THE JOURNAL OF PROSTHETIC DENTISTRY

SYSTEMATIC REVIEW

Survival and complications of monolithic ceramic for tooth-supported fixed dental prostheses: A systematic review and meta-analysis

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ABSTRACT

Statement of problem. Although recent studies have reported the success of implant-supported monolithic restorations, consensus on the use of monolithic ceramic restorations is lacking.

Purpose. The purpose of this systematic review and meta-analysis was to evaluate the survival and biological and technical complication rates of monolithic single crowns and fixed partial dentures (FPDs).

Material and methods. An electronic search was conducted by 2 independent authors on the PubMed/MEDLINE, Scopus, and Cochrane Library databases. The Newcastle-Ottawa scale and Cochrane risk of bias tool were used to assess the quality and risk of bias of the included studies. Meta-analysis was performed by using the R software program.

Results. The search identified 763 articles, 18 of which met the eligibility criteria. A total of 15 studies evaluated monolithic ceramic single crowns, and 4 studies evaluated FPDs. The studies included 1061 monolithic single crowns (524 lithium disilicate, 461 zirconia, and 76 polymer-infiltrated ceramic network [PICN]) and 104 FPDs (36 lithium disilicate and 68 zirconia). Meta-analysis of single-arm studies indicated the proportion of survival, biological, and technical complication rates of 1% (95% confidence interval [CI]: 0% to 3%), 1% (CI: 0% to 4%), and 2% (CI: 1% to 4%), respectively, for single crowns, independent of ceramic material, and 3% (CI: 0% to 34%), 5% (CI: 1% to 21%), and 5% (CI: 1% to 21%) for FPDs, respectively. Only 5 studies performed a direct comparison between monolithic and veneered ceramic restorations, and no significant difference was observed in terms of survival (risk ratio [RR]: 0.68; CI: 0.25-1.91; P=.96), biological (RR: 0.69; CI: 0.31-1.53; P=.35), and technical complication rates (RR: 0.87; CI: 0.40-1.88; P=.29).

Conclusions. The use of monolithic ceramic can be considered a favorable treatment for tooth-supported single crowns and FPDs, with high survival and low complication rates. However, further randomized controlled trials are needed to reassess these clinical performances, mainly by comparing them with the performance of veneered restorations. (J Prosthet Dent 2021;■:■-■)

Ceramic restorations have been widely used as an esthetic alternative to metal-ceramic restorations.[1-22] Different parameters should be considered for the selection of ceramic materials, including esthetic, mechanical, and physical properties; etchable materials for adhesive restorations; type and location of the restoration; tooth preparation margins; and parafunctional habits.[23-25]

Yttria-stabilized tetragonal zirconia polycrystalline (Y-TZP) restorations have been made with a zirconia core with a veneering ceramic or as monolithic restorations,[1,3,22-29] but chipping of the ceramic veneer is a common complication.[2,8,30-40] Therefore, monolithic zirconia or lithium disilicate restorations have become popular to avoid these complications.[2,24,30,31,41] Monolithic lithium disilicate restorations can be obtained by waxing and heat pressing or through computer-aided design and computer-assisted manufacturing (CAD-CAM) technology.[5,8,20,27,39] CAD-CAM monolithic restorations can also be made from polymer-infiltrated ceramic

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.
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Clinical Implications

Although the evidence is limited because of the low number of randomized controlled trials, monolithic ceramic is suitable for single crowns, independent of ceramic material, and for FPDs. However, monolithic FPDs present slightly greater failure risks than single crowns.

network (PICN) and resin nanoceramics.[23] However, the survival and complication rates of these different monolithic restorations remain unclear.

Therefore, this study aimed to systematically evaluate clinical studies investigating the survival rate and biological and technical complications of monolithic restorations. The research hypotheses were that monolithic restorations would present high survival rates with low biological and technical complications and that the survival and complication rates of monolithic and veneered restorations would be similar.

MATERIAL AND METHODS

This study followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines[42] and was registered in the International Prospective Register of Systematic Reviews (PROSPERO) under the number CRD42018095713.

