Clinical success rate of two-piece zirconia dental implants

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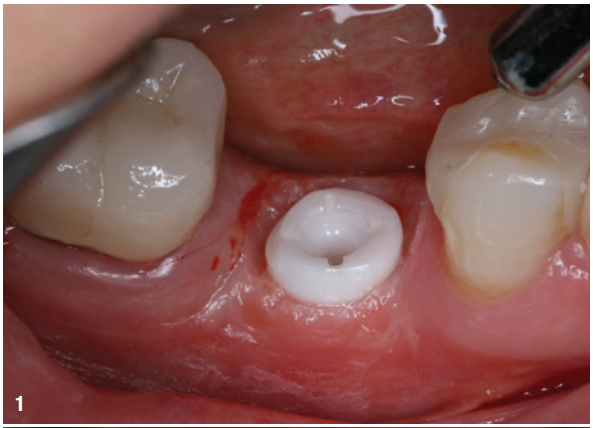
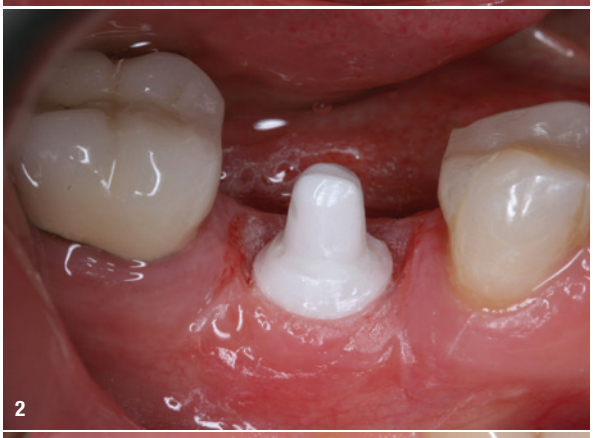
With the recent development of mechanically improved and clinically versatile zirconia implants, their clinical use over the past several years has become more widespread globally. Although zirconia implants currently represent a niche market, their popularity worldwide is growing rapidly.[1] Studies show that zirconia implants offer many advantages over metal implants, including aesthetics, greatly reduced plaque retention and incidence of peri-implantitis, lower accumulation of surface biofilm compared with titanium implants, outstanding biocompatibility, and a degree of osseointegration and soft-tissue response that is superior to that of titanium dental implants.[2–5] Owing to the white colour of zirconia implants, they do not exhibit the unsightly metallic grey shadowing under the gingival tissue as do titanium implants. This fact alone imparts a significant aesthetic advantage of zirconia over metals as a material choice for dental implants. Zirconia has a very high hardness scale, is a strong insulator, is not electrogalvanic and does not corrode. Overall, zirconia implants provide an excellent aesthetic and biocompatible alternative not only for today's health-conscious patients but for mainstream dentistry as well.

This article reports on a study involving only one of the many zirconia dental implant models offered by Z-Systems. Specifically, the clinical performance of all Z5c implants placed in our dental practice between January 2016 and July 2022 will be presented.

The Z5c is a two-piece implant system which has an implant with a flared platform intended to be at tissue level and an abutment which is cemented into an internal access hole in the middle of the platform. The proprietary Zirkolith process and SLM (Surface Laser Modified) technology used in the production of all Z-Systems' implants were introduced in 2009.[6]

All Z5 implants are made from TZP-A Bio-HIP. The hot isostatic pressing (HIP) process results in a material which has a far greater flexural strength than titanium.[7] The laser modification of the surface increases the surface area, facilitating excellent osseointegration and tissue response. The tissue-level design of the implants allows for preparation of both the abutment and the





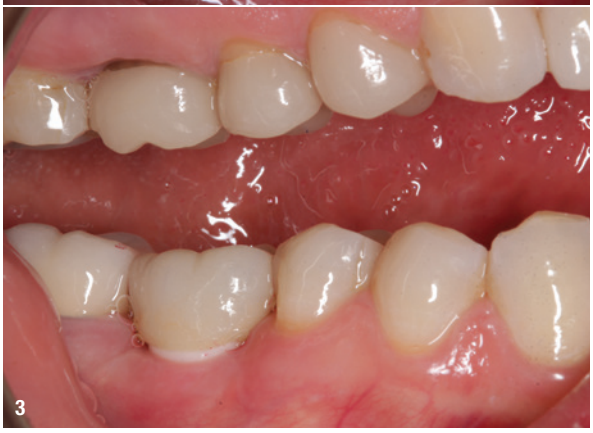


Fig. 1: Z5c implant after the four- to six-month healing period and preparation and exposure of the implant margins with the Waterlase prior to cementing the abutment. **Fig. 2:** Abutment cemented and prepared prior to scanning. **Fig. 3:** IPS e.max CAD crown milled with CEREC and cemented on the same day.

