The Clinical Success of Zirconia-Based Crowns: A Systematic Review

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Purpose: This review aimed to evaluate the documented clinical success of zirconia-based crowns in clinical trials. ***Materials and Methods:*** Electronic databases were searched for original studies reporting on the clinical performance of tooth- or implant-supported zirconia-based crowns, including PubMed, Cochrane Library, and Science Direct. The electronic search was complemented by manual searches of the bibliographies of all retrieved full-text articles and reviews as well as a hand search of the following journals: *International Journal of Prosthodontics, Journal of Oral Rehabilitation, International Journal of Oral & Maxillofacial Implants,* and *Clinical Oral Implants Research*. ***Results:*** The search yielded 3,216 titles. Based on pre-established criteria, 42 full-text articles were obtained. While 16 studies fulfilled the inclusion criteria, only 3 randomized controlled trials were reported. Seven studies reported on tooth-supported and 4 on implant-supported crowns, and 5 studies reported on both types of support. Ten studies on tooth-supported and 7 on implant-supported crowns provided sufficient material for statistical analysis. Life table analysis revealed cumulative 5-year survival rates of 95.9% for tooth-supported and 97.1% for implant-supported crowns. For implant-supported crowns, the most common reasons for failure were technical (veneering material fractures). For tooth-supported crowns, technical (veneering material fractures, loss of retention) and biologic (endodontic/periodontic) reasons for failure were equally common. The most common complications for implant-supported crowns were veneering material fractures and bleeding on probing. For tooth-supported crowns, the most common complications were loss of retention, endodontic treatment, veneering material fractures, and bleeding on probing. ***Conclusion:*** The results suggest that the success rate of tooth-supported and implant-supported zirconia-based crowns is adequate, similar, and comparable to that of conventional porcelain-fused-to-metal crowns. These results are, however, based on a relatively small number of studies, many that are not controlled clinical trials. Well-designed studies with large patient groups and long follow-up times are needed before general recommendations for the use of zirconia-based restorations can be provided. *Int J Prosthodont 2014;27:33–43. doi: 10.11607/ijp.3647*

All-ceramic dental restorations have been a popular alternative to conventional metal-ceramic restorations thanks to their excellent biocompatibility and good esthetics. The use of nonoxide-based ceramic restorations, such as porcelain and glass-ceramics, was limited to anterior restorations of small size due to the risk of complete fracture.[1] Yttria-stabilized tetragonal zirconia polycrystals (zirconia) ceramics, with their ability for phase transformation and crack propagation arrest, have provided new possibilities and treatment options. Laboratory tests of this material have proved its excellent mechanical properties and thus paved the way for extended applications and increased use of this material.[2]

Studies reporting on the clinical success of zirconia-based restorations have focused on fixed dental prostheses.[3] Until recently, there were only two available studies reporting on the results of zirconia crowns, although this treatment is at least as common as the fixed dental prosthesis.[4,5]

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When teeth are lost, an implant-supported restoration may be used. A few studies reported on all-ceramic restorations supported by implants.[6] The results showed that zirconia-based restorations on implants are more prone to veneering material fractures than tooth-supported restorations. However, this information is mainly based on fixed dental prostheses.

Since zirconia-based restorations are a topic of great current interest and the number of published studies has increased recently, a systematic review evaluating and comparing results is warranted. The aim of this study was to systematically search and review available studies reporting the results from clinical trials. The study focuses on zirconia-based single crown restorations. The goal was to make an inventory of the current literature to summarize the information on clinical performance and to analyze and discuss the complications to provide clinicians with helpful instruments in the decision-making process of when and where the use of zirconia-based restorations is appropriate.

Materials and Methods

Search Strategy

A search for studies reporting on the clinical performance of tooth- or implant-supported zirconia-based crowns was made in the following electronic databases: PubMed (US National Library of Medicine), The Cochrane Library (The Cochrane Collaboration), and Science Direct (Elsevier) in May 2012.

PubMed Search. Two blocks of search terms were created, with MeSH terms and free-text terms, and then combined. Block 1 included MeSH terms "crowns" and "dental restoration, permanent" and the free-text terms "crown," "crowns," "dental restoration," and "dental restorations." Block 2 included the MeSH terms "ceramics" and the supplementary concepts "zirconium oxide," "yttria stabilized tetragonal zirconia," and "yttria" and the free-text terms "ceramic," "ceramics," "zirconia," "zirconium oxide," "zirconium dioxide," "yttria," "yttrium," "yttria stabilized tetragonal zirconia," "ytzp," "y-tzp," "all-ceramic," and "all-ceramics" (Fig 1).

The following limits for the electronic search were set: articles had to be written in English and have abstracts available. A limit was also set for publication dates. The period from January 2000 until October 2012 was searched because a pilot search did not reveal any in vivo publications on zirconia for dental use before 2000.

