A Systematic Review of Clinical Success of Ceramic Implants

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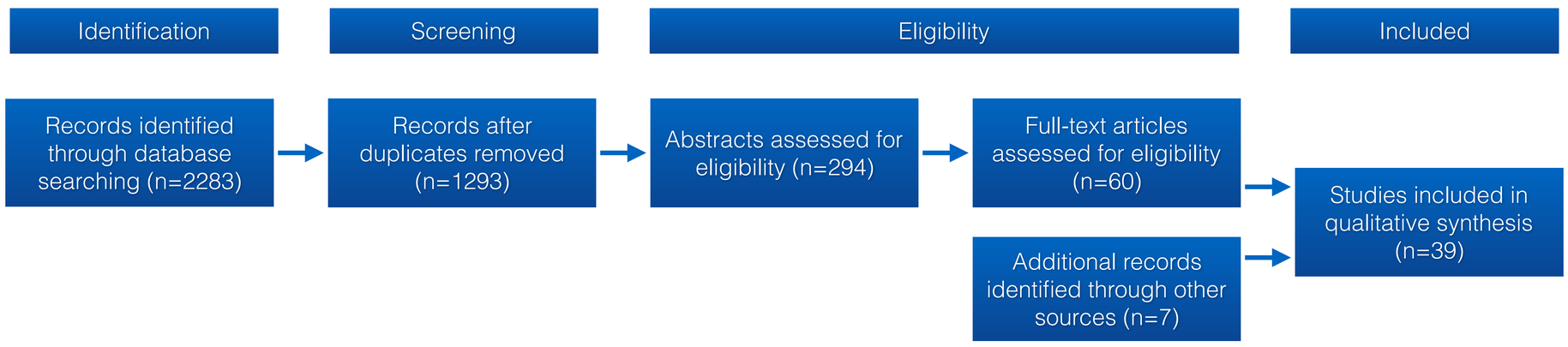
Objectives: The current hype for metal-free holistic dental reconstructions, the demand for anterior aesthetics and the still unsubstantiated argument about titanium hypersensitivity fuel the debate about the viability of ceramic dental implants. In fact, to date many zirconia implant manufacturers have already obtained European and US-American market accreditation, sometimes in the absence of any clinical pretrials. In this regard, aim of this study was to review the available evidence about the reliability and clinical performance of alumina and yttria-partially stabilized tetragonal zirconia polycrystal (Y-TZP) dental implants.

Methods: An electronic search was conducted in 8 databases (MEDLINE, Cochrane Library databases, Biosis, Embase, Web of Science) until January 2016; the screening process yielded a final sample of 39 publications; 10 clinical studies referred to alumina and 29 to zirconia dental implants. Irrespective of their study design, only clinical trials with a mean follow-up period of at least 1 year were eligible for inclusion and were further processed for data extraction. The following flow chart summarizes the selection methodology.