Patent

The only scientifically proven two-piece zirconia implant system

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- **No process-induced micro-cracks**
- **Ideal surface topography for hard- and soft-tissue adaptation**

*Brunello G, Rauch N, Becker K, Hakimi AR, Schwarz F, Becker J. Two-piece zirconia implants in the posterior mandible and maxilla: A cohort study with a follow-up period of 9 years. Clin Oral Implants Res. 2022 Dec;33(12):1233-1244. doi: 10.1111/clr.14005. Epub 2022 Oct 31. PMID: 36184914.

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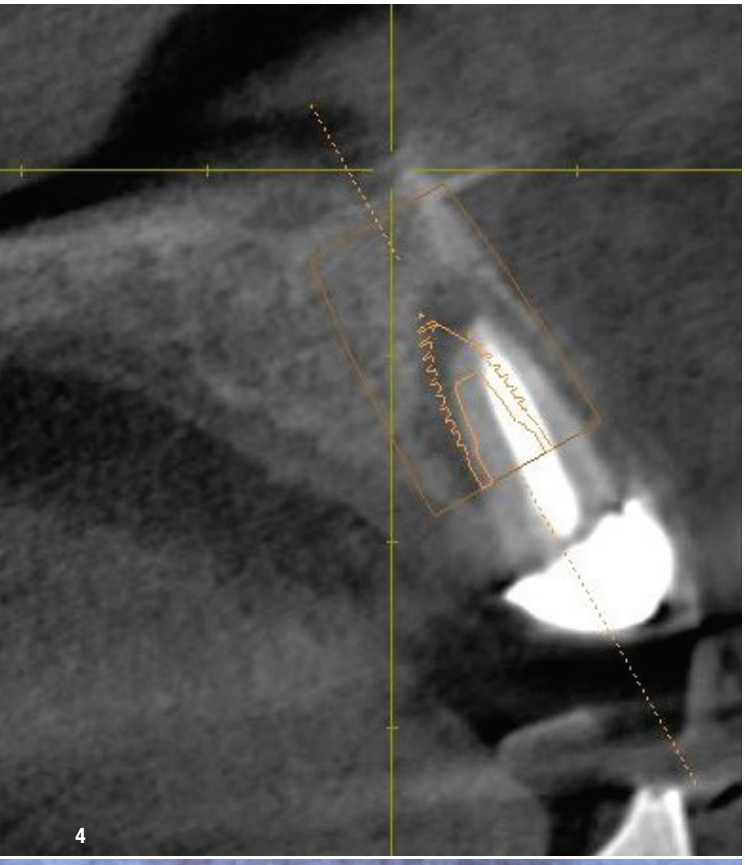

