BIOMECHANICAL PROBLEMS OF CEMENT FIXATION OF ARTIFICIAL CROWNS ON IMPLANTS

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Abstract: Relevance. In modern dentistry, the long-term functioning of artificial crowns on implants under the influence of systematic functional loads is relevant. Purpose: biomechanical study in a mathematical experiment of the stress-strain state (SSS) of the implant, artificial crown and fixing cement under functional load in the vertical and oblique direction. Material and methods. A mathematical analysis of the strength of the connection between an artificial crown and a dental implant under the influence of vertical and inclined functional loads (150 N) was carried out using the finite element method (FEM). Results. The parameters of the stress-strain state (SSS) in a metal-ceramic crown, fixing cement, and titanium dental implant were obtained . With a vertical load, a sufficient margin of safety in the construction materials is shown; with an inclined load, the safety margin of glass ionomer cement is exhausted and the maximum safety margin is noted in the cervical zone of the implant and abutment screw . Conclusion. The choice of cement fixation of an artificial crown to an implant is justified when installing an intraosseous implant in a position as close as possible to the vertical axis of the artificial crown. Otherwise, it is advisable to use screw fixation of the crown and the use of implants with a reinforced screw when connecting the abutment and implant.

Key words: dental implant, fixing cement, artificial crown, mathematical modeling, stress-strain state

Introduction. In practical dentistry, the cement method of fixing an artificial crown to the supporting abutment of an intraosseous dental implant is widely used. At the same time, there are frequent cases of decementing of crowns on implants, which leads to micromobility of the prosthetic structure and loosening of the implant.

Insufficiently reliable fixation of the prosthesis to the implant abutment can lead to progressive resorption of peri-implant bone tissue [18].

At the same time, at the present stage of research in the field of materials science and design, there are highly informative methods for studying strength parameters, in particular, mathematical modeling of the stress-strain state of structures using the finite element method (FEM) is widely used [9,10].

The purpose of the presented study is a mathematical analysis of the strength of the cement connection of an artificial crown to a dental implant

when exposed to vertical and inclined functional loads.

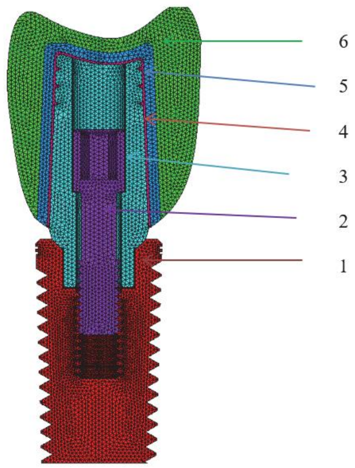
Material and methods. Using the ANSYS software package, mathematical modeling of the stress-strain state (SSS) in the materials of a metal-ceramic crown, fixing cement, and titanium dental implant was carried out using the finite element method (FEM). The calculations were performed in a physically and geometrically nonlinear formulation. The three-dimensional mathematical model of an intraosseous implant with cement fixation of a metal-ceramic crown corresponded to the natural sample in design and physical and mechanical parameters of the materials. A load of 150 N was applied to the occlusal surface of the crown in two versions (in the vertical direction and at an angle of 45°). The distribution of stresses in all elements of the prosthetic structure and implant was analyzed by magnitude (MPa), safety factor (Zp), displacement (µm), equivalent plastic deformation

Characteristics of materials mathematical mo 320MPa; for cobalchrome alloy 220 GPa; 0.30; divisions containing those necessary for the mathematical 320MPa; for glass ionomer cement 20.9 GPa; modeling physical and mechanical parameters, from 0.35; 120MPa; for titanium 113.8 GPa; 0.32; 880 MPa corresponded to the data from literature sources: mo (Table 1). elasticity, Poisson's ratio, yield strength of ceramics are respectively 70 GPa; 0.19;

Table 1.

Characteristics of materials of the mathematical model

Material	Elastic modulus E, GPa	Coeff Poisson	Hardening modulus MPa	Yield strength MPa
Ceramics	70	0.19	3182	320
Cobalt chrome alloy	220	0.30	500	320
Glass ionomer cement	20.9	0.35	10	120
Titanium	113.8	0.32	490	880
Composite	9.25	0.33	300	36



Rice. 1. Model of an intraosseous implant with cement fixation of a metal-ceramic crown: 1 implant , 2 screw, 3 abutment , 4 cement, 5 metal frame of the crown, 6 ceramic veneer.