Science Direct Search. The search terms "zirconia" [Field: Abstract, Title, Keyword] AND "crown" [All Fields] for the subject "Medicine and Dentistry" were used.

Cochrane Library Search. The search term "zirconia" [Title, Abstract or Keywords] was used.

Titles of possible relevance were screened initially, followed by a screening of abstracts. Full-text articles reporting on results from clinical trials on zirconia-based crowns were retrieved.

The electronic search was complemented by a manual search of the following journals: *International Journal of Prosthodontics, Journal of Oral Rehabilitation, International Journal of Oral & Maxillofacial Implants,* and *Clinical Oral Implants Research.* Manual searches of the bibliographies of all retrieved full-text articles and reviews that reported on the clinical performance of zirconia-based restorations were also performed.

Study Selection

Original studies reporting on the clinical performance of tooth- or implant-supported zirconia-based crowns were included. Patients had to have been examined clinically at follow-up visits. No limits were set regarding the number of patients included, presence of a control group, or length of follow-up time. For studies reporting on the same patient cohort multiple times, only the latest study with the longest follow-up was included (Table 1).

Inclusion criteria were studies involving a clinical trial (prospective or retrospective) reporting on tooth- or implant-supported zirconia-based crowns and patients who were examined clinically at follow-up.

Exclusion criteria were in vitro studies, case reports, studies on partial-coverage crowns, and follow-up data not based on clinical examination.

Failure was defined as restorations having been removed. Complication was defined as one or more events affecting function and/or esthetics. Such an event could be transient or repairable and not necessitating removal of the restoration. Survival was defined as the restoration being in situ with or without complications.

In the case of studies with incomplete information on, eg, survival, failure, and complication rates, the corresponding authors were contacted. If information was provided, the article was included. If not, the article was excluded from further analysis.

Statistical Analysis

Life table analysis was performed, and cumulative survival and complication rates were calculated.

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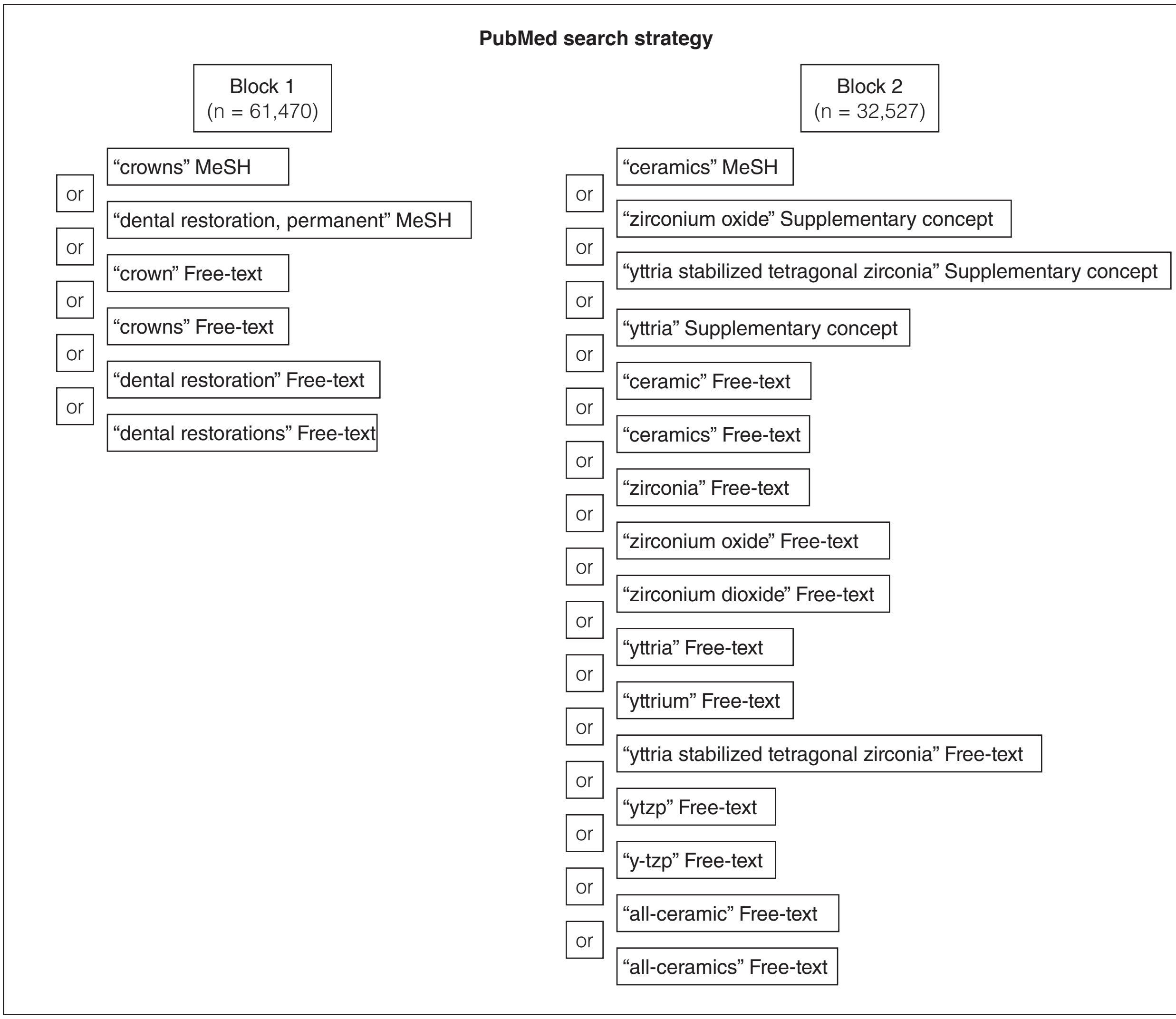