The eligibility criteria included human clinical trials with at least 10 participants and with 12 months of follow-up. The included studies evaluated the survival and complication rates of monolithic restorations, investigated only tooth-supported fixed dental prostheses with single crowns or fixed partial dentures (FPDs), and were published in the English language. Retrospective studies, review articles, case reports, in vitro studies, and studies that evaluated implant-supported crown or partial-coverage restorations were excluded.

An electronic search was conducted by 2 authors (L.C.M., C.A.A.L.) independently on the PubMed/MEDLINE, Scopus, and Cochrane Library databases for articles published until September 2020. The keywords used were (dental prosthes* [MeSH Terms] OR crown [MeSH Terms] OR fixed dental prosthes*) AND (monolithic). The same authors performed a hand search in the *Journal of Dentistry*, *Journal of Prosthodontics*, *Journal of Prosthodontics Research*, *Journal of Dental Research*, *Journal of Advanced Prosthodontics*, and *Journal of Prosthetic Dentistry*. In addition, OpenGrey (http://www.opengrey.eu) was used to search the non−peer-reviewed literature using the same search terms. If there was any doubt related to any information, the authors were contacted. Any disagreement was resolved with a third author (E.P.P.) until a consensus was reached. The kappa statistic (κ) was used to verify the interinvestigator agreement in the selection of the studies.[43]

The participants, interventions, comparisons, outcomes, and study design (PICOS) question used was, "Do monolithic ceramics have favorable survival and complications rates for tooth-supported fixed dental prostheses?" Participants were those rehabilitated with ceramic tooth-supported single crowns or FPDs; the intervention was a monolithic ceramic restoration; the prognosis was the primary purpose of this systematic review[44]; however, some included studies performed direct evaluation with veneered restorations, and a comparison could be made. The primary outcome evaluated was the survival rates, while biological and technical complication rates were considered secondary outcomes. The review considered only randomized controlled trials (RCTs) and prospective studies.

One author (L.C.M.) tabulated all the essential information from the articles, and a second author (A.A.P.) reviewed and checked all the collected information. Any disagreement was resolved with a third author (E.P.P.) until a consensus was reached. The quality assessment of studies was assessed by 2 authors (L.C.M., C.A.A.L.) by using the Newcastle-Ottawa scale (NOS),[45] while the Cochrane collaboration tools were used to evaluate the risk of bias in the RCT.[46]

A meta-analysis was performed by using a software program (R version 4.0.2; The R Foundation for Statistical Computing [http://www.r-projetct.org/]). The package "meta" was used to perform the statistical calculations and to generate forest plots. A single-arm meta-analysis of proportion was performed to evaluate the cumulative prevalence of survival and complication rates.[47] A subanalysis considering the different ceramic materials was performed for the single crowns but was not possible for FDPs because of fewer studies. In direct comparison, the risk ratio (RR) was used to compare monolithic and veneered restorations to evaluate the survival, biological, and technical complication rates. Data were considered significant when $P<.05$ with a 95% confidence interval (CI). The I2 data were used to estimate heterogeneity. If I2 was greater than 50%, the random effect model was used; otherwise, the fixed effect model was used.[48]

RESULTS

The search yielded 1233 studies: 487 from PubMed/MEDLINE, 681 from Scopus, 63 from Cochrane Library, and 2 from the manual search. After the removal of duplicates, 833 studies remained. After reading the titles and abstracts, 31 studies were selected for full-text reading and analysis by applying the eligibility criteria. After full-text reading, 13 studies were excluded (Supplemental Table 1 available online). Thus,