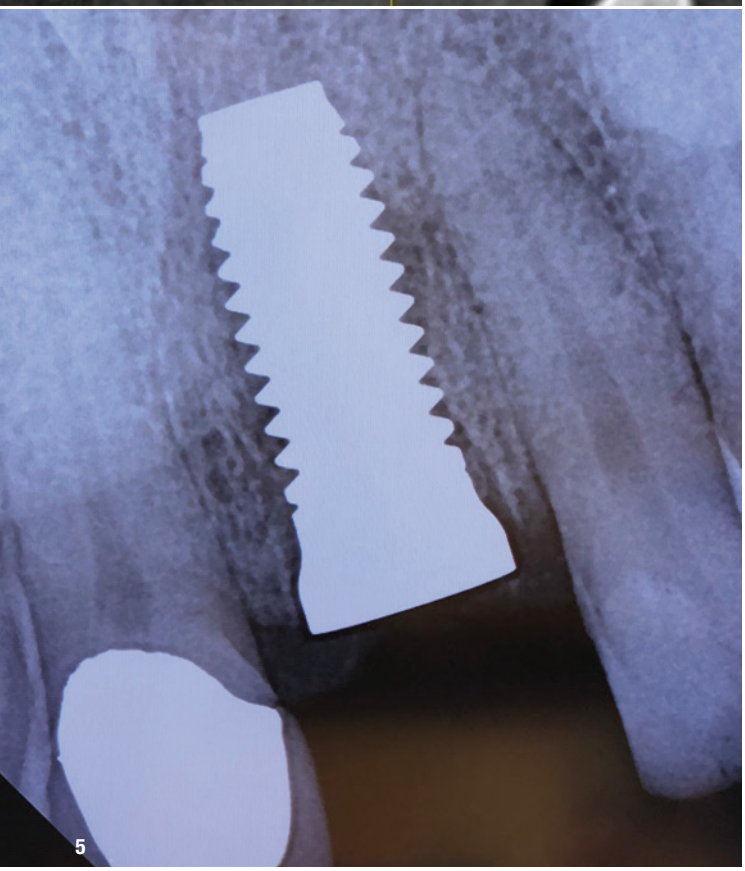

Fig. 4: Failing endodontically treated maxillary incisor planned for extraction and immediate replacement with a Z5c implant.
Fig. 5: Radiograph of the implant after immediate placement.

margins. The most desirable attribute of the tissue-level implant is that it does not interfere with the highly vulnerable biological zone between the alveolar crest and the gingival surface.

Materials and methods

Of the 110 implant cases, 74 were performed in female patients and 36 in male patients. The final cases included in the study were a cohort of 73 patients, 47 female patients and 26 male patients.

All the surgeries followed a semi-guided protocol. A CBCT scan was obtained, and a surgical guide was made using various methods. The surgical guides were intended and designed to be used for the initial osteotomy with a pilot drill to a depth short of 2 mm of the projected depth. In most cases, a flapless or conservative papilla-sparing flap design was used. A radiograph with a guide pin was taken to confirm and modify depth and angulation after the initial osteotomy. Bone threading was performed except in sites of D3 and D4 bone quality. All the implants were placed within 1 mm of the gingival level; however, most were placed either at or slightly below gingival level. Only implants of 4 and 5 mm in diameter and lengths of 8, 10 and 12 mm were used, depending on the osseous anatomy. The placement torque ranged from 25 to 35 Ncm.

All the patients were required to wear a protective Essix appliance 24/7, even while eating, for two months. The Essix appliances were made on a preoperative model with a vacuum forming unit using Essix A+ or PLUS Plastic (Dentsply Sirona) of 1 mm thickness. The implant sites were blocked out to prevent any contact during wear. The healing times ranged from three to six months.

After healing, testing for successful osseointegration was carried out with a torque test at 20 Ncm. After the internal access hole had been thoroughly decontaminated and primed, the abutments were cemented with a dual-polymerising resin cement, such as PANAVIA SA Cement Universal (Kuraray Noritake Dental) or RelyX Unicem (3M). After placement of the abutment, a Periotest reading (Medizintechnik Gulden) was obtained. Fully integrated implants exhibit a Periotest value of between –0.5 and –7.0, a higher negative number indicating stronger integration.

The abutment and implant shoulder were typically ground and shaped with a fine, red-striped diamond bur to conform to the contours of the gingiva and create adequate abutment angulation, taper and clearance. The implant margins were prepared and exposed with the Waterlase (BIOLASE) prior to cementing the abutment. The crowns were made in-house on the same day with CEREC technology from either IPS e.max CAD (Ivoclar) or Lava Ultimate materials (3M). Their occlusion was designed with less intensity than on the rest of the dentition. The crowns were cemented with the same dual-polymerising resin cement used for the abutments. The implants were typically followed up every six months during the recall appointments, and Periotest values were taken (Figs. 1–21).