Fig 1 Search strategy for the PubMed database.

Results

The results of the search of the PubMed database are presented in Fig 2.

The search of the Cochrane Library produced one record, an additional review. The reference list was searched but did not produce records not identified in the PubMed search. The search of the Science Direct database produced 263 records. All of these were already identified in the PubMed search.

The manual search of the dental journals produced one additional article.[7] The manual searches of the bibliographies of all full-text articles and reviews produced two additional relevant reports.[8,9] The latter was replaced with a later publication on the same cohort[10] when the author was contacted to provide additional information.

In total, 16 studies were included in the present review as seen in Fig 3.[4,7,8,10–22] The majority were prospective studies performed in university settings. Three of the studies were randomized, comparing zirconia-based restorations with metal-ceramic or other all-ceramic restorations.[4,13,14] One additional study included a comparison between zirconia-based and metal-ceramic restorations, but the choice of material was not randomized.[17]

Seven studies reported on tooth-supported[4,11,12,16–18,22] and four on implant-supported crowns,[10,13,14,19] and five studies reported on both types of support.[7,8,15,20,21] Observation times ranged from 1 month to 7 years. Nine studies reported on a combination of anterior and posterior restorations, one study reported solely on anterior restorations, and four studies reported solely on posterior restorations.

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Table 1 Characteristics of the Included Studies

Author	TS/IS	Core material	Veneer material	Cement	No. of SCs	Placement (%)
Beuer et al (2010)[11]	TS	IPS e.max ZirCAD	Glass-ceramic IPS e.max Ceram	GIC Ketac Cem	50	30 ant 70 post
Cehreli et al (2009)[4]	TS	Cercon	NR	RMGIC RelyX	15	100 post
Groten and Hutting (2010)[12]	TS	Cercon	Porcelain Cercon Ceram Kiss	Resin cem (n = 63) RelyX Unicem or "conventional cement" (n = 8)	71	46 ant 54 post
Hosseini et al (2011)[13]	IS	KaVo zirconia (ZS) (n = 27) Procera zirconia (n = 11)	Glass-ceramic HeraCeram Zirkonia (n = 34) IPS e.max Ceram (n = 4)	ZincPh DeTrey Zinc n=35 Resin cem Panavia (n = 3)	38	100 post
Hosseini et al (2012)[14]	IS	Procera zirconia (n = 61)	Glass-ceramic IPS Empress 2 (n = 59) IPS e.max Ceram (n = 5)	Resin cem Panavia	61	81 ant 19 post
Keough et al (2011)[15]	TS	Zircore	Porcelain Cerabien ZR	RMGIC GC Fuji PLUS	3,192* (3,989 including FDPs)	38 ant* 62 post*
	IS	Zircore		RMGIC GC Fuji PLUS or Temporary cements Tempbond, Durelon		
Kollar et al (2008)[8]	TS	Procera Zirconia	Porcelain Cerabien, Nobel Rondo	Resin cem Panavia, Variolink	31	NR
	IS	Procera Zirconia	Glass-ceramic IPS e.max Ceram	GIC Ketac Cem 13 IS screw-retained	40	
Nothdurft et al (2010)[10]	IS	Cercon	Porcelain Cercon Ceram Kiss	RMGIC GC Fuji CEM	40	100 post
Poggio et al (2012)[16]	TS	WEGO Zirconia Diazir IPS e.max ZirCAD 3M Lava Procera Zirconia Wieland Zirconia	Porcelain NR	GIC NR ZincPh NR Resin cem NR	102	50 ant 50 post
Rinke et al (2011)[17]	TS	Cercon	Porcelain Cercon Ceram Kiss	RMGIC Dyract Cem Plus	50	100 post
Sagirkaya et al (2012)[7]	TS	Cercon (n = 5) ZirkonZahn (n = 33) 3M Lava (n = 23) Katana Zirconia (n = 13)	NR	Resin cem Panavia	74	NR
	IS	Cercon (n = 1) ZirkonZahn (n = 12) 3M Lava (n = 3) Katana (n = 17)	NR	Resin cem Panavia	33	NR
Schmitt et al (2010)[18]	TS	3M Lava	Porcelain Lava Ceram	GIC Ketac Cem	19	100 ant
Schwarz et al (2012)[19]	IS	Cercon	Porcelain Cercon Ceram Kiss	Permanent (45%) ZincPh Harvard GIC Ketac Cem Resin cem RelyX Unicem Temporary (55%) Dycal Tempbond	53	19 ant 81 post
Silva et al (2011)[20]	TS IS	3M Lava	Porcelain Lava Ceram Overlay	Resin cem RelyX Unicem	NR	NR
Tartaglia et al (2011)[21]	TS	Zirite	Porcelain Noritake CZR	GIC Ketac Cem	202	21 ant 79 post
	IS				36	14 ant 86 post
Örtorp et al (2012)[22]	TS	Procera zirconia	Porcelain Vita Lumin	Resin cem RelyX Unicem (n = 200) ZincPh Phosacem (n = 16)	216	22 ant 78 post

