly distribute or spread the occlusal loads of the prosthetic system around the world, the point of stress concentration was still being noticed around the posterior implants. This observation implies that as long as undesirable loading directions exist, increasing the number of implants will not fully neutralize the biomechanical risk. Other studies related to the clinical and biomechanical aspects in the past also underscore that the distribution of implants, the design of a prosthetic, and the occlusal scheme also matter when focusing on the long-term stability of an implant [9, 50].

The biomechanical behavior that was observed during this study also needs to be interpreted in relation to the influence of the components of the prosthetics and the material properties. Past research has indicated that a change in the properties of the surfaces of implants or the materials used in the production of a prosthetic can alter the way stress is transferred at the bone-implant interface [10]. Specifically, the examples of composite implant coats include calcium carbonate and silica-based materials that were reported to enhance the interactions between implants and bones and possibly alter the processes of stress transfer. On the same note, nanoparticles have been found to reinforce the denture base materials, enabling increased mechanical stiffness and better load-bearing capacity in the prosthetic systems [3, 51].

The soft tissue compliance was also incorporated in the present model by the introduction of a simulated mucus layer below the denture base. Despite the fact that the mucosal layer helped in the partial attenuation of loads [15], the findings showed that the effect was not effective to counter the amplification of stress upon oblique loading circumstances. These results contribute to the prior clinical observations that the force direction and occlusal scheme are still the primary causes of biomechanical stress in implant-supported complete dentures, despite the supporting soft tissue [6, 52, 53].

Although one can deduce valuable biomechanical information about a body through finite element modeling, there are a number of limitations to the results of this study. Finite element analysis is based on simplified assumptions about material behaviour and loading conditions, such as the assumptions that the material is homogeneous and isotropic and is linearly elastic [15, 16]. Additionally, the model provided a model of the condition of the static loading and the presence of total osseointegration between the implants and the bone. Although these assumptions make computational analysis possible, they are not a complete reproduction of the dynamic and complicated biological environment that exists in the oral cavity. However, finite element modeling is a common approach to the study of biomechanical behavior in the field of implant dentistry and a useful tool to study the pattern of stress distribution that could affect the stability of implants and the success of the prosthesis [9, 50].

This research has quite a few limitations, which should be taken into account when explaining the findings. The model was the finite element that all materials were homogeneous, isotropic, and that the material was linearly elastic; this is not a perfect description of the detailed mechanism of action of biological tissues in the oral cavity. Furthermore, the simulation presented the study of the case of static loading, which is not the case in clinical practice of masticatory forces, which is dynamic and multidirectional. The other constraint is that the model had assumed that there would be full osseointegration of the implants to the surrounding bone, which is not necessarily possible in the clinical setting. Moreover, the geometric model was founded on the mean anatomical sizes and failed to consider the patient-specific bone quality, bone density, and the placement of implants. Nevertheless, in spite of such limitations, finite element analysis becomes a commonly embraced technique to study the distribution of biomechanical stress and offers great results concerning the factors that may affect implant stability in implant-supported prosthetic systems.

Conclusion

The findings within the confines of this finite element analysis suggest that the direction of loading has a big role to play in the distribution of stress in implant-supported complete denture systems. Oblique loading also produced much greater stress and strain results in bone implants and peri-implant bone than vertical loading, especially in the crestal cortical bone around posterior implants. Even though adding more implants to the system helped in redistributing the loading, local stress concentration was still observed in conditions of non-axial loading. These results imply that the number of implants is not enough to remove biomechanical risk, and that the distribution of the implants, the design of the prosthesis, and the guidance of the direction of the occlusal loading are important in long-term preservation of the implants.

Acknowledgments: The authors thank the College of Dentistry / Mustansiriyah University for the facilities provided to accomplish this study.

Conflict of interest: None

Financial support: None

Ethics statement: This study is an in vitro study and does not involve human participants or animals; therefore, ethical approval was not required.