Statistical processing of the study results was carried out using a standard set of Microsoft office application tools Office Excel 2016. The arithmetic mean (M) and standard error of the mean (m) were calculated. The statistical significance of the obtained results (p) was calculated using the Student's t test (t) and its interpretation based on the standard table of critical values of the Student coefficient. The significance level (a) corresponded to probability a

error equal to 5% (a = 0.05), results were considered statistically significant at $p < 0.05$.

Results. The maximum stresses under vertical load of a metal-ceramic crown with cement fixation were:

abutment 71.0 MPa,
screw 1.0MPa,
implant 53.0 MPa,
ceramics 90.0 MPa,
crown frame 87.0 MPa,
cement 119.0 MPa (Table 2).

Table 2.

Parameters of the stress-strain state of a metal-ceramic crown and supporting implant with cement fixation.

Scope of Analysis	Equivalent voltages. MPa		Margin of safety		Displacement µm	
	V	n	V	n	V	n
abutment	71	853	12.4	1.03	2	113
abutment screw	1	875	>10	1.01	0	63
implant	53	882	16.5	1.00	0	4
ceramics	90	60	3.64	5.34	4	154
crown frame	87	181	3.68	1.77	1	125

cement	119	179	0.99 ~3%	0.67 ~7%	2	114

Note: v vertical load, n inclined load.

The corresponding safety factor values ranged from 0.99 times for cement to 16.5 times for titanium implants.

A minimum safety margin (0.99) with the occurrence of irreversible plastic deformations and partial destruction is characteristic of the cement layer at the edge of the artificial crown.

Movements of structural materials under load did not exceed 4 µm; they were more typical for ceramic veneering, cement and abutment .

The magnitude of the maximum stresses under a displaced load of a cemented crown on an implant is:

abutment 853.0 MPa,

screw 875.0 MPa,

implant 882.0 MPa,

ceramics 60.0 MPa,

crown frame 181.0 MPa,

cement 179.0 MPa.

When the crown is cemented and the load is inclined, the safety margin is exhausted

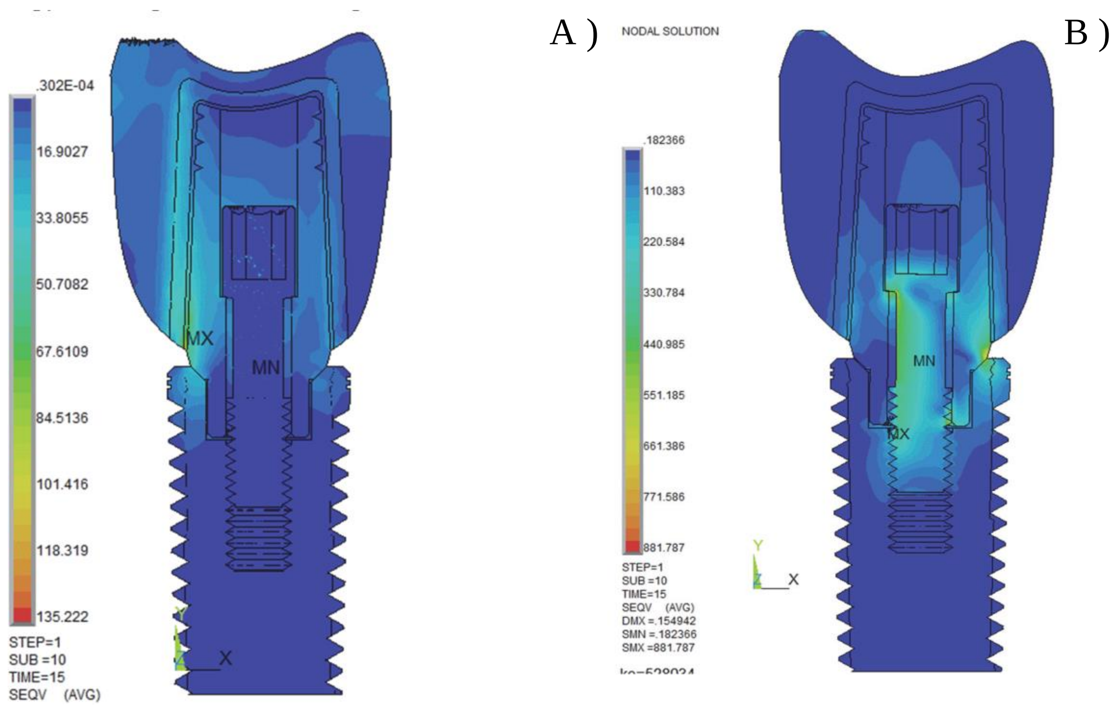
[135.222 STEP=1 SUB =10 TIME=15 SEQV (AVG)

glass ionomer cement (0.67), which leads to its cracking and spalling.