Ant = anterior; post = posterior; BOP = bleeding on probing; GIC = glass-ionomer cement; IS = implant-supported; TS = tooth-supported; NR = not reported; PPD = pocket probing depth; RMGIC = resin-modified glass-ionomer cement; ZincPh = zinc phosphate cement; endo = endodontic; SC = single crown; infl = inflammation.
*Results not separated between respective groups.

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		Failures		Complications	
Mean observation time	Survival (%)	Technical	Biologic	Technical	Biologic
3 y 35 mo ± 14	100	0	0	0	0
2 y	93.3	1 fractured crown	0	3 slight marginal discrepancies 6 color mismatches	0
2 y (mean: 21 mo) (range: 1–68 mo)	98.0	2 veneer fractures	1 pulpitis	2 chippings 1 crack	0
1 y (median: 13.5 mo) (range: 11–20 mo)	100	0	0	0	1 marginal fistula 3 suppuration on probing 2 PPD depths > 5 mm
3 y (median: 37.1 mo)	97.0	1 veneer fracture 1 marginal adapt	0	1 chipping 3 cement excess	1 marginal bone loss > 2 mm 7 buccal fistulae (4 apical, 3 marginal)
1–74 mo	99.9*	9* 3 core fractures 9 veneer fractures	NR	NR chippings mentioned but no frequency reported	NR
2 y 12–30 mo	NR	0	2 teeth lost due to root fracture	0	1 marginal recess BOP: 22% (n = 7)
	100	0	0	5 chippings	3 marginal recess BOP: 30% (n = 12)
1 y	100	0	0	10% 4 chippings	1 inlf
2 y 20.9 mo (SD: 13.6) (range: 10–72)	99	0	1 endo (extraction)	2 chippings	0
2 y (mean: 18.2 ± 4.6 mo)	100	0	0	1 chipping	0
4 y 46.3 ± 0.7 mo	95.6	3 2 core fractures (same tooth) 1 veneer fracture	2 1 endo (new crown) 1 endo (extraction)	0	1 1 endo
4 y 46.3 ± 0.7 mo	100	0	0	0	0
3 y 39.2 mo	100	0	0	1 chipping	0
6 y (mean: 2.1 mo) (SD: 1.4 mo)	86.8	6 veneer fractures	1 peri-implantitis	7 chippings 4 loss of retention (recemented)	0
7 y	97.2*	16* veneer fractures	0	35* chippings	0
3 y	98.2*	0	0	3 loss of retention	0
		0	0	0	0
5 y	88.3	10 4 veneer fractures 6 loss of retention	9 1 caries 1 pain 7 endo/perio	11 2 chippings 9 loss of retention	18 9 endo treatment 9 other

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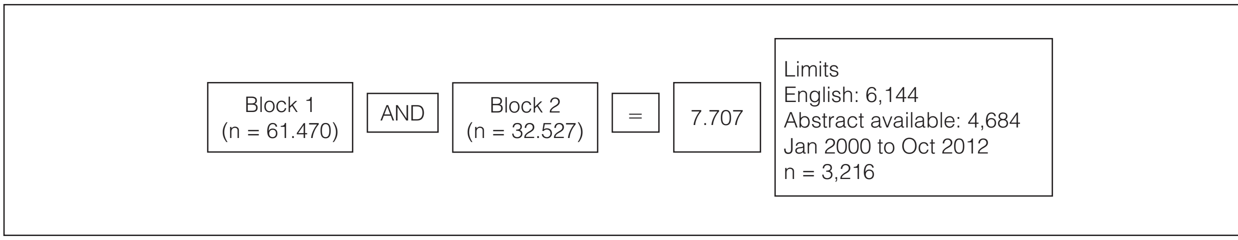

Fig 2 Results of the search of the PubMed database.