References

1. Kurukchi A, Al-Radha A, Mahmood A. Radiographic evaluation of the impact of PRF membrane layering on peri-implant tissue: Randomized controlled clinical trial. Georgian Med News. 2025;366:148–54.
2. Nazaryan R, Sosonna L, Iskorostenska O, Storozheva M, Fomenko Y, Heranin S, et al. Anatomical features of the ostiomeatal complex and their impact on complications in dental implantation. Georgian Med News. 2025;358:163–7.
3. Bandiaky ON, Lokossou DL, Soueidan A, Le Bars P, Gueye M, Mbodj EB, et al. Implant-supported removable partial dentures compared to conventional dentures: A systematic review and meta-analysis of quality of life, patient satisfaction, and biomechanical complications. Clin Exp Dent Res. 2022;8(1):294–312. doi:10.1002/cre2.521
4. Alidema SH, Bundevska J, Maja S, Dimoski G, Halili R. Prosthodontic Management of Ridge Resorption: An Updated Review. J Int Dent Med Res. 2022;15(2):867–72.
5. Feine JS, Carlsson GE, Awad MA, Chehade A, Duncan WJ, Gizani S, et al. The McGill consensus statement on overdentures. Mandibular two-implant overdentures are the first choice standard of care for edentulous patients. Gerodontology. 2002;19(1):3–4.
6. Berzaghi A, Testori T, Scaini R, Bortolini S. Personalized occlusal scheme: occlusion and biomechanical risk factors in implant-supported complete fixed dentures. Narrative Review. Preprints. 2024. doi:10.20944/preprints202412.0854.v1
7. Berzaghi A, Testori T, Scaini R, Bortolini S. Occlusion and Biomechanical Risk Factors in Implant-Supported Full-Arch Fixed Dental Prostheses—Narrative Review. J Pers Med. 2025;15(2). doi:10.3390/jpm15020065
8. Donos N, Mezzomo LA, Mardas N, Goldoni M, Calciolari E. Efficacy of tooth-supported compared to implant-supported full-arch removable prostheses in patients with terminal dentition. A systematic review. J Clin Periodontol. 2022;49(S24):224–47. doi:10.1111/jcpe.13688
9. Hussein WJ, Al-Najjar AZ, Al-Mashhadane FA. The Impact of Varying Chlorhexidine Concentrations on the Healing of Recurrent Aphthous Ulcers: a Clinical Evaluation. Bull Stomatol Maxillofac Surg. 2025;21(7):24–8.
10. Baggi L, Cappelloni I, Di Girolamo M, Maceri F, Vairo G. The influence of implant diameter and length on stress distribution of osseointegrated implants related to crestal bone geometry: A three-dimensional finite element analysis. J Prosthet Dent. 2008;100(6):422–31. doi:10.1016/S0022-3913(08)60259-0
11. Hassan NA, Al-Jaboori ASK, Al-Radha ASD. Evaluation of Cortical Bone Thickness of Posterior Implant Sites Using CBCT in the Iraqi Population. Int J Dent. 2022;2022:5723397. doi:10.1155/2022/5723397
12. Monje A, González-Martín O, Ávila-Ortiz G. Impact of peri-implant soft tissue characteristics on health and esthetics. J Esthet Restor Dent. 2023;35(1):183–96. doi:10.1111/jerd.12912
13. Papavasiliou G, Kamposiora P, Bayne SC, Felton DA. Three-dimensional finite element analysis of stress-distribution around single tooth implants as a function of bony support, prosthesis type, and loading during function. J Prosthet Dent. 1996;76(6):633–40.
14. Ghadaq Muyser, Radhwan HH. Translucency of Nanoparticles Reinforced Denture Base Materials. Al-Rafidain Dent J. 2024;24(2):342–50.
15. Tian Y, Sadowsky SJ, Brunski JB, Yuan X, Helms JA. Effects of masticatory loading on bone remodeling around teeth versus implants: Insights from a preclinical model. Clin Oral Implants Res. 2022;33(3):342–52. doi:10.1111/clr.13893
16. Geng JP, Tan KBC, Liu GR. Application of finite element analysis in implant dentistry: A review of the literature. J Prosthet Dent. 2001;85(6):585–98.
17. Lin PJ, Su KC. Biomechanical Design Application on the Effect of Different Occlusion Conditions on Dental Implants with Different Positions—A Finite Element Analysis. Appl Sci. 2020;10(17). doi:10.3390/app10175986
18. Wu AYJ, Hsu JT, Fuh LJ, Huang HL. Biomechanical effect of implant design on four implants supporting mandibular full-arch fixed dentures: In vitro test and finite element analysis. J Formos Med Assoc. 2020;119(10):1514–23. doi:10.1016/j.jfma.2020.03.011
19. Żmudzki J, Chladek G, Kasperski J. Biomechanical factors related to occlusal load transfer in removable complete dentures. Biomech Model Mechanobiol. 2015;14(4):679–91. doi:10.1007/s10237-014-0628-6
20. Torres IM, Pinho RS, Gutierrez FL, Cortes MA. Quality of COVID-19 Care in Sierra Leone: Development and Application of a Standardized National Assessment Tool. J Med Sci Interdiscip Res. 2025;5(1):57–66. doi:10.51847/iyWOEhcb12
21. Peterson SL, Rogers EK. Enhancing Accuracy of SARS-CoV-2 Point-of-Care Testing Through Proficiency Testing: Experiences from a Provincial EQA Program in Canada. J Med Sci Interdiscip Res. 2025;5(1):67–79. doi:10.51847/o7GFl1Vzrn
22. Laaksonen OJ, Virtanen MP. Role of m^6A RNA Methylation in Mediating Resistance to Chemotherapy and Immunotherapy in Cancer. Arch Int J Cancer Allied Sci. 2025;5(1):75–98. doi:10.51847/9lbgiSgyyw
23. Ismail SF, Hassan NA, Musa MH. Plasma VEGF-A Short Isoforms as a Predictive Biomarker for Bevacizumab Efficacy in First-Line Treatment of Metastatic Colorectal Cancer: A Phase II Study