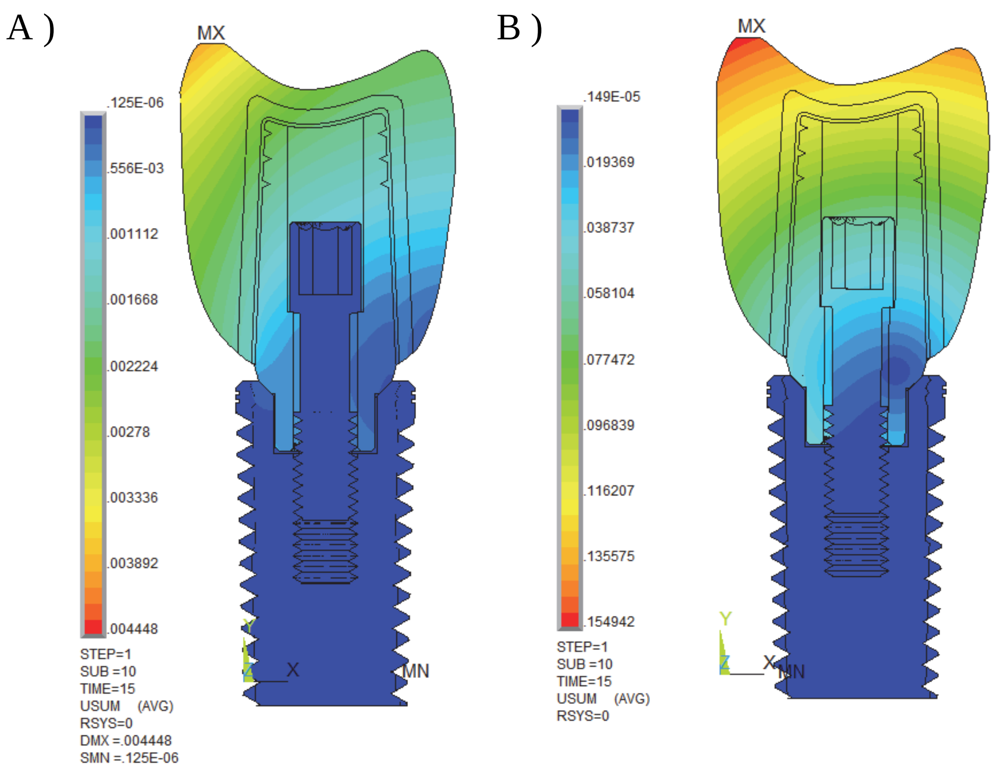
Maximum safety margins are noted in the following zones: in the cervical zone of the abutment screw , implant (Zp , respectively, 1,011.00). The greatest margin of safety is noted for ceramic cladding (5.34 times).

With an inclined load, the displacement of construction materials increases significantly (from 48 µm in implants to 113 µm in an abutment and up to 154 µm in a crown).