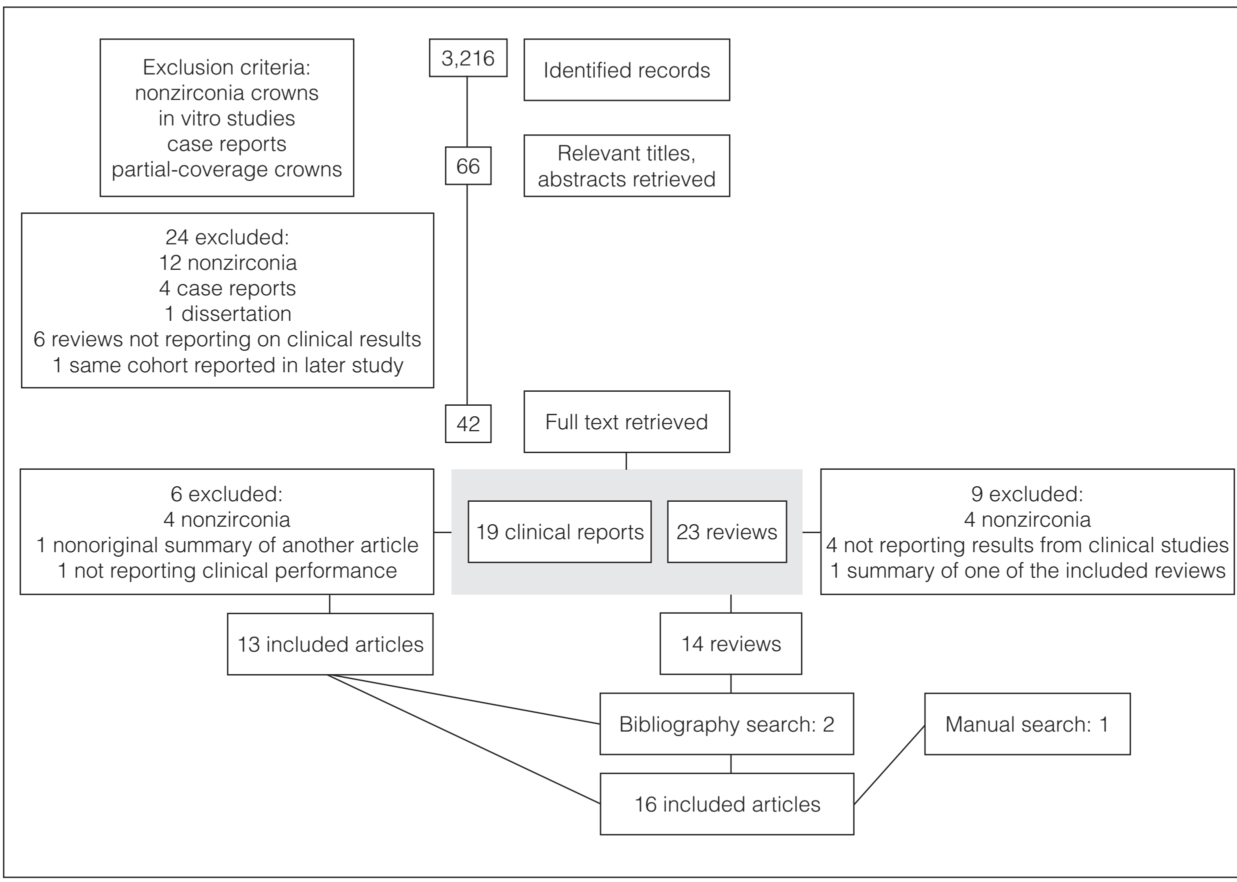

Fig 3 Study selection.

Two studies did not specify whether the restorations were placed in anterior or posterior positions. In total, most crowns were placed in a posterior position.

Two studies[15,20] did not separate the results between the different groups (tooth- or implant-supported restorations). These studies were excluded from further analysis. Sufficient data for calculation of cumulative survival rates were available in 10 studies reporting on tooth-supported restorations[4,7,8,11,12,16–18,21,22] and 7 studies reporting on implant-supported restorations.[7,8,10,13,14,19,21] Analysis was based on 830 tooth-supported and 301 implant-supported crowns. Sufficient data for calculation of cumulative complication rates were available in 7 studies reporting on tooth-supported restorations[7,11,12,16,17,18,21] and 4 studies reporting on implant-supported restorations.[7,10,13,21] Analysis was based on 568 tooth-supported and 147 implant-supported crowns.