(WJOG7612GTR). Arch Int J Cancer Allied Sci. 2025;5(1):125–37. doi:10.51847/PcIAGZ3VSM

24. Salem HM, Watanabe S, Chang AH. Ethical Concerns in Managing Anorexia Nervosa: A Content Analysis of Ethics Consultation Records. Asian J Ethics Health Med. 2025;5:25–35. doi:10.51847/oHEI6FgL3V
25. Jannath A, Elango R, Chidambaranathan AM. A Scoping Review on Ethical Issues in the Mpox Outbreak. Asian J Ethics Health Med. 2025;5:36–51. doi:10.51847/EQ8at7Q7lA
26. Makoae M, Mokhele T, Naidoo I, Sifunda S, Sewpaul R. The Influence of COVID-19 on Standard Child Immunisation Practices in South Africa. Bull Pioneer Res Med Clin Sci. 2025;5(1):28–36. doi:10.51847/tJtNDImcXV
27. Chen X, Hu X, Shi S, Tian Q. Marriage and Its Influence on Overweight and Obesity: Insights from China. Bull Pioneer Res Med Clin Sci. 2025;5(1):51–9. doi:10.51847/BpWlOExjJ4
28. Bandi V, Dey SK, Rao O. Factors Influencing the Physician Prescribing Behaviour of Medicines in Developed and Developing Countries: A Systematic Review. J Integr Nurs Palliat Care. 2024;5:21–34. doi:10.51847/ZS3boQgksO
29. Aslan FE, Sanlier NB, Cinar F. Studies Conducted in Turkey on the Effect of Hypothermia on the Surgical Process: A Meta-Analysis Study. J Integr Nurs Palliat Care. 2024;5:35–41. doi:10.51847/6mGzMdUDph
30. Jeung YY. Studying the Effect of Positive Thinking Training on Fear of Childbirth and Health Anxiety in Pregnant Women. J Integr Nurs Palliat Care. 2024;5:55–61. doi:10.51847/XEoAEL5hmj
31. Danchin A, Ng TW, Turinici G. Transmission Pathways and Mitigation Strategies for COVID-19. Interdiscip Res Med Sci Spec. 2024;4(1):1–10. doi:10.51847/p0YhQPxvkW
32. Hillman T. A Predictive Approach for Determining the Optimal Anti-CCR5 Monoclonal Antibody. Interdiscip Res Med Sci Spec. 2024;4(1):11–22. doi:10.51847/jVJ3mRs3yR
33. Cuenca-Martínez F, Herranz-Gómez A, Madroñero-Miguel B, Reina-Varona Á, Touche RL, Angulo-Díaz-Parreño S, et al. A Systematic Review of the Literature on the Connection Between Cervical Spine Abnormalities and Internal Disorders of the Temporomandibular Joint. J Curr Res Oral Surg. 2025;5:1–10. doi:10.51847/e4CoCM6iSZ
34. Mishra N, Dadhich A, Vande AV, Saluja H, Shah S, Mishra M. A Comparative Assessment of Topical 5-Fluorouracil and Modified Carnoy's Solution for the Treatment of Odontogenic Keratocyst. J Curr Res Oral Surg. 2025;5:11–6. doi:10.51847/OrVjjlmrxW
35. Alhossan A, Al Aloola N, Basoodan M, Alkathiri M, Alshahrani R, Mansy W, et al. Assessment of Community Pharmacy Services and Preparedness in Saudi Arabia during the COVID-19 Pandemic: A Cross-Sectional Study. Ann Pharm Educ Saf Public Health Advocacy. 2024;4:43–9. doi:10.51847/C52qAb0bZW
36. Frost N, Deckert PM, Nolte CH, Kohl R, Schreiber SJ. Challenges and Strategies in Recruiting Patients for a Trial on Patient-Centered Navigation in Age-Associated Diseases. Ann Pharm Educ Saf Public Health Advocacy. 2024;4:50–62. doi:10.51847/BLHlqwfTFT
37. Kunie K, Kawakami N, Shimazu A, Yonekura Y, Miyamoto Y. Examining the Impact of Managerial Communication on the Link Between Nurses' Job Performance and Psychological Empowerment. Ann Organ Cult Leadersh Extern Engagem J. 2025;6:1–7. doi:10.51847/SF5ZX3J4OT
38. Aksoy C, Akaydin A. Exploring the Influence of Strategic Leadership on Employee Performance in the Aviation Sector. Ann Organ Cult Leadersh Extern Engagem J. 2025;6:8–15. doi:10.51847/kbN4B2z6Bs
39. Li CX, Zhang L, Yan YR, Ding YJ, Lin YN, Zhou JP, et al. Exploring Advanced Diagnostic Techniques for Salivary Gland Disorders: A Narrative Overview. Asian J Curr Res Clin Cancer. 2024;4(1):1–10. doi:10.51847/uN2cjdmOP8
40. Ashwin SP, Sinduja P, Jayaraman S, Priyadharshini R. Evaluation of 8-OHDG, SOD, and GPx Biomarkers among Individuals with OPMD and OSCC. Asian J Curr Res Clin Cancer. 2024;4(1):11–7. doi:10.51847/DIQtos2d7D
41. Owusu A, Bonnaire K, Hailemeskel B. Lovastatin in the Context of Organ Transplantation: Comprehensive Review and Survey Findings. Ann Pharm Pract Pharmacother. 2024;4:1–7. doi:10.51847/VKrex2ILgt
42. Jin LW, Tahir NAM, Islahudin F, Chuen LS. Exploring Treatment Adherence and Quality of Life Among Patients with Transfusion-Dependent Thalassemia. Ann Pharm Pract Pharmacother. 2024;4:8–16. doi:10.51847/B8R85qakUv
43. Watanabe H, Mori A. ED-71 Protects Against Glucocorticoid-Triggered Osteoporosis by Influencing Osteoblast Differentiation through Notch and Wnt/β-Catenin Pathways. Pharm Sci Drug Des. 2025;5:1–19. doi:10.51847/aqKnaGGMQB
44. Romero I, Campos M. Initial Investigation into the Therapeutic Effects and Pharmacological Mechanisms of Modified Danggui-Shaoyao San for Managing Depression in Chronic Kidney Disease Patients. Pharm Sci Drug Des. 2025;5:20–32. doi:10.51847/24JvICiLe0
45. Alves R, Mendes T, Pinto J, Correia N. Warfarin Pharmacogenomics in the Era of Precision Medicine: Persistent Underrepresentation of Non-European Ancestries and Implications for Global Health Equity. Spec J Pharmacogn Phytochem Biotechnol. 2025;5:1–26. doi:10.51847/3jxE52PnLi
46. Chen WJ, Wu CL, Huang YC, Lin PC, Tsai MH. Precision Medicine Readiness Among Malaysian Community Pharmacists: High Perceived Value, Moderate Knowledge, and Urgent Training Needs. Spec J Pharmacogn Phytochem Biotechnol. 2025;5:27–38. doi:10.51847/xiZEcWNmB8
47. Michalakis KX, Calvani P, Hirayama H. Biomechanical considerations on tooth-implant supported fixed partial

