Alumina and Zirconia

The increased demand for improved esthetics, along with the preference for non-metal restorative materials have increased the use of dental ceramics. The ceramic materials used for Nobel Biocare's all-ceramic crowns, bridges, laminates and abutments consist of densely sintered, high purity (99.5%) aluminum oxide (alumina) and yttria-stabilized zirconium oxide (Y-TZP zirconia). These ceramic materials possess several desirable characteristics for use in modern dentistry, including biocompatibility and good mechanical properties[1-16].

Alumina

Studies focused on evaluating the clinical performance of all-ceramic alumina crowns, bridges, and abutments in dental practice have shown good results[2,17-45]. Cumulative success rates of 98% and 92% after 5 and 10 years, respectively, have been reported for alumina crowns[22,26,30,31]. Tests have shown that the alumina crowns and bridges exceed the biomechanical requirements for all-ceramic fixed partial dentures[33]. Moreover, both short and long-term clinical studies have shown good results for the alumina abutments[35-45]; a cumulative success rate of 98% after 5 years[43], favourable marginal bone levels, and healthy surrounding soft tissue have been reported[41-43].

Zirconia

Zirconia has a flexural strength and fracture toughness almost twice as high as that of alumina, which makes zirconia very resistant to masticatory forces, with maintained exact precision of fit[46,47,56]. Clinical studies aiming at evaluating zirconia abutments have shown high success rates and good esthetic results, with healthy mucosal conditions and stable marginal bone levels[48-52]. Furthermore, compared to titanium, zirconia has been shown to accumulate less bacteria in vivo in terms of presence and total number of potential putative pathogens[53,54]. Data also reveal that the tissues around zirconia healing caps undergo a lower rate of inflammation-associated processes compared to titanium[55]. Clinical studies evaluating the long-term performance of zirconia crowns and bridges are ongoing.

References

1. *Al-Dohan HM, Yaman P, Dennison JB, Razzoog ME, Lang BR. Shear strength of core-veneer interface in bi-layered ceramics. J Prosthet Dent 2004;91(4):349-55.*
2. *Andersson M, Odén A. A new all-ceramic crown. A dense-sintered, high-purity alumina coping with porcelain. Acta Odontol Scand 1993;51:59-64.*
3. *Anusavice KJ. Degradability of dental ceramics. Adv Dent Res 1992;6:82-9.*
4. *Chai J, Takahashi Y, Sulaiman F, Chong K, Lautenschlager EP. Probability of fracture of all-ceramic crowns. Int J Prosthodont 2000;13(5):420-4.*
5. *Esquivel-Upshaw JF, Chai J, Sansano S, Shonberg D. Resistance to staining, flexural strength, and chemical solubility of core porcelains for all-ceramic crowns. Int J Prosthodont 2001;14(3):284-8.*
6. *Harrington Z, McDonald A, Knowles J. An in vitro study to investigate the load at fracture of Procera AllCeram crowns with various thickness of occlusal veneer porcelain. Int J Prosthodont 2003;16(1):54-8.*

7. *Hegenbarth EA. Procera aluminum oxide ceramics; A new way to achieve stability, precision and esthetics in all-ceramic restorations. Quintessence Dent Technol 1996;19:21-34.*

8. *Pallis K, Griggs JA, Woody RD, Guillen GE, Miller AW. Fracture resistance of three all-ceramic restorative systems for posterior applications. J Prosthet Dent 2004;91(6):561-9.*

9. *Potiket N, Chiche G, Finger IM. In vitro fracture strength of teeth restored with different all-ceramic crown systems. J Prosthet Dent. 2004 Nov;92(5):491-5.*

10. *Snyder MD, Hogg KD. Load-to-fracture value of different all-ceramic crown systems. J Contemp Dent Pract. 2005 Nov 15;6(4):54-63.*

11. *Thomas P, Barnstorf S, Summer B, Willmann G, Przybilla B. Immuno-allergological properties of aluminium oxide (Al2O3) ceramics and nickel sulfate in humans. Biomaterials. 2003 Mar;24(6):959-66.*

12. *Wagner WC, Chu TM. Biaxial flexural strength and indentation fracture toughness of three new dental core ceramics. J Prosthet Dent. 1996 Aug;76(2):140-4.*

13. *Webber B, McDonald A, Knowles J. An in vitro study of the compressive load at fracture of Procera AllCeram crowns with varying thickness of veneer porcelain. J Prosthet Dent 2003;89(2):154-60.*