The cumulative 5-year survival rate of tooth-supported zirconia-based crowns was 95.9% (Fig 4a). The cumulative 5-year survival rate of implant-supported zirconia-based crowns was 97.1% (Fig 4b). For implant-supported crowns, the most common reasons for failure were technical, ie, veneering material fracture (78%). For tooth-supported crowns, there were no differences between the

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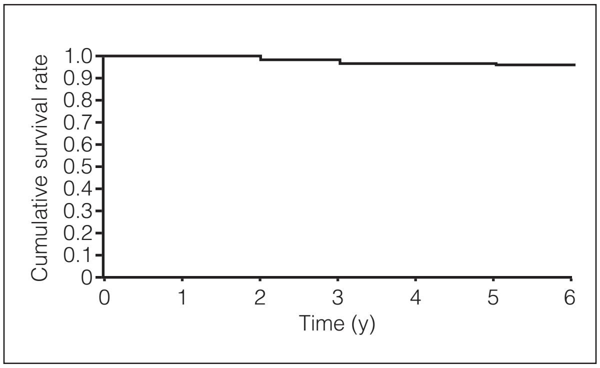

Fig 4a Five-year cumulative survival rates of tooth-supported single crowns.

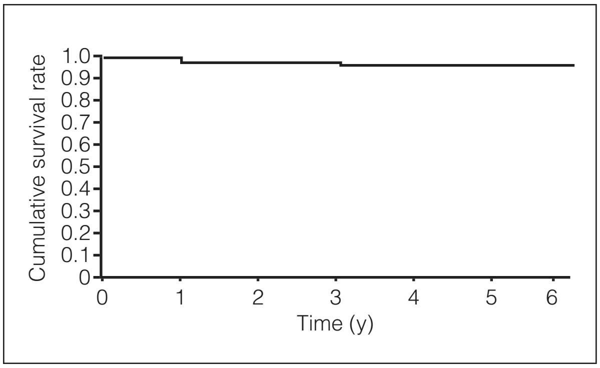

Fig 4b Five-year cumulative survival rates of implant-supported single crowns.

number of technical and biologic failures. The most common reasons for failure were endodontic/periodontic related (35%), veneering material fractures (23%), and loss of retention (19%) (Table 2).

The cumulative 5-year complication rate of tooth-supported zirconia-based crowns was 5.6% (Fig 5a). The cumulative 3-year complication rate of implant-supported zirconia-based crowns was 7.5% (Fig 5b). For tooth-supported crowns, the most common complications were loss of retention (21%), endodontic treatment (18%), veneering material fractures (14%), and bleeding on probing (12%). For implant-supported crowns, the most common complications were veneering material fractures (31%) and bleeding on probing (22%) (Table 3).

Table 2 Reasons for Failure of Zirconia Crowns

	n
Technical failures	
Tooth-supported restorations	
Complete fracture	3
Veneer fracture	7
Loss of retention	6
Total	16
Implant-supported restorations	
Veneer fracture	7
Marginal adaptation	1
Total	8
Overall total	24
Biologic failures	
Tooth-supported restorations	
Root fracture	2
Caries	1
Endodontic complications (extraction)	4
Endodontic and/or periodontic treatment	7
Pain (new crown)	1
Total	15
Implant-supported restorations	
Peri-implantitis	1
Total	1
Overall total	16

Discussion

The porcelain-fused-to-metal crown has been regarded as the gold standard crown restoration for a long time, given its well-documented clinical performance based on numerous reports. In the present review, zirconia-based crowns show equal 5-year survival rates exceeding 95%. Crowns of previous all-ceramic materials, eg, glass-ceramics, have also been reported to perform similarly well but only in anterior locations.[2]

Three of the studies in the present review compared metal-ceramic and zirconia-based crowns.[13,14,17] Hosseini et al regarded the two materials as comparable, with no significant differences in survival rates. Metal-ceramic crowns were at higher risk of technical complications and loss of retention, whereas zirconia-based crowns showed less optimal marginal adaptation but improved color match. The latter two differences were statistically different but did not affect overall survival. Rinke et al found no significant differences between the two materials.

Even though survival rates for metal-ceramic and zirconia-based crowns appear to be similar, the reported increased risk of veneering material fractures for zirconia-based restorations has been a cause for concern. To avoid exposing zirconia frameworks to unfavorably high temperatures during veneer firing, creating undesirable phase transformation, veneering materials of low firing temperature are often used. Lowering the firing temperature also affects the mechanical properties, increasing the risk for veneer fractures.[23] Early reports on zirconia-based restorations reported a high incidence of veneering material fractures.[2] More recent publications, however,

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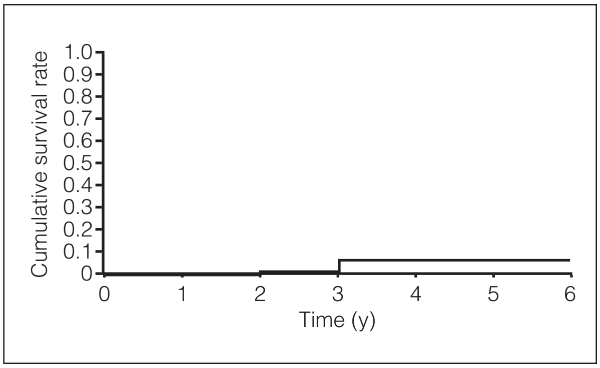

Fig 5a Five-year cumulative complication rates of tooth-supported single crowns.