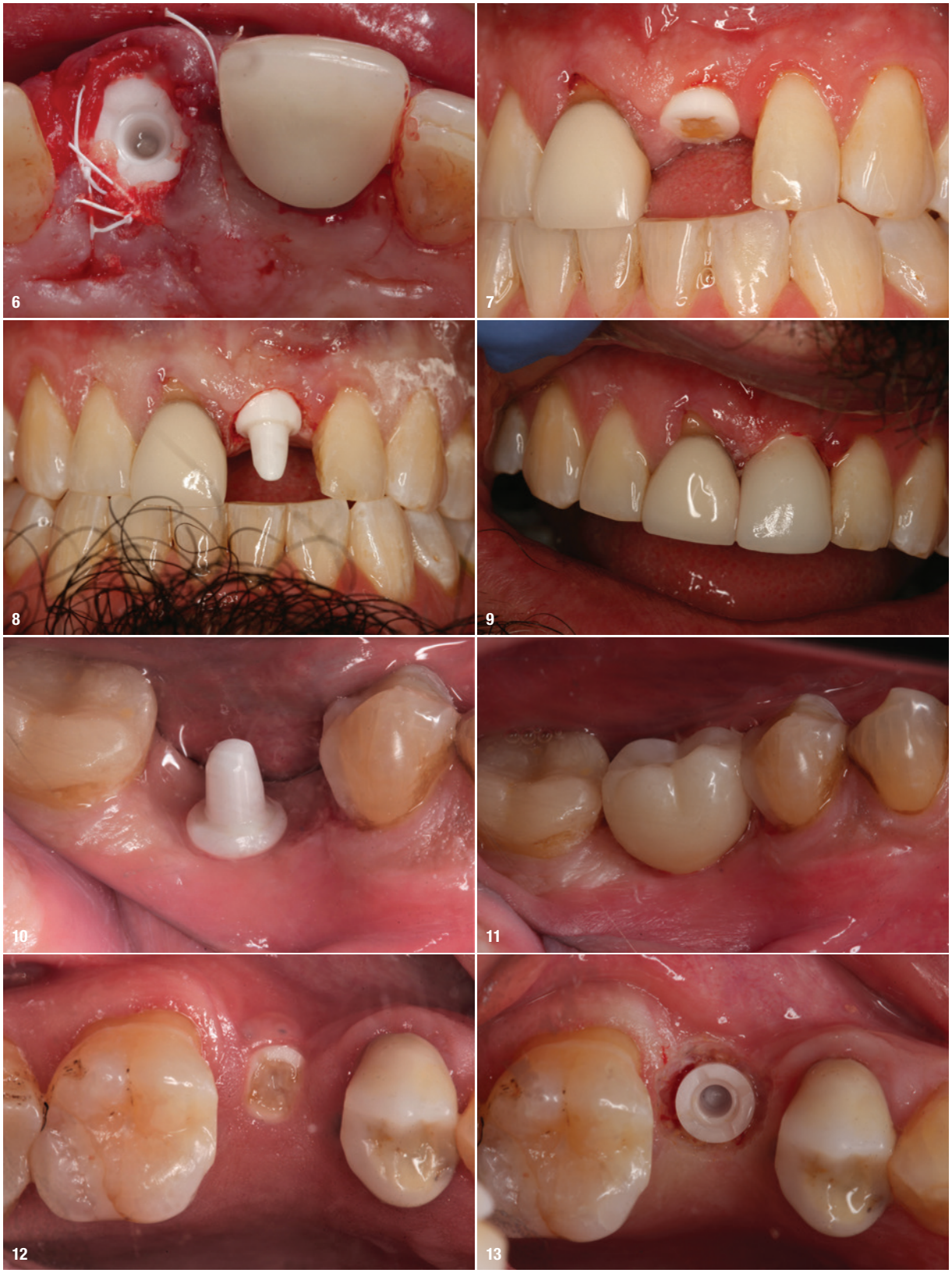

Fig. 6: Occlusal view of the implant after immediate placement. **Fig. 7:** Occlusal view of the same implant after five months of healing, ready to be restored. **Fig. 8:** Same implant after laser exposure of the margins, abutment cementation and preparation for a CEREC-milled crown. **Fig. 9:** Same implant after receiving the final crown on the same day. **Fig. 10:** Implant ready to be scanned, demonstrating excellent tissue response after ideal margin exposure and emergence profile creation performed on the same day with the Waterlase. **Fig. 11:** Same implant restored on the same day with a CEREC-milled IPS e.max CAD crown. **Fig. 12:** Implant replacing a maxillary second premolar after four months of healing, demonstrating excellent tissue healing and no foreign-body response. **Fig. 13:** Same implant after laser margin exposure and removal of the abutment access hole seal.