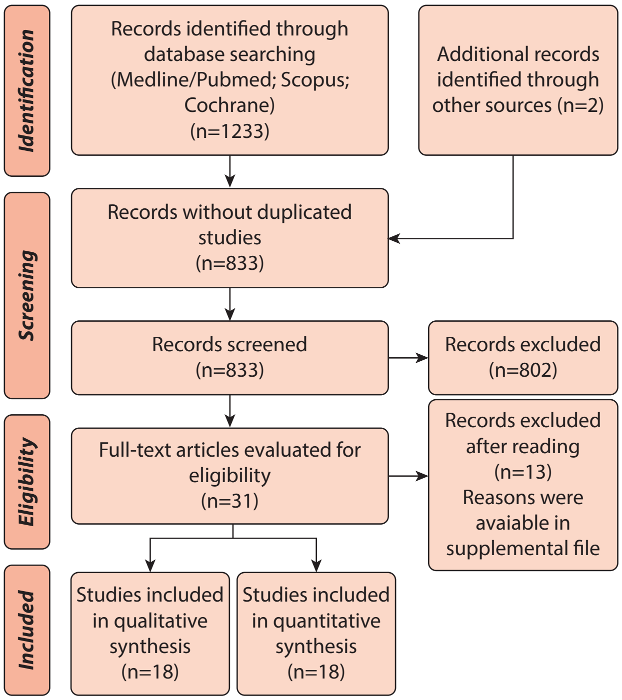


Figure 1. Flow diagram of strategy search.

18 studies met the eligibility criteria.[4,6-22] There were 14 studies[6-10,12-19] that evaluated only single crowns and 3 studies[20-22] that evaluated FPDs. Only 1 study[11] considered both restoration types. The details of the search strategy are presented in Figure 1. The κ investigator agreement for articles selected from PubMed/MEDLINE was κ=0.81, Scopus κ=0.87, and The Cochrane Library κ=1.0, indicating a high level of agreement.[43]

Almost all studies were prospective studies,[4,6,8-22] except for 1 RCT.[7] A total of 682 participants were examined, with a mean age of 53.25 years. A total of 1061 monolithic single crowns (524 lithium disilicate, 461 zirconia, and 76 PICN) and 104 FPDs (36 lithium disilicate and 68 zirconia) were evaluated. The mean follow-up period was 40.8 months. The restorations were predominantly in the posterior teeth. Only 5 studies, of which 4 evaluated single crowns[7-10] and 1 FPDs,[22] considered the direct comparison between the monolithic and veneered ceramic restorations. Data were tabulated for survival and complication rates for single crowns (Table 1) and FPDs (Table 2).

Survival rates were evaluated in all included studies. Eight of the single crown studies[4,7,8,11,13,15-17] and 2 of the FPD studies[11,21] reported no failures during the follow-up periods. For single crowns, the cumulative proportion of monolithic restoration failures was 1% (CI: 0% to 3%; I^2=73%). Monolithic lithium disilicate crowns presented a similar prevalence of prosthesis failures (1%; CI: 0% to 6%; I^2=77%) when compared with monolithic zirconia (1%; CI: 0% to 4%; I^2 = 54%). PICN showed a slightly high prevalence of prosthesis failures (7%; CI: 3% to 15%) when compared with lithium disilicate and zirconia restorations; however, only 1 study[18] evaluated PICN, which compromised the extrapolation of data (Fig. 2). A low proportion rate of biological complications was observed (1%; CI: 0% to 4%; I^2=87%). A subanalysis based on restorative materials showed a low prevalence of biological complications for lithium disilicate (1%; CI: 0% to 10%; I^2=88%), zirconia (0%; CI: 0% to 9%; I^2=85%), and PICN (7%; CI: 3% to 15%) (Fig. 3). The low prevalence of technical complications was also evaluated (2%; CI: 1% to 4%; I^2=67%) independently of the ceramic restorative material and yielded the following results: lithium disilicate, 2%, CI: 1% to 7%, I^2=73%; zirconia, 2%, CI: 0% to 6%, I^2=65%; and PICN, 5%, CI: 2% to 13% (Fig. 4).

In the meta-analysis of FPDs, only 4 studies were considered for analysis which compromised the subanalysis according to the restorative material. However, a low prevalence of failures (3%; CI: 0% to 34%; I^2=82%), biological complications (5%; CI: 1% to 21%; I^2=52%), and technical complications (5%; CI: 1% to 21%; I^2=52%) was observed in the FPDs. The increase in the CI may be related to the fact that 1 study[20] had the longest follow-up period of the included studies (mean: 167 months), which explained the higher incidence of failures and complications (Fig. 5). Regarding the studies that performed direct comparisons between monolithic and veneered ceramic restorations, no significant difference was observed in terms of survival rates (P=.47; RR: 0.68; CI: 0.25−1.91; heterogeneity: I2=0%; P=.96) and biological (P=.37; RR: 0.60; CI: 0.31−1.53; heterogeneity: I2=8%; P=.35) and technical complications (P=.72; RR: 0.87; CI: 0.40−1.88; heterogeneity: I2=21%; P=.29) (Fig. 6).

