ZTM 4 (25) 2016, 215-226

Zirkonoxidimplantate – Entwicklungsstand und offene Fragen

Teil 1: Klinische und biologische Aspekte

1. Addison O, Davenport AJ, Newport RJ, Kalra S, Monir M, Mosselmans JFW, Proops D, Martin RA. Do 'passive' medical titanium surfaces deteriorate in service in the absence of wear? J R So Interface 2012;9:3161–3164.
2. Afrashtehfar KI, Del Fabbro M. Clinical performance of zirconia implants: A meta-review. J Prosthet Dent. 2020 Mar;123(3):419-426. doi: 10.1016/j.prosdent.2019.05.017. Epub 2019 Aug 23. PMID: 31451193.
3. Aita H, Hori N, Takeuchi M, Suzuki T, Yamada M, Anpo M, Ogawa T. The effect of ultraviolet functionalization of titanium on integration with bone. Biomaterials. 2009 Feb;30(6):1015-25. doi: 10.1016/j.biomaterials.2008.11.004. Epub 2008 Nov 29. PMID: 19042016.
4. Balmer M, Spies BC, Kohal RJ, Hämmerle CH, Vach K, Jung RE. Zirconia implants restored with single crowns or fixed dental prostheses: 5-year results of a prospective cohort investigation. Clin Oral Implants Res. 2020 May;31(5):452-462. doi: 10.1111/clr.13581. Epub 2020 Feb 5. PMID: 31981374.
5. Balmer M, Spies BC, Vach K, Kohal RJ, Hämmerle CHF, Jung RE. Three-year analysis of zirconia implants used for single-tooth replacement and three-unit fixed dental prostheses: A prospective multicenter study. Clin Oral Implants Res. 2018 Mar;29(3):290-299. doi: 10.1111/clr.13115. Epub 2018 Jan 12. PMID: 29330869.
6. Becker J, John G, Becker K, Mainusch S, Diedrichs G, Schwarz F. Clinical performance of two-piece zirconia implants in the posterior mandible and maxilla: a prospective cohort study over 2 years. Clin Oral Implants Res. 2017 Jan;28(1):29-35. doi: 10.1111/clr.12610. Epub 2015 May 6. PMID: 25951536.
7. Benic GI, Thoma DS, Sanz-Martin I, Munoz F, Hämmerle CHF, Cantalapiedra A, Fischer J, Jung RE. Guided bone regeneration at zirconia and titanium dental implants: a pilot histological investigation. Clin Oral Implants Res. 2017 Dec;28(12):1592-1599. doi: 10.1111/clr.13030. Epub 2017 Jun 26. PMID: 28653343.
8. Bergemann C, Duske K, Nebe JB, Schöne A, Bulnheim U, Seitz H, Fischer J. Microstructured zirconia surfaces modulate osteogenic marker genes in human primary osteoblasts. J Mater Sci Mater Med 2015 Jan;26(1):5350. doi: 10.1007/s10856-014-5350-x. Epub 2015 Jan 13. PMID: 25578704; PMCID: PMC4289972.
9. Bormann KH, Gellrich NC, Kniha H, Schild S, Weingart D, Gahlert M. A prospective clinical study to evaluate the performance of zirconium dioxide dental implants in single-tooth edentulous area: 3-year follow-up. BMC Oral Health. 2018 Nov 1;18(1):181. doi: 10.1186/s12903-018-0636-x. PMID: 30382850; PMCID: PMC6211599.
10. Brezavšček M, Fawzy A, Bächle M, Tuna T, Fischer J, Att W. The Effect of UV Treatment on the osteoconductive capacity of zirconia-Based materials. Materials (Basel). 2016 Nov 24;9(12):958. doi: 10.3390/ma9120958. PMID: 28774080; PMCID: PMC5457022.
11. Cadosch D, Al-Mushaiqri MS, Gautschi OP, Meagher J, Simmen HP, Filgueira L. Biocorrosion and uptake of titanium by human osteoclasts. J Biomed Mater Res A. 2010 Dec 15;95(4):1004-10. doi: 10.1002/jbm.a.32914. Epub 2010 Sep 24. PMID: 20872748.
12. Cadosch D, Chan E, Gautschi OP, Meagher J, Zellweger R, Filgueira L. Titanium IV ions induced human osteoclast differentiation and enhanced bone resorption in vitro. J Biomed Mater Res A. 2009 Oct;91(1):29-36. doi: 10.1002/jbm.a.32183. PMID: 18683234.