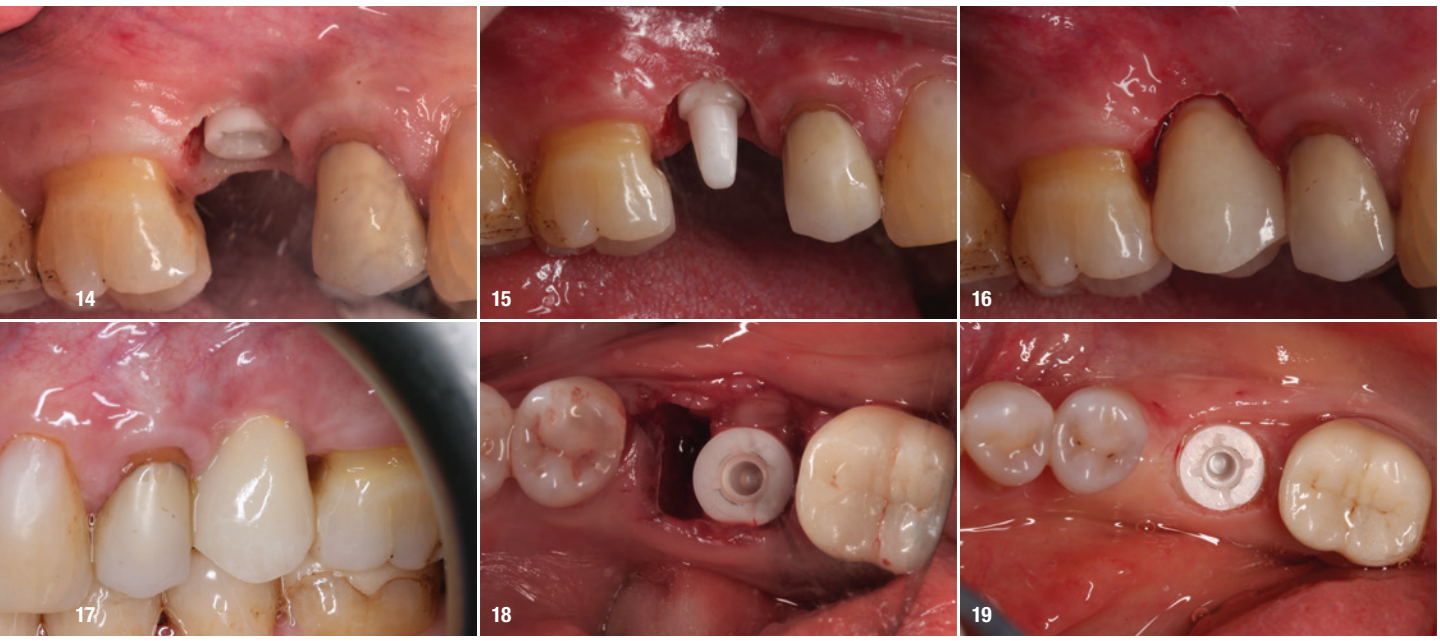

Fig. 14: Side view of the same implant. **Fig. 15:** Side view of the same implant after cementation and preparation of the abutment. **Fig. 16:** Same implant restored with a CEREC-milled IPS e.max CAD crown on the same day. **Fig. 17:** Same implant and crown at the three-month follow-up, demonstrating excellent tissue response. **Fig. 18:** Immediate implantation and simultaneous grafting after extraction of a mandibular molar. **Fig. 19:** Occlusal view of the same implant after four months of healing, demonstrating excellent tissue response.

Results and discussion

Of the 110 implant cases, 104 were successful and six failed (Table 1), yielding a success rate of 94.5% and a failure rate of 5.5%. The failure rates according to sex were not statistically significant. The average time between implantation and removal due to failure of the implants was 7.33 months. Of the six failures, three of them were delayed, occurring after initial osseointegration and final restoration of the implant. The follow-up period for the successful implants ranged from eight months to seven years, representing the time elapsed from their respective placements to the date of completion of this study.

In a retrospective analysis of the failures in this study, all of them had an underlying mitigating circumstance which increased the risk of implant failure. One case revealed elevated blood glucose and cholesterol levels along with a low vitamin D_3 level in a blood test performed in the months after implantation. One other failure case also had a low vitamin D_3 level. Two other cases had a simultaneous crestal sinus lift and insufficient primary stability when the implant was placed. One case in an older female patient failed owing to reckless chewing habits and non-compliance during the period immediately after restoration. Other causes of failure may have been insufficient primary stability (namely an insertion torque of around 20 Ncm) and epithelial migration into the implant–bone interface.

Failure was more common in patients older than the age of 40 (Table 2; Fig. 22). Owing to the low number of failures, however, the statistical significance of age and site location (Table 3) could not be determined. Additionally, there are many other risk factors which may contribute to

Months elapsed to failure*	Tooth no.	Sex (M/F)	Age (years)
2	16	M	55
6	37	F	63
6	46	F	58
8†	13	F	76
8†	46	F	43
14†	37	M	59

Table 1: Variables of failed implants.

* Average number of months elapsed between implantation and failure was 7.33.

† Failed after restoration.