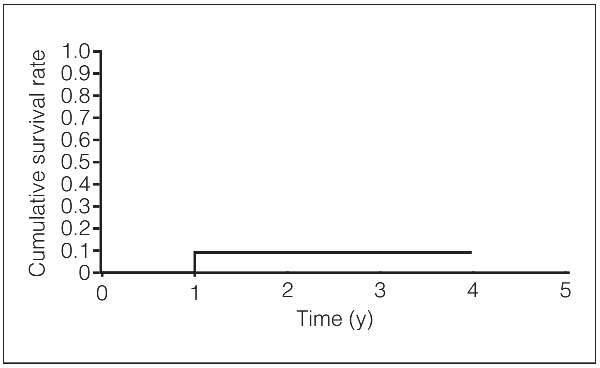

Fig 5b Three-year cumulative complication rates of implant-supported single crowns.

Table 3 Types of Complications of Zirconia Crowns

	n
Technical complications	
Tooth-supported restorations	
Veneer fracture	8
Veneer crack	1
Loss of retention	12
Marginal discrepancy	3
Color mismatch	6
Total	30
Implant-supported restorations	
Veneer fracture	17
Loss of retention	4
Excess cement	3
Total	24
Overall total	54
Biologic complications	
Tooth-supported restorations	
Endodontic treatment	10
Bleeding on probing	7
Marginal recession	1
Other	9
Total	27
Implant-supported restorations	
Mucosal inflammation	1
Marginal recession	3
Bleeding on probing	12
Suppuration on probing	3
Pocket probing depth > 5 mm	2
Marginal bone loss > 2 mm	1
Marginal fistula	4
Apical fistula	4
Total	30
Overall total	57

where metal-ceramic crowns are compared with zirconia-based crowns in randomized settings, have not found differences between the two materials for single crown restorations.[13,14] These reports are based on a limited number of patients and follow-up, but the results are promising and similar results have been noted in randomized studies on fixed dental prostheses.[24]

No difference in survival between tooth- and implant-supported crowns was found. This is in contrast to other publications where implant-supported restorations were found to be at higher risk of having technical complications, mostly veneering material fractures.[25,26]

The natural tooth's resilient periodontal ligament attachment permits some movement, whereas osseointegrated dental implants do not, thereby precluding any movement. Moreover, a rigid abutment often provides improved support that permits sustained higher loads as shown in in vitro studies.[27,28] However, in in vivo situations, the veneering material becomes the weak link since it is subjected to loads that exceed its strength, resulting in fractures of the veneering material.

For zirconia-based fixed dental prostheses, there has been a significant difference in success rates depending on whether the restoration is tooth- or implant-supported, with implant-supported restorations showing significantly higher frequencies of veneering material fractures.[3,6] This was not confirmed in the present review. Possible reasons for the excellent results are probably due to the fact that a single-tooth restoration is far less complex in terms of design, loads sustained, and strains developed in the restoration compared with fixed dental prostheses. Many of the studies included in the present review are also quite recent, and another explanation could therefore lie in the improved knowledge of different factors of possible influence on veneering materials as well as of how to handle and produce zirconia-based restorations,[2] suggesting that we have passed a certain "learning curve."

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Still, the most common reason for failure and complications for implant-supported crowns was fractures of the veneering material, whereas both technical and biologic factors caused failure for tooth-supported restorations. This is probably explained by the differences between tooth- and implant-supported restorations discussed above. Despite the number of failures and complications, the survival rate for implant-supported restorations is excellent, and the importance of the veneering material fractures should not be overemphasized.

As the survival rates were high with few failures, relatively few complications occurred and the studies differ in design, etc, comparisons are difficult. Many different brands of zirconia are represented in each study. Some authors have suggested that crowns made of a fully sintered zirconia material, which may have improved mechanical properties, will outperform crowns machined from presintered zirconia and that this could be important in avoiding complete fractures.[29] However, the technique of producing restorations from presintered zirconia now dominates the market as it is less time consuming and more cost-effective with less wear of instruments. As very few complete fractures occurred (only three occasions reported in two publications[4,7]), the risk of this type of failure is minimal and the choice of type of zirconia substructure is therefore probably of minimal or no clinical importance.

Loss of retention was a common reason for failure and complications with tooth-supported restorations. Loss of retention may be due to improper preparation of the supporting abutment and/or cementation technique. When an improper preparation is the cause of loss of retention, a new crown has to be made. In contrast, when failure occurs because of the choice of cement or cementation technique, the crown may be recemented. There was no information on the possible causes of loss of retention in the individual studies, and several different cements were used, so no conclusions could be drawn.