13. Cadosch D, Gautschi OP, Chan E, Simmen HP, Filgueira L. Titanium induced production of chemokines CCL17/TARC and CCL22/MDC in human osteoclasts and osteoblasts. J Biomed Mater Res A. 2010 Feb;92(2):475-83. doi: 10.1002/jbm.a.32390. PMID: 19205012.

14. Cadosch D, Sutanto M, Chan E, Mhawi A, Gautschi OP, von Katterfeld B, Simmen HP, Filgueira L. Titanium uptake, induction of RANK-L expression, and enhanced proliferation of human T-lymphocytes. J Orthop Res. 2010 Mar;28(3):341-7. doi: 10.1002/jor.21013. PMID: 19810098.

15. Cionca N, Hashim D, Mombelli A. Zirconia dental implants: where are we now, and where are we heading? Periodontol 2000. 2017 Feb;73(1):241-258. doi: 10.1111/prd.12180. PMID: 28000266.

16. Comino-Garayoa R, Cortés-Bretón Brinkmann J, Peláez J, López-Suárez C, Martínez-González JM, Suárez MJ. Allergies to titanium dental implants: What do we really know about them? A Scoping Review. Biology (Basel). 2020 Nov 18;9(11):404. doi: 10.3390/biology9110404. PMID: 33217944; PMCID: PMC7698636.

17. Delgado-Ruiz R, Romanos G. Potential causes of titanium particle and ion release in implant dentistry: A systematic review. Int J Mol Sci. 2018 Nov13;19(11):3585. doi: 10.3390/ijms19113585. PMID: 30428596; PMCID: PMC6274707.

18. Faucheux N, Tzoneva R, Nagel MD, Groth T. The dependence of fibrillar adhesions in human fibroblasts on substratum chemistry. Biomaterials. 2006 Jan;27(2):234-45. doi: 10.1016/j.biomaterials.2005.05.076. PMID: 16023199.

19. Fischer J, Schott A, Märtin S. Surface micro-structuring of zirconia dental implants. Clin Oral Implants Res. 2016 Feb;27(2):162-6. doi: 10.1111/clr.12553. Epub 2015 Jan 30. PMID: 25639609.

20. Haro Adánez M, Nishihara H, Att W. A systematic review and meta-analysis on the clinical outcome of zirconia implant-restoration complex. J Prosthodont Res. 2018 Oct;62(4):397-406. doi: 10.1016/j.jpor.2018.04.007. Epub 2018 Jul 5. PMID: 29983377.

21. Hashim D, Cionca N, Courvoisier DS, Mombelli A. A systematic review of the clinical survival of zirconia implants. Clin Oral Investig. 2016 Sep;20(7):1403-17. doi: 10.1007/s00784-016-1853-9. Epub 2016 May 24. PMID: 27217032; PMCID: PMC4992030.

22. Hisbergues M, Vendeville S, Vendeville Ph. Zirconia: Established facts and perspectives for a Biomaterial in Dental Implantology. J Biomed Mater Res Part B: Appl Biomater 2009 Feb;88(2):519-29. doi: 10.1002/jbm.b.31147. PMID: 18561291.

23. Hoene A, Walschus U, Patrzyk M, Finke B, Lucke S, Nebe B, Schroeder K, Ohl A, Schlosser M. In vivo investigation of the inflammatory response against allylamine plasma polymer coated titanium implants in a rat model. Acta Biomater 2010;6:676-83. doi: 10.1016/j.actbio.2009.09.003.

24. Jäggi M, Gyr S, Astasov-Frauenhoffer M, Zitzmann NU, Fischer J, Rohr N. Influence of different zirconia surface treatments on biofilm formation. Dent Mater, under review.

25. Javed F, Almas K, Crespi R, Romanos GE. Implant surface morphology and primary stability: is there a connection? Implant Dent. 2011 Feb;20(1):40-6. doi: 10.1097/ID.0b013e31820867da. PMID: 21278526.