Age (years)	Implant success rates
20–29	3/3 = 100%
30–39	10/10 = 100%
40–49	16/17 = 94.12%
50–59	20/23 = 86.96%
60–69	36/37 = 97.30%
70–79	17/18 = 94.44%
80–89	2/2 = 100%

Table 2: Implant success rates according to age.

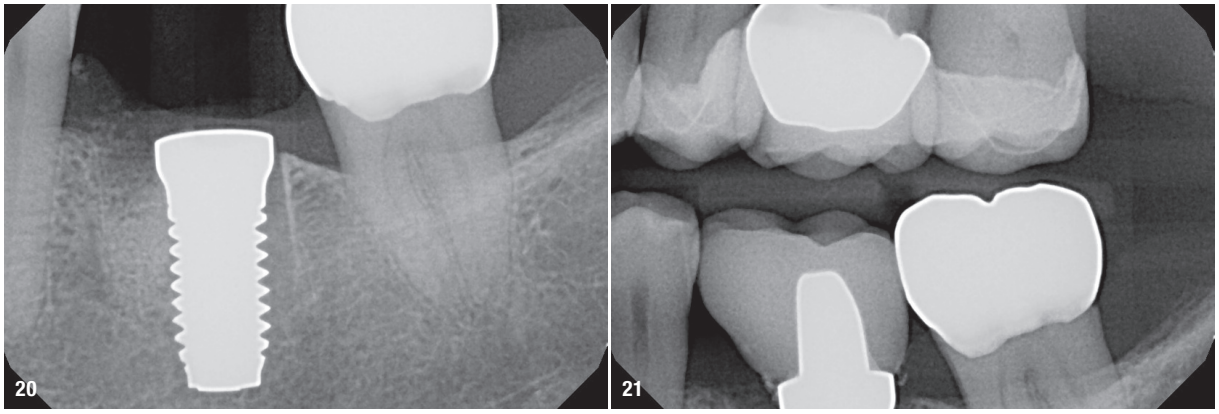

Fig. 20: Radiograph of the same implant after four months of healing. **Fig. 21:** Bitewing radiograph of the crown after cementation.

Maxilla (44 implants)		Mandible (66 implants)	
Tooth no.	No. of implants	Tooth no.	No. of implants
18	–	38	–
17	2	37	7
16	6	36	22
15	6	35	6
14	5	34	3
13	2	33	1
12	–	32	–
11	2	31	–
21	1	41	–
22	–	42	–
23	1	43	–
24	4	44	2
25	8	45	4
26	7	46	18
27	–	47	3
28	–	48	–

Table 3: Number of implants placed in the maxilla and mandible.*
* Includes failed implants.

implant failure, such as immediate implantation, bone quality, low vitamin D_3 levels, bruxism, prediabetes, smoking and patient cooperation in wearing the protective devices. It is common to expect higher success rates among younger populations. Regardless of age, however, careful case selection combined with the highly biocompatible nature of zirconia, as well as the improved health status of the current ageing population, suggest that age should represent only a small determinant of implant success. Similarly, implant failure in relation to sex and tooth specificity in our study was not statistically reliable, owing to the low number of failures reported.

Conclusion

This clinical survey, along with many others in the literature, proves that zirconia implants exhibit high success rates comparable to those of titanium implants and can serve as a viable alternative. The population demand for aesthetic and biocompatible implants is constantly rising. More studies are highlighting the allergies to titanium.[8] Dentists are encouraged to acknowledge the risk factors of all implants on one hand and the biocompatibility, science, workflow and encouraging success rates of zirconia implants on the other. Dentists are also encouraged to embrace them as an alternative to satisfy rising demand in a modern ageing population which has a higher standard of living and therefore higher expectations regarding aesthetics and biocompatibility.

about the author

Dr Joseph Sarkissian studied microbiology at the University of Alabama in the US and then attended the dental school of the University of Göttingen in Germany, graduating in 1989. Over the next eight years, he practised dentistry on the Mediterranean island of Cyprus. During that time, he trained in homeopathy, abandoned the use of amalgam and expanded his knowledge of the biological aspects of dental therapy. In 1998, he moved to Los Angeles and received his licence to practise in California in the US. He owns a state-of-the-art biological dental practice in Glendale in California. Dr Sarkissian is a member of the International Academy of Oral Medicine and Toxicology, World Clinical Laser Institute, International Academy of Biological Dentistry and Medicine, and International Association for Orthodontics.

Literature

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