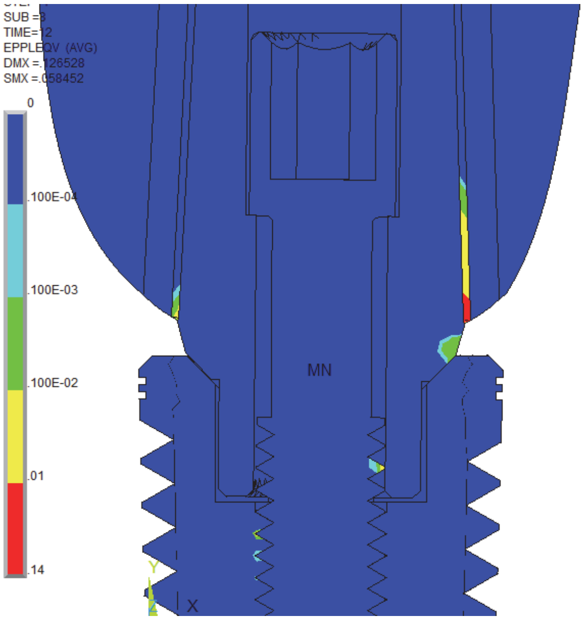
Thus, with a vertical functional load, three-dimensional mathematical modeling of the stress-strain state in the prosthetic structure and implant with cement fixation of crowns showed a sufficient margin of safety in the abutment , its screw, implant, ceramics and metal-ceramic frame of the crown and cement (Fig. 24). A significant increase in stresses and displacements in all areas of the crown on the implant was recorded when a load was applied at an angle of 45° to the occlusal surface.



Rice. 2. Distribution of equivalent stresses in the metal-ceramic crown and supporting implant (150N): a) vertical load, b) inclined load.



Rice. 3. Displacements in the metal-ceramic crown and supporting implant (150N): a) vertical load, b) oblique load.



Rice. 4. Plastic deformations under inclined load with cement fixation (150N).

Conclusion. The study showed the possibility of using cement fixation of an artificial crown on a dental implant from the standpoint of the strength of all structural elements, including fixing cement. However, all elements of the prosthetic structure and implant when cementing the artificial crown to the implant have sufficient strength only under vertical functional load. Deviation of the load from the vertical causes plastic deformations in the fixation cement, as well as in the cervical area of the implant and abutment screw .

Thus, there is a basis for choosing cement or screw fixation of the crown on the implant to ensure long-term fixation, namely, the choice of cement fixation of the artificial crown to the implant is justified when installing an intraosseous implant in a position as close as possible to the vertical axis of the artificial crown.

Otherwise, it is advisable to use screw fixation of the crown and the use of implants with a reinforced screw when connecting the abutment and implant.

BIBLIOGRAPHICAL LIST

1. Tashpulatova K. et al. Technique for eliminating traumatic occlusion in patients using Implant-supported bridges //European Journal of Molecular & Clinical Medicine. – 2020. – Т. 7. – №. 2. – С. 6189-6193.
2. Safarov M.T., Ro'zimbetov X.B., Tashpulatova K.M., Safarova N.T. (2023). Tish Implantatlarida To'liq Yoyli Protezlarning Biomexanikasi. *Conferences*, 35–36. извлечено от https://journals.scinnovations.uz/index.php/aposo/article/view/1030
3. Сафаров , М., Ахмаджонов, М., & Рузимбетов, А. (2022). Изучение микробиологического статуса у больных с перимплантитами в области мостовидных протезов. *Conferences*, 138. извлечено от https://journals.scinnovations.uz/index.php/aposo/article/view/111
4. Tashpulatova K.M., Safarov M.T., & Ruzimbetov H.B. (2023). Hemodynamic Changes In The Mucous Membrane Of The Alveolar Ridge Of The Lower Jaw With Partial Defects Of The Dentition. ОБРАЗОВАНИЕ НАУКА И

ИННОВАЦИОННЫЕ ИДЕИ В МИРЕ, 34(4), 42–48. Retrieved from https://www.newjournal.org/index.php/01/article/view/9797