Bleeding on probing was another common complication for crowns. The reasons for mucosal/periodontal complications are biologic, oral health related, and patient dependent rather than material specific. These complications should therefore not reflect negatively on zirconia as a restorative material per se. In fact, ceramic materials have been found to accumulate less plaque and plaque with reduced vitality compared with other restorative materials.[30,31]

Endodontic reasons were reported for causing both failure and complications for the tooth-supported crowns. Crown preparation always involves a risk, causing trauma to the vital tooth, and the risk is increased the more extensive the preparation.[32] When zirconia was introduced, many manufacturers recommended that the thickness of the framework be designed with a reasonable safety margin (larger than what is required for metal frameworks) to avoid fracture. Today, there are studies suggesting that zirconia frameworks may be made equally as thin as metal frameworks.[33,34] The need for more extensive preparation for zirconia-based restorations, and thereby the risk of endodontic complications, may therefore be reduced.

One group[13,14] reported zirconia-based crowns to have less optimal marginal adaptation compared with metal-ceramic crowns. This could possibly affect the risk of marginal discoloration, plaque accumulation, and caries. As mentioned above, most zirconia-based restorations are produced from blocks of presintered zirconia that are fully sintered after machining. This final sintering involves a shrinkage that must be compensated for and has raised concerns as to whether this affects marginal fit. One early study[35] reported less than optimal marginal adaptation and a high risk of caries for zirconia-based fixed partial dentures made of a specific type of presintered zirconia, but this study was initiated when the technology was in the prototype stage. Production methods have since improved. A recent review[36] concluded that although postsintered milling provided superior accuracy compared with presintered, the differences were minor. Marginal fit was clinically acceptable for both systems.

The literature search for the present review was systematically performed, following suggested guidelines concerning the definition of the research question, the search plan, the retrieval of publications, and data extraction.[37] However, the inclusion and exclusion criteria were not as strict as some authors suggest, using, eg, highly specific requirements for PICO (population, intervention, control and outcome) criteria and/or systems for evaluation of quality of evidence.[38] No limits concerning the minimum number of included patients, presence of a control group, randomization, or minimum follow-up were set. This was done since there are still comparatively few studies on zirconia-based crowns, some with few patients enrolled and most with short follow-up periods. Life table analysis of cumulative survival rates, based on heterogenous studies with different sized populations and follow-up times, only provides estimates of survival. This affects the quality of the conclusions that can be made and limits them to preliminary short term indications.

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Conclusion

Current and scientifically relevant literature on the success rates of zirconia-based single crowns is limited and characterized by a serious lack of well-designed controlled clinical trials. Nonetheless, the results from this review suggest that the survival rates of tooth-supported and implant-supported zirconia-based crowns are comparable with the survival rate of porcelain-fused-to-metal crowns. It must be emphasized that these results are based on relatively few and uncontrolled clinical trials; hence, they should be interpreted with caution. Well-designed studies with large patient groups and long follow-up protocols are needed before general recommendations for the use of zirconia-based restorations can be ascertained.

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Literature Abstract

A retrospective comparative ten-year study of cumulative survival rates of remaining teeth in large edentulism treated with implant-supported fixed partial dentures or removable partial dentures

This study had two aims: *(1)* to compare survival rates for natural teeth in patients with either implant-supported fixed partial dentures (IFDs) or removable partial dentures (RPDs), and *(2)* to determine risk factors for this tooth loss. Patients were required to have at least one natural tooth and an edentulous span of four teeth or more in the same arch. Twenty-one patients with IFDs and 82 patients with RPDs were selected and data over a 10-year period were collected. How patients were originally assigned to each group was not determined. Survival analysis was performed for both groups for the following categories: whole remaining teeth (presumed to be all teeth surviving), teeth adjacent to the restored space, and teeth opposing the restored space. Reasons for tooth loss were classified as root fracture, caries, periodontal lesion, and periapical lesion. The results indicated a greater cumulative survival rate of whole remaining teeth (40.0%, IFD group vs 24.4%, RPD group). However, there was no significant difference between the two groups for teeth adjacent to or opposing the IFD or RPD restoration. It was observed that the most common cause of tooth loss in the RPD group was periodontal lesions. The authors suggested that treatment with IFD has a protective effect on the remaining teeth in patients with large edentulous cases although recognizing a large age difference at time of treatment between the groups. The absence of patient selection criteria for the type of prosthodontic treatment and the lack of baseline periodontal measurements were also recognized weaknesses. Multiple regression analysis for risk factors for remaining tooth loss, identified RPD wearing, and being male were significant. This was attributed to higher occlusal forces in the men.

Yamazaki S, Arakawa H, Maekawa K, Hara E S, Noda K, Minakuchi H, Sonoyama W, Matsuka Y, Kuboki T. *J Prosthodont Res* 2013;57:156–161. **References:** 19. **Reprints:** T. Kuboki, Department of Oral Rehabilitation and Regenerative Medicine, Okayama University Graduate School of Medicine, Dentistry and Pharmaceutical Sciences, 2-5-1 Shikata-cho, Okayama 700-8525, Japan. **Email:** kuboki@md.okayama-u.ac.jp
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