14. *Wood KC, Berzins DW, Luo Q, Thompson GA, Toth JM, Nagy WW. Resistance to fracture of two all-ceramic crown materials following endodontic access. J Prosthet Dent. 2006 Jan;95(1):33-41.*

15. *Zeng K, Oden A, Rowcliffe D. Evaluation of mechanical properties of dental ceramic core materials in combination with porcelains. Int J Prosthodont 1998;11(2):183-9.*

16. *Zeng K, Oden A, Rowcliffe D. Flexure tests on dental ceramics. Int J Prosthodont 1996;9(5):434-9.*

17. *Andersson M, Razzoog ME, Oden A, Hegenbarth EA, Lang BR. Procera: a new way to achieve an all-ceramic crown. Quintessence Int. 1998 May;29(5):285-96.*

18. *Bonnard P, Hermans M, Adriaenssens P, Daelemans P, Malevez C. Anterior esthetic rehabilitation on teeth and dental implants optimized with Procera technology: a case report. J Esthet Restor Dent. 2001;13(3):163-71.*

19. *Brunton PA, Smith P, McCord JF, Wilson NH. Procera all-ceramic crowns: a new approach to an old problem? Br Dent J. 1999 May 8;186(9):430-4.*

20. *Chai J, McGivney GP, Munoz CA, Rubenstein JE. A multicenter longitudinal clinical trial of a new system for restorations. J Prosthet Dent 1997;77(1):1-11.*

21. *Fradeani M, D'Amelio M, Redemagni M, Corrado M. Five-year follow-up with Procera all-ceramic crowns. Quintessence Int. 2005 Feb;36(2):105-13.*

22. *Galindo ML, Hagmann E, Marinello CP, Zitzmann NU. Long-term clinical results with Procera AllCeram full-ceramic crowns. Schweiz Monatsschr Zahnmed 2006;116:804-809.*

23. *Haag P, Andersson M, Vult von Steyern P, Odén A. 15 years of clinical experience with Procera® Alumina. A Review. Appl Osseointegrat Res 2004;4:7-12*

24. *Jokstad A. A split-mouth randomized clinical trial of single crowns retained with resin-modified glass-ionomer and zinc phosphate luting cements. Int J Prosthodont. 2004 Jul-Aug;17(4):411-6.*

25. *Naert I, Van der Donck A, Beckers L. Precision of fit and clinical evaluation of all-ceramic full restorations followed between 0.5 and 5 years. J Oral Rehabil. 2005 Jan;32(1):51-7.*

26. *Oden A, Andersson M, Krystek-Ondracek I, Magnusson D. Five-year clinical evaluation of Procera AllCeram crowns. J Prosthet Dent 1998;80(4):450-6.*

27. *Ottl P, Piwowarczyk A, Lauer HC, Hegenbarth EA. The Procera AllCeram system. Int J Periodontics Restorative Dent 2000;20(2):151-61.*

28. *Razzoog ME, Lang LA, McAndrew KS. AllCeram crowns for single replacement implant abutments. J Prosthet Dent 1997;78(5):486-9.*

29. *Walter MH, Wolf BH, Wolf AE, Boening KW. Six-year clinical performance of all-ceramic crowns with alumina cores. Int J Prosthodont. 2006 Mar-Apr;19(2):162-3.*

30. *Zarone F, Sorrentino R, Vaccaro F, Russo S, De Simone G. Retrospective clinical evaluation of 86 Procera AllCeram™ anterior crowns on natural and implant-supported abutments. Clin Implant Dent Relat Res. 2005; 7 2005;7 (Suppl 1):S95-103.*

31. *Ödman P, Andersson B. Procera AllCeram crowns followed for 5 to 10.5 years: a prospective clinical study. Int J Prosthodont. 2001 Nov-Dec;14(6):504-9.*

32. *Sadan A, Blatz M, Lang B. Clinical considerations for densely sintered alumina and zirconia restorations: Part 1. Int J Periodontics Restorative Dent 2005; 25:213-19.*

33. *Lang B, Maló P, Guedes C, Wang RF, Kang B, Lang L, Razzoog ME. Procera® AllCeram Bridge. Appl Osseointegrat Res 2004;4:13-21.*

34. *Att W, Kurun S, Gerds T, Strub JR. Fracture resistance of single-tooth implant-supported all-ceramic restorations: an in vitro study. J Prosthet Dent. 2006 Feb;95(2):111-6.*

35. *Heydecke G, Sieraalta M, Razzoog MF. Evolution and use of aluminium oxide single-tooth implant abutments: a short review and presentation of two cases. Int J Prosthodont 2002;15(5):488-93.*