dentures. J Dent Biomech. 2012;3:1758736012462025. doi:10.1177/1758736012462025

48. Singh R, Desai SR, Manjunath RGS. Influence of implant design and length on stress distribution in immediately loaded implants in the posterior maxilla - A two-dimensional finite element analysis. J Indian Soc Periodontol. 2023;27(6):600–6. doi:10.4103/jisp.jisp_531_22
49. Valente F, Marrocco A, Falcinelli C. Impact of physiological and non-physiological loading scenarios and crown material on periimplant bone stress distribution: A 3D finite element study. J Mech Behav Biomed Mater. 2025;163:106894. doi:10.1016/j.jmbbm.2025.106894
50. Romero M, Herrero-Climent M, Ríos-Carrasco B, Brizuela A, Romero MM, Gil J. Investigation of the Influence of Roughness and Dental Implant Design on Primary Stability via Analysis of Insertion Torque and Implant Stability Quotient: An In Vitro Study. J Clin Med. 2023;12(13). doi:10.3390/jcm12134190
51. Fathi RG, Taqa GA. Osseointegration of titanium implants modulated by vitamin K2 and yerba mate extract in an animal model. Regul Mech Biosyst. 2025;16(1):e25034. doi:10.15421/0225034
52. Azeez ZA, Kareem RA, Abdulwahhab SS. The effect of nano titanium oxide particle incorporation on the characteristics of denture base material. Mater Today Proc. 2021;42:2102–5. doi:10.1016/j.matpr.2020.12.292
53. Kareem RA, Naji GAH, Jawad SN. Differential Analyses of Naturally Prepared and Synthetic CaCO3/SiO2 Composite Implant Coating Material: an in vitro Study. J Medic Chem Sci. 2022;5(4):581–6. doi:10.26655/JMCHEMSCI.2022.4.13