26. Judgar R, Giro G, Zenobio E, Coelho PG, Feres M, Rodrigues JA, Mangano C, Iezzi G, Piattelli A, Shibli JA. Biological width around one- and two-piece implants retrieved from human jaws. Biomed Res Int. 2014; 2014:850120. doi: 10.1155/2014/850120. Epub 2014 Jun 23. PMID: 25050375; PMCID: PMC4094864.

27. Jung RE, Grohmann P, Sailer I, Steinhart YN, Fehér A, Hämmerle C, Strub JR, Kohal R. Evaluation of a one-piece ceramic implant used for single-tooth replacement and three-

unit fixed partial dentures: a prospective cohort clinical trial. Clin Oral Implants Res. 2016 Jul;27(7):751-61. doi: 10.1111/clr.12670. Epub 2015 Jul 27. PMID: 26212100.

28. Kirsten A, Hausmann A, Weber M, Fischer J, Fischer H. Bioactive and thermally compatible glass coating on zirconia dental implants. J Dent Res. 2015 Feb;94(2):297-303. doi: 10.1177/0022034514559250. Epub 2014 Nov 24. PMID: 25421839; PMCID: PMC4438729.
29. Kohal RJ, Spies BC, Vach K, Balmer M, Pieralli S. A prospective clinical cohort investigation on zirconia implants: 5-year results. J Clin Med. 2020 Aug 10;9(8):2585. doi: 10.3390/jcm9082585. PMID: 32785031; PMCID: PMC7464596.
30. Mombelli A, Hashim D, Cionca N. What is the impact of titanium particles and biocorrosion on implant survival and complications? A critical review. Clin Oral Implants Res. 2018 Oct;29 Suppl 18:37-53. doi: 10.1111/clr.13305. PMID: 30306693.
31. Noumbissi S, Scarano A, Gupta S. A literature review study on atomic ions dissolution of titanium and its alloys in implant dentistry. Materials (Basel). 2019 Jan 24;12(3):368. doi: 10.3390/ma12030368. PMID: 30682826; PMCID: PMC6384935.
32. Olmedo D, Fernández MM, Guglielmotti MB, Cabrini RL. Macrophages related to dental implant failure. Implant Dent. 2003;12(1):75-80. doi: 10.1097/01.id.0000041425.36813.a9. PMID: 12704960.
33. Özkurt Z, Kazazoğlu E. Zirconia dental implants: a literature review. J Oral Implantol. 2011 Jun;37(3):367-76. doi: 10.1563/AAID-JOI-D-09-00079. Epub 2010 Jun 14. PMID: 20545529.
34. Piconi C, Maccauro G. Zirconia as a biomaterial. Biomaterials 1999 Jan;20(1):1-25. doi: 10.1016/s0142-9612(98)00010-6. PMID: 9916767.
35. Pieralli S, Kohal RJ, Jung RE, Vach K, Spies BC. Clinical outcomes of zirconia dental implants: A systematic review. J Dent Res. 2017 Jan;96(1):38-46. doi: 10.1177/0022034516664043. Epub 2016 Oct 1. PMID: 27625355.
36. Pieralli S, Kohal RJ, Lopez Hernandez E, Doerken S, Spies BC. Osseointegration of zirconia dental implants in animal investigations: A systematic review and meta-analysis. Dent Mater. 2018 Feb;34(2):171-182. doi: 10.1016/j.dental.2017.10.008. Epub 2017 Nov 6. PMID: 29122237.
37. Roehling S, Schlegel KA, Woelfler H, Gahlert M. Zirconia compared to titanium dental implants in preclinical studies-A systematic review and meta-analysis. Clin Oral Implants Res. 2019 May;30(5):365-395. doi: 10.1111/clr.13425. Epub 2019 Apr 16. PMID: 30916812.
38. Roehling S, Woelfler H, Hicklin S, Kniha H, Gahlert M. A retrospective clinical study with regard to survival and success rates of zirconia implants up to and after 7 years of loading. Clin Implant Dent Relat Res. 2016 Jun;18(3):545-58. doi: 10.1111/cid.12323. Epub 2015 Mar 19. PMID: 25801578.
39. Rohr N, Balmer M, Jung RE, Kohal R-J, Spies B, Hämmerle CHF, Fischer J. Influence of zirconia implant surface topography on first bone implant contact within a prospective cohort study. Clin Implant Dent Relat Res. 2021;1–7. doi.org/10.1111/cid.13013.
40. Rohr N, Bergemann C, Nebe JB, Fischer J. Crystal structure of zirconia affects osteoblast behavior. Dent Mater 2020 Jul;36(7):905-913. doi: 10.1016/j.dental.2020.04.017. Epub 2020 May 30. PMID: 32487484.
41. Rohr N, Fricke K, Bergemann C, Nebe JB, Fischer J. Efficacy of plasma-polymerized allylamine coating of zirconia after five years. J Clin Med. 2020 Aug 27;9(9):2776. doi: 10.3390/jcm9092776. PMID: 32867239; PMCID: PMC7565740.
42. Rohr N, Nebe JB, Schmidli F, Müller P, Weber M, Fischer H, Fischer J. Influence of bioactive glass-coating of zirconia implant surfaces on human osteoblast behavior in