The Cochrane risk-of-bias tool for the RCT[7] was low risk for selection, attrition, and reporting bias. Regarding the performance and detection bias, the study reported that it was a single-blind study but did not specify how it was blinded.

A quality assessment of 17 studies was conducted by using NOS for cohort studies.[6,8-22] Most of the evaluated studies showed between 7 and 8 stars.[4,6-9,11-15,17-21] Only 2 studies[10,22] showed 9 stars, while only 1 study was classified with 6 stars.[16] The absence of stars for the majority of studies was mostly related to a lack of terms for the nonexposed cohort and inadequate follow-up of the outcome of interest, which in this systematic review was considered 36 months. Only 1 study did not show the outcomes of interest in line with the aims of the study (Supplemental Table 2 available online).

Regarding the funnel plot evaluation for each included analysis, some single-arm meta-analyses presented asymmetry. Although some studies remained outside the funnel, this could not be attributed to

Table 1. Characteristics of included studies of single-crown restorations (n=15)

Author	Year	Study Design	Patient, n	Mean Age, y	Mean Follow-up, mo	Restorations, n	Material	Region	NOS (Star)	Survival Rate (%)	Complications Reported	
											Biological, n	Technical, n
Fasbinder et al[4]	2010	Prosp	42	NR	24	MLD: 62	MLD: IPS e.max CAD; Ivoclar Vivadent	Post	7	100%	0	02 (DB)
Cortellini and Canale[6]	2012	Prosp	76	36	36	MLD: 235	MLD: IPS e.max CAD; Ivoclar Vivadent	Ant/ Post	8	99.6%	0	0
Esquivel-Upshaw et al[7]	2013	RCT	24	NR	36	MLD: 12[a] VLD: 12[a]	MLD: IPS e.max Press and IPS e.max Ceram; Ivoclar Vivadent VLD: IPS Empress 2 and IPS Eris; Ivoclar Vivadent	Post	-	MLD: 100% VLD: 100%	0	MLD: 01 (C) 01 (LPC) VLD: 01 (C)
Seydler and Schmitter[8]	2015	Prosp	22	45.7	24	MLD: 30 VZ: 30	MLD: IPS e.max CAD; Ivoclar Vivadent VZ: IPS e.max ZirCAD+IPS e.max CAD; Ivoclar Vivadent	Post	8	MLD: 100% VZ: 100%	MLD: 02 (EP) VZ: 02 (EP) 03 (PD)	0
Huettig and Gehrke[9]	2016	Prosp	45	NR	30	MLD: 151 VLD: 176	MLD: IPS e.max Press; Ivoclar Vivadent VLD: IPS e.max Ceram; Ivoclar Vivadent	Ant/ Post	8	MLD: 98 % VLD: 97.2%	MLD: 01 (EP) 01 (SC) VLD: 01 (SC)	MLD: 02 (DB) 03 (C) VLD: 01 (DB) 02 (C)
Bömicke et al[10]	2017	Prosp	60	62.5	36	MZ: 82 VZ: 66	MZ: Cercon HT; DeguDent VZ: Cercon Ceram Kiss; DeguDent	Ant/ Post	9	MZ: 97.56% VZ: 96.96%	MZ: 4 (EP) VZ: 01 (EP) 01 (PD)	MZ: 02 (DB) VZ: 01 (DB) 01 (C)
Worni et al[11]	2017	Prosp	34	59.1	23.8	MZ: 56[b]	Ceramill Zolid; Amann Girrbach	Ant/ Post	7	100%	0	0
Rauch et al[12]	2018	Prosp	31	55.4	121.2	MLD: 34	MLD: IPS e.max CAD; Ivoclar Vivadent	Post	8	85.3%	03 (EP) 03 (SC) 01 (F)	01 (DB) 01 (F)
Kitaoka et al[13]	2018	Prosp	18	69	24	MZ: 25	Aadva Zirconia EI; GC Corporation	Post	7	100%	0	0
Hansen et al[14]	2018	Prosp	13	56.3	20	MZ: 84	BruxZir Zirconia; Glidewell	Ant/ Post	7	98.8%	0	01 (F) 04 (C)
Konstantinidis et al[15]	2018	Prosp	65	49.5	12	MZ: 65	Zenostar Zr Translucent; Wieland	Post	7	100%	0	0
Pathan et al[16]	2019	Prosp	60	NR	12	MZ: 60	DGStar; DentGallop	Post	6	100%	0	0
Tang et al[17]	2019	Prosp	46	41.3	24	MZ: 49	Zenostar Zr Translucent; Wieland	Post	7	100%	0	01 (CAT)
Spitznagel et al[18]	2020	Prosp	34	52.6	36	PINC: 76	VITA Enamic; VITA Zahnfabrik	Post	8	93.5%	0	04 (F)
Miura et al[19]	2020	Prosp	13	53.1	42	MZ: 40	Cercon HT; Dentsply Sirona Shofu Disk ZR-SS; Shofu Inc inColis TZI; Dentsply Sirona	Ant/ Post	8	92.8%	0	02 (F) 01 (CA) 01 (CAT)