Results

Author (year)	Study design	Implant system	Number of patients/implants included	Mean follow-up period	Cumulative survival rate/success rate (%)	mMBL assessment
Wörle (1981)[3]	retrospective case series	Frialit Fritz, Tübingen, Sandhaus (Al_2O_3)	16/25	2.4 years	84 % / NR	NR
Strub et al. (1987)[3]	prospective comparative study	Crystalline Bone Screw, Incermed (Al_2O_3) vs. titanium implants	41/60	6 years	25% / NR	1.5mm
Koth et al. (1988)[3]	prospective cohort study	Single-crystal sapphire implant (Bioceram, Kyocera Corporation)	18/28	5 years	77.7% / NR	NR
Brose et al. (1988)[3]	prospective cohort study	Custom-made Al_2O_3 implant (two-piece)	31/31	3.2 years	23% / NR	NR
De Wijs et al. (1994)[3]	prospective cohort study	Tübingen implant, Frialit (polycrystalline Al_2O_3)	101/127	4.5 years	87 % / NR	NR
Steflik et al. (1995)[3]	prospective cohort study	Single-crystal sapphire implant (Bioceram, Kyocera Corporation)	18/28	10 years	65.4 % / NR	NR
Fartash et al. (1996)[3]	prospective cohort study	Single-crystal sapphire implant (Bioceram, Kyocera Corporation)	86/324	12 years	91.3% / NR	NR
Fartash et al. (1997)[3]	prospective cohort study	Single-crystal sapphire implant (Bioceram, Kyocera Corporation)	49/150	10 years	44.2% - 97.7% / NR	NR
Pigot et al. (1997)[3]	prospective cohort study	Crystalline Bone Screw (Incermed SA)	39/141	2-3 years	78.1 % / NR	NR
Berge et al. (2000)[3]	retrospective case series	Single-crystal sapphire implant (Bioceram, Kyocera Corporation)	30/116	8.2 years	68.7 % / NR	0.2mm
Blaschke et al. (2006)[4]	prospective case series	VOLLZIRKON, Z-Look3, Z-Systems (monotype)	34/66	NR (range: 2-5 years)	98% / NR	NR
Oliva et al. (2007)[4]	retrospective comparative study	Ceraroot, Oral Iceberg coated vs. uncoated (monotype)	36/50 vs. 50	1 year	98% vs. 98% / NR	NR
Lambrich et al. (2008)[4]	retrospective comparative study	Z-Look3, Z-Systems (monotype) vs. titanium	124/127 vs. 234	21.4 months (5-45 months)	91.3% vs. 97.22% / NR	NR
Pirker et al. (2009)[4]	prospective comparative study	prototype zirconia implants (monotype)	18/6 vs. 12	6-34 months	0% vs. 92%	NR
Borgonovo et al. 2010[4]	prospective case series	WhiteSKY, Bredent Medical (monotype)	18/46	6-24 months	89 % / NR	NR
Cannizzaro et al. (2010)[4]	randomized controlled clinical trial	Z-Look3, Z-Systems non-occlusal vs. occlusal loading (monotype)	40/20 vs. 20	1 year	87 % / NR	0.7mm vs. 0.9mm (NSS)
Oliva et al. (2010)[4]	retrospective comparative study	Ceraroot coated vs. uncoated vs. acid-etched (monotype)	378/831	5 years	92.77% vs. 93.57% vs. 97.6% / NR	NR
Borgonovo et al. (2011)[4]	prospective case series	WhiteSKY, Bredent Medical (monotype)	16/26	NR (range: 1-2 years)	96.16% / 91.6%	NR
Kohal et al. (2012)[4,6]	prospective cohort study	prototype implant, Nobel Biocare (monotype)	65/66	1 year	95.4% / 66%	1.31mm
Borgonovo et al. (2012)[4]	prospective case series	WhiteSKY, Bredent Medical (monotype)	8/29	NR (range: 1-4 years)	100% / NR	1.2mm
Gahlert et al. (2013)[4]	retrospective case series	Z-Look3, Z-Systems (monotype)	66/121	36.75 months (20-56 months)	82.4% / NR	NR
Kohal et al. (2013)[4,7]	prospective cohort study	prototype implant, Nobel Biocare (monotype)	28/56	1 year	98.2% / 60%	1.95mm
Siddiqi et al. (2013)[4] Osman et al. (2014)[4]	randomized controlled clinical trial	titanium vs. zirconia Southern Implants (monotype)	24/ 84 vs. 84	1 year	82.1% vs. 71.2%	0.18 vs. 0.42mm (SS)
Payer et al. (2013)[4]	prospective cohort study	WhiteSKY, Bredent Medical (monotype)	20/20	2 years	95% / 95%	1.29mm
Borgonovo et al. (2013)[4]	prospective case series	WhiteSKY, Bredent Medical (monotype)	6/14	4 years	100% / 100%	0.67mm
Borgonovo et al. (2013)[4]	prospective case series	WhiteSKY, Bredent Medical (monotype)	13/35	4 years	100% / 100%	1.63mm
Borgonovo et al. (2013)[4]	prospective case series	WhiteSKY, Bredent Medical (monotype)	8/12	13.5 months	100% / 100%	NR
Cionca et al. (2014)[4]	prospective cohort study	Zeramex, Dentalpoint AG (two-piece)	32/49	1 year	87 % / NR	NR
Brüll et al. (2014)[4]	retrospective case series	ZV3, Zirkonvision (monotype and two-piece)	74/121	18.4 ± 10.4 months	96.5 % / NR	0.1±0.6mm
Mellinghoff (2015)[4]	prospective case series	Z-Look3, Z-Systems (monotype)	23/51	2.5 years (0.5-4)	100 % /100%	0.63mm
Borgonovo et al. (2015)[4]	prospective case series	WhiteSKY, Bredent Medical (monotype)	13/20	4 years	100% / 100%	2.1mm
Jung et al. (2015)[4]	prospective cohort study	ceramic.implant, VITA Zahnfabrik (monotype)	60/71	1 year	98.3 % / 98.6%	0.78±0.79mm
Grassi et al. (2015)[4]	prospective cohort study	WhiteSKY, Bredent Medical (monotype)	17/32	5.1 years (4.3-6)	96.8 % / 96.9%[8]	1.23mm
Gahlert et al. (2015)[4]	prospective cohort study	PURE Ceramic Implant, Straumann (monotype)	44/44	1 year	97.6% / 97.6%	1.02±0.90mm[5]
Spies et al. (2015)[4]	prospective cohort study	ATZ Ziraldent, Metoxit (monotype)	40/53	3 years	94.2% / 96%	0.79mm
Röhling et al. (2015)[4]	retrospective case series	Z-Look3, Z-Systems (monotype)	71/161	5.94 years (2.82-7.67)	77.3% / 77.6%	0.97±0.07mm
Becker et al. (2015)[4]	prospective cohort study	ZV3, Zircon Vision (two-piece)	48/ 48	2 years	95.8 % / NR	NR
Payer et al. (2015)[4]	randomized controlled clinical trial	Ziterion (two-piece zirconia vs. titanium)	22/16 vs.15	1 year	93.3% vs. 100%	1.48mm vs. 1.43mm
Spies et al. (2016)[4]	prospective cohort study	ATZ Ziraldent, Metoxit (monotype)	27/27	1 year	88.9% / 91.7%	0.77mm