36. *Kucey BK, Fraser DC. The Procera abutment--the fifth generation abutment for dental implants. J Can Dent Assoc 2000;66(8):445-9.*

37. *Marchack CB, Yamashita T. Fabrication of digitally scanned custom shaped abutment: a clinical report. J Prosthet Dent 2001;85(2):113-5.*

38. *Prestipino V, Ingber A. All-ceramic implant abutments. Esthetic indications. J Esthetic Dentistry 1996;8(6):255-262.*

39. *Prestipino V, Ingber A. Esthetic high-strength implant abutments. Part I. J Esthetic Dentistry 1993;5(1):29-36.*

40. *Prestipino V, Ingber A. Esthetic high-strength implant abutments. Part II. J Esthet Dent 1993;5(2):63-8.*

41. *Andersson B, Scharer P, Simion M, Bergstrom C. Ceramic implant abutments used for short-span fixed partial dentures: a prospective 2-year multicenter study. Int J Prosthodont 1999;12(4):318-24.*

42. *Andersson B, Taylor A, Lang BR, Scheller H, Scharer P, Sorensen JA, Tarnow D. Alumina ceramic implant abutments used for single-tooth replacement: a prospective 1- to 3-year multicenter study. Int J Prosthodont 2001;14(5):432-8.*

43. *Andersson B, Glauser R, Maglione M, Taylor A. Ceramic implant abutments for short-span FPDs: a prospective 5-year multicenter study. Int J Prosthodont 2003;16(6):640-6.*

44. *Henriksson K, Jemt T. Evaluation of custom-made procera ceramic abutments for single-implant tooth replacement: a prospective 1-year follow-up study. Int J Prosthodont 2003;16(6):626-30.*

45. *Sadoun M, Perelmuter S. Alumina-zirconia machinable abutments for implant-supported single-tooth anterior crowns. Pract Periodontics Aesthet Dent 1997;9(9):1047-53.*

46. *Yildirim M, Fischer H, Marx R, Edelhoff D. In vivo fracture resistance of implant-supported all-ceramic restorations. J Prosthet Dent 2003;90(4):325-31.*

47. *Sierraalta M, Odén A, Razzoog ME. Material strength of zirconia produced with two methods. J Dent Res 2003;82(Spec Iss A):AADR abstract # 0450*

48. *Att W, Kurun S, Gerds T, Strub JR. Fracture resistance of single-tooth implant-supported all-ceramic restorations after exposure to the artificial mouth. J Oral Rehabil 2006;33:380-386.*

49. *Cibirka RM, Nelson SK, Rueggeberg FA. Examination of the implant-abutment interface after fatigue testing. J Prosthet Dent 2001;85(3):268-75.*

50. *Glauser R, Sailer I, Wohlwend A, Studer S, Schibli M, Scharer P. Experimental zirconia abutments for implant-supported single-tooth restorations in esthetically demanding regions: 4-year results of a prospective clinical study. Int J Prosthodont 2004;17(3):285-90.*

51. *Lang LA, Sierraalta M, Hoffensperger M, Wang RF. Evaluation of the precision of fit between the Procera custom abutment and various implant systems. Int J Oral Maxillofac Implants 2003;18(5):652-8.*

52. *Tan PL, Dunne Jr JT. An esthetic comparison of a metal ceramic crown and cast metal abutment with an all-ceramic crown and zirconia abutment: a clinical report. J Prosthet Dent 2004;91(3):215-8.*

53. *Scarano A, Piattelli M, Caputi S, Favero GA, Piattelli A. Bacterial adhesion on commercially pure titanium and zirconium oxide disks: an in vivo human study. J Periodontol 2004;75(2):292-6.*

54. *Rimondini L, Cerroni L, Carrassi A, Torricelli P. Bacterial colonization of zirconia ceramic surfaces: an in vitro and in vivo study. Int J Oral Maxillofac Implants 2002;17(6):793-8.*

55. *Degidi M, Artese L, Scarano A, Perrotti V, Gehrke P, Piattelli A. Inflammatory infiltrate, microvessel density, nitric oxide synthase expression, vascular endothelial growth factor expression, and proliferative activity in peri-implant soft tissues around titanium and zirconium oxide healing caps. J Periodontol. 2006 Jan;77(1):73-80.*

56. *Kessler-Liechti G, Mericske-Stern R. Rehabilitation of an abraded occlusion with Procera-ZrO2 all-ceramic crowns. A case report. Schweiz Monatsschr Zahnmed 2006;116:156-167.*