5. Safarov M.T., Tashpulatova K.M., & Ruzimbetov Kh.B. (2023). Analysis Of The Effectiveness Of Methods For Fixing Artificial Crowns And Bridges On Dental Implants. ОБРАЗОВАНИЕ НАУКА И ИННОВАЦИОННЫЕ ИДЕИ В МИРЕ, 34(4), 36–38. Retrieved from https://newjournal.org/index.php/01/article/view/9795
6. Ташпулатова К.М., Сафаров М.Т., Шарипов С.С., Рузимбетов Х.Б. (2023). Среднесрочный Прогноз Эффективности Несъемных Зубных Протезов На Дентальные Имплантаты. Conferences, 101–103. извлечено от http://journals.scinnovations.uz/index.php/aposo/article/view/1117
7. Сафаров М.Т., Ширинова Ш., Ташпулатова К.М., Рузимбетов Х.Б. (2023). Адаптация Жевательных Мышц У Пациентов При Протезировании Мостовидными Протезами, Фиксированных На Дентальных Имплантатах. Conferences, 93–95. извлечено от http://journals.scinnovations.uz/index.php/aposo/article/view/1113
8. Рузимбетов Х.Б.,Сафаров М.Т., Ташпулатова К.М. (2023). Микробиологические Исследования При Воспалительных Осложнениях В Околоимплантатных Зонах. Conferences, 79–82. извлечено от http://journals.scinnovations.uz/index.php/aposo/article/view/1107
9. Сафаров М.Т., Ташпулатова К.М., Рузимбетов Х.Б., Шакирова Д. (2023). Клинико-Рентгенографическое Исследование Изменений Твердых Тканей Вокруг Имплантата У Пациентов С Частичной Адентией. *Conferences*, 89–90. извлечено от http://journals.scinnovations.uz/index.php/aposo/article/view/1111
10. Safarov M. T. et al. Evaluation of the Compensatory-Adaptive Mechanisms of Bridge Prosthetics at the Terminal Dentition Defects with the Use of Intraosseous Implants by the Method of Electromyography //American Journal of Medicine and Medical Sciences. – 2020. – Т. 10. – №. 9. – С. 657-659.
11. Сафаров М. Т. и др. Микробиологический статус больных, пользующихся искусственными коронками с опорой на дентальные имплантаты при периимплантитах //Conferences. – 2023. – С. 376-379.
12. Сафаров М.Т., РузимбетовХ.Б.,Сафарова Н.Т.,Холбоев Х. (2023). Изучение Функциональной Эффективности Мостовидных Протезов, Фиксированных На Дентальных Имплантатах. *Conferences*, 372–374. извлечено от http://journals.scinnovations.uz/index.php/aposo/article/view/902
13. Safarov, M., & Tashpulatova, K. (2022). Study Of The Microflora Of The Oral Cavity In Patients Using Dental Bridges With Dental Implants For Peri-Implantitis. *Conferences*, 172–173. извлечено от http://journals.scinnovations.uz/index.php/aposo/article/view/78

14. Safarov M. T. et al. Permanent prosthetics on dental implants //Eurasian Journal of Otorhinolaryngology-Head and Neck Surgery. – 2023. – Т. 2. – С. 70-74. https://doi.org/10.57231/j.ejohns.2023.2.3.012
15. Safarov M. T., Akhmadzhonov M., Ruzimbetov A. Study of microbiological status in patients with perimplantitis in the area of bridges. – Conferences, 2022.
16. Safarov M. T., Tashpulatova K. M., Ruzimbetov H. B. To Question About Osteointegration Dental Implants And Ways Her Stimulations //TADQIQOTLAR. – 2023. – Т. 27. – №. 3. – С. 82-89.
17. Safarov M. T., Tashpulatova K. M., Ruzimbetov H. B. Modern Representation About Osteointegration Of Dental Implants //TADQIQOTLAR. – 2023. – Т. 27. – №. 3. – С. 98-106.
18. Safarov M. T., Tashpulatova K. M., Ruzimbetov H. B. The Problem Of Inflammation In Peri-Implant Tissue And Factors Affecting Its Course //TADQIQOTLAR. – 2023. – Т. 27. – №. 3. – С. 90-97.
19. Мусаева К. А. и др. Биомеханика несъемных полнодуговых протезов с опорой на имплантаты //Conferences. – 2023. – С. 370-372.
20. Мусаева, К. (2023). Prosthodontic treatment of patients with osteoporosis. Актуальные проблемы стоматологии и челюстно-лицевой хирургии 4, 1(02), 103. извлечено от https://inlibrary.uz/index.php/problems-dentistry/article/view/16170
21. Мусаева К. А. К Вопросу Ортопедической Реабилитации При Остеопорозе //Conferences. – 2022. – С. 90-91.
22. Мусаева, К., Асом, Б., & Салиев, С. (2018). Улучшение фиксации полных съемных пластиночных протезов в условиях выраженной атрофии в области верхнечелюстных бугров. Stomatologiya, 1(2(71), 27–28. извлечено от https://inlibrary.uz/index.php/stomatologiya/article/view/1714
23. Мусаева, К. (2017). Особенности стоматологического статуса пациентов с хроническими заболеваниями почек. Stomatologiya, 1(1(66), 62–64. извлечено от https://inlibrary.uz/index.php/stomatologiya/article/view/2364