[3] aluminium oxide investigation; [4] zirconium dioxide investigation; [5] secondary outcome measurement 6 months after occlusal loading; [6] single tooth reconstruction; [7] fixed dental prosthesis reconstruction; [8] outcome at one-year follow-up
NR: not reported; SS: statistically significant; NSS: not statistically significant; mMBL: mean Marginal Bone Loss

Conclusion: Whereas alumina dental implants showed no convincing long-term results (survival rates: 23%-97.7%) and are withdrawn from the market, zirconia shows promising survival and success rates. Still, the available evidence to date is very weak to substantiate the statement that zirconia could substitute titanium. This systematic review identified 29 clinical studies on zirconia implants. Many of the available studies demonstrate high level of bias due to their study design (retrospective) or due to the small sample size. Only three randomised controlled trials investigating the reliability of zirconia implants are available (Cannizzaro et al. 2010, Osman et al. 2014, Payer et al. 2015). The reported one-year survival rates for one-piece zirconia implants from well-designed lower-biased available studies range from 87% (Cannizzaro et al. 2010) up to 97.6% (Gahlert et al. 2015). For the same implant design, the 2-year and 3-year observation period shows 95% and 94.2% survival rates respectively (Payer et al. 2013; Spies et al. 2015). For longer observation periods Grassi et al. report survival rates 96.8% in 5 years. For two-piece zirconia implants only 3 studies are available with survival rates ranging from 87% to 93.3% in one year (Cionca et al. 2014, Payer et al. 2015) and 95.8% in 2 years (Becker et al. 2015). According to the available evidence it seems that immediately loaded zirconia implants in post-extraction sites fail more often than in healed sites (Cannizzaro et al. 2010). According to the same study there is no evidence that immediate non-occlusal loading of one-piece zirconia implants decreases early implant losses. Reporting of secondary outcome measures (marginal bone remodelling/loss) and defining the primary outcomes unanimously (Roos et al.1997, Östman 2007) seems to be of great value. In their study Kohal et al. showed the significance of reporting both survival and success rates (Kohal et al. 2012). Mid-term and long-term outcomes from larger well-designed longitudinal investigations with standardized baseline situations are necessary before making any further conclusions. Apart from that, future research should address the following issues: the impact of the hydrothermal degradation of Y-TZP on long-term reliability of the reconstructions, the viability of the adhesive abutment connection of two-piece zirconia implants and the predictability of zirconia in augmented bone. A meta-analysis of the available evidence in this review was not possible due to the heterogeneity of study designs, endpoint outcomes and sample demographics.

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