vitro. Dent Mater. 2019 Jun;35(6):862-870. doi: 10.1016/j.dental.2019.02.029. Epub 2019 Mar 16. PMID: 30890265.

43. Rohr N, Zeller B, Matthisson L, Fischer J. Surface structuring of zirconia to increase fibroblast viability. Dent Mater 2020 Jun;36(6):779-786. doi: 10.1016/j.dental.2020.03.024. Epub 2020 Apr 27. PMID: 32354484.
44. Rupp F, Liang L, Geis-Gerstorfer J, Scheideler L, Hüttig F. Surface characteristics of dental implants: A review. Dent Mater. 2018 Jan;34(1):40-57. doi: 10.1016/j.dental.2017.09.007. Epub 2017 Oct 10. PMID: 29029850.
45. Schwarz F, John G, Hegewald A, Becker J. Non-surgical treatment of peri-implant mucositis and peri-implantitis at zirconia implants: a prospective case series. J Clin Periodontol. 2015 Aug;42(8):783-788. doi: 10.1111/jcpe.12439. Epub 2015 Aug 26. PMID: 26249545.
46. Schwarz F, Langer M, Hagena T, Hartig B, Sader R, Becker J. Cytotoxicity and proinflammatory effects of titanium and zirconia particles. Int J Implant Dent. 2019 Jul 9;5(1):25. doi: 10.1186/s40729-019-0178-2. PMID: 31286286; PMCID: PMC6614223.
47. Sicilia A, Cuesta S, Coma G, Arregui I, Guisasola C, Ruiz E, Maestro A. Titanium allergy in dental implant patients: a clinical study on 1500 consecutive patients. Clin Oral Implants Res. 2008 Aug;19(8):823-35. doi: 10.1111/j.1600-0501.2008.01544.x. PMID: 18705814.
48. Siddiqi A, Payne AGT, De Silva RK, Duncan WJ. Titanium allergy: could it affect dental implant integration? Clin Oral Implants Res. 2011 Jul;22(7):673-680. doi: 10.1111/j.1600-0501.2010.02081.x. Epub 2011 Jan 20. PMID: 21251079.
49. Sivaraman K, Chopra A, Narayan AI, Balakrishnan D. Is zirconia a viable alternative to titanium for oral implant? A critical review. J Prosthodont Res. 2018 Apr;62(2):121-133. doi: 10.1016/j.jpor.2017.07.003. Epub 2017 Aug 18. PMID: 28827030.
50. Staehlke S, Rebl H, Finke B, Mueller P, Gruening M, Nebe JB. Enhanced calcium ion mobilization in osteoblasts on amino group containing plasma polymer nanolayer. Cell Biosci. 2018 Mar 21;8:22. doi: 10.1186/s13578-018-0220-8. PMID: 29588849; PMCID: PMC5863460.
51. Suito H, Iwawaki Y, Goto T, Tomotake Y, Ichikawa T. Oral factors affecting titanium elution and corrosion: an in vitro study using simulated body fluid. PLoS One. 2013 Jun 7;8(6):e66052. doi: 10.1371/journal.pone.0066052. PMID: 23762461; PMCID: PMC3676376.
52. Tuna T, Wein M, Altmann B, Steinberg T, Fischer J, Att W. Effect of ultraviolet photofunctionalisation on the cell attractiveness of zirconia implant materials. Eur Cell Mater. 2015 Jan 23;29:82-94; discussion 95-6. doi: 10.22203/ecm.v029a07. PMID: 25612543.
53. Tuna T, Wein M, Swain M, Fischer J, Att W. Influence of ultraviolet photofunctionalization on the surface characteristics of zirconia-based dental implant materials. Dent Mater. 2015 Feb;31(2):e14-24. doi: 10.1016/j.dental.2014.10.008. Epub 2014 Nov 22. PMID: 25467951.
54. U.S. Food & Drug Administration (FDA). Biological responses to metal implants. 2019. https://www.fda.gov/media/131150/download
55. Wennerberg A, Albrektsson T. Effects of titanium surface topography on bone integration: a systematic review. Clin Oral Implants Res. 2009 Sep;20 Suppl 4:172-84. doi: 10.1111/j.1600-0501.2009.01775.x. PMID: 19663964.
56. Wennerberg A, Albrektsson T, Chrcanovic B. Long-term clinical outcome of implants with different surface modifications. Eur J Oral Implantol. 2018;11 Suppl 1:S123-S136. PMID: 30109304.

57. Zipprich H, Weigl P, Ratka C, Lange B, Lauer HC. The micromechanical behavior of implant-abutment connections under a dynamic load protocol. Clin Implant Dent Relat Res. 2018 Oct;20(5):814-823. doi: 10.1111/cid.12651. Epub 2018 Jul 24. PMID: 30039915.

ZTM 4 (25) 2021, 190-195
Die Münchner Schiene – vollanatomische zahnfarbene Schienen aus Polycarbonat

ZT Josef Schweiger M.Sc., Prof. Dr. Jan-Frederik Güth, Prof. Dr. Daniel Edelhoff

1. Edelhoff D, Schweiger J. CAD/CAM-gefertigte zahnfarbene Schienen zur ästhetischen und funktionellen Evaluierung einer neuen Vertikaldimension der Okklusion. Quintessenz Zahntech 2013;39(11):1610–1623.
2. Edelhoff D, Schweiger J. CAD/CAM tooth-colored occlusal splints for the evaluation of a new vertical dimension of occlusion: a case report. Quintessence Dent Technol 2014, 37:1610–1623.
3. Edelhoff D, Schweiger J, Prandtner O, Trimpl J, Stimmelmayr M, Güth JF: CAD/CAM-Schienen zur funktionellen und ästhetischen Evaluierung neu definierter Bisslagen. Quintessenz 2016; 67(10):1195-1209
4. Edelhoff D, Schweiger J, Prandtner O, Trimpl J, Stimmelmayr M, Güth JF: CAD/CAM splints for the functional and esthetic evaluation of newly defined occlusal dimensions. Quintessence Int 2017;48(3): 181–191
5. Sierpinska T, Kuc J, Golebiewska M. Morphological and Functional Parameters in Patients with Tooth Wear before and after Treatment. Open Dent J 2013; 7:55-61
6. Brisman AS. Esthetics: A comparison of dentists`and patients` concepts. J Am Dent Assoc 1980; 100:345-352
7. Rosenstiel SF, Ward DH, Rashid RG. Dentists`preferences of anterior tooth proportion – a web based study. J Prosthodont 2000; 9(3):123-136
8. Wolfarth S, Thormann H, Freitag S et.al. Assessment of dental appearance following changes in incisor proportions. Eur J Oral Sci 2005; 113(2):159-165
9. Magne P, Gallucci GO, Belser U. Anatomic crown width/lenth ratios of unworn and worn maxillary teeht in white subjects. J Prosthet Dent 2003; 89(5):453-461
10. Berli C, Thieringer FM, Sharma N, Müller JA, Dedem P, Fischer J, Rohr N. Comparing the mechanical properties of pressed, milled and 3D-printed resins for occlusal devices. J Prosthet Dent. 2020; 124(6):780-786
11. Schwerin C, Kelch M. Vom digitalen Wax-up über den 3-D-Druck zur zahnfarbenen gefrästen Schiene. Das Münchner Schienenkonzept im Workflow 4.0. Quintessenz Zahntech 2018;44(5):640–651.