Ant, anterior; C, chipping; CA, crown abrasion; CAD, computer-aided design; CAT, crack antagonist tooth; DB, debonding; EP, endodontic problem; F, fracture; LPC, loss of proximal contact; MLD, monolithic lithium disilicate; MZ, monolithic zirconia; NOS, Newcastle-Ottawa Scale; NR, not reported; PD, periodontal disease; Post, posterior; Prosp, prospective; RCT, randomized controlled trial; SC, secondary caries; VLD, veneered lithium disilicate; VZ, veneered zirconia. [a]Only monolithic and veneered ceramic considered. [b]Only tooth-supported monolithic single crowns considered.

Table 2. Characteristics of included studies of fixed partial dentures (n=4)

Author	Year	Study Design	Patient, n	Mean Age, y	Mean Follow-up, mo	Restorations, n	Material	Region	NOS (Star)	Survival Rate (%)	Complications Reported	
											Biological, n	Technical, n
Worni et al[11]	2017[a]	Prosp[a]	34[a]	59.1[a]	23.8[a]	15[b]	Ceramill Zolid; Amann Girrbach[a]	Ant/ Post[b]	7	100%[b]	0[b]	0[b]
Garling et al[20]	2019	Prosp	28	47.5	167	MLD: 36	IPS e.max Press; Ivoclar Vivadent	Ant/ Post	8	66.6%	MLD: 06 (NR)	MLD: 06 (F)
Pontevedra et al[21]	2020	Prosp	20	56	28	MZ: 20	Zenostar T; Wieland	Post	7	MZ: 100%	0	0
Habibi et al[22]	2020	Prosp	51	61.5	36	MZ: 33 VZ: 34	MZ: Cercon HT; DeguDent VZ: Cercon Ceram Kiss; DeguDent	Ant/ Post	9	MZ: 96.7% VZ: 93.8%	MZ: 02 (EP) VZ: 03 (EP)/02 (SC)/01 (PD)	MZ: 01 (DB) 01 (F) VZ: 01(F) 03(C)/01(FF)/ 01(DB)/01(DB)

Ant, anterior; DB, debonding; EP, endodontic problem; F, fracture; FF, framework fracture; MLD, monolithic lithium disilicate; MZ, monolithic zirconia; NOS, Newcastle-Ottawa Scale; NR, not reported; PD, periodontal disease; Post, posterior; Prosp, prospective; SC, secondary caries; VLD, veneered lithium disilicate; VZ, veneered zirconia. [a]Same information reported for single crowns. [b]Only tooth monolithic fixed partial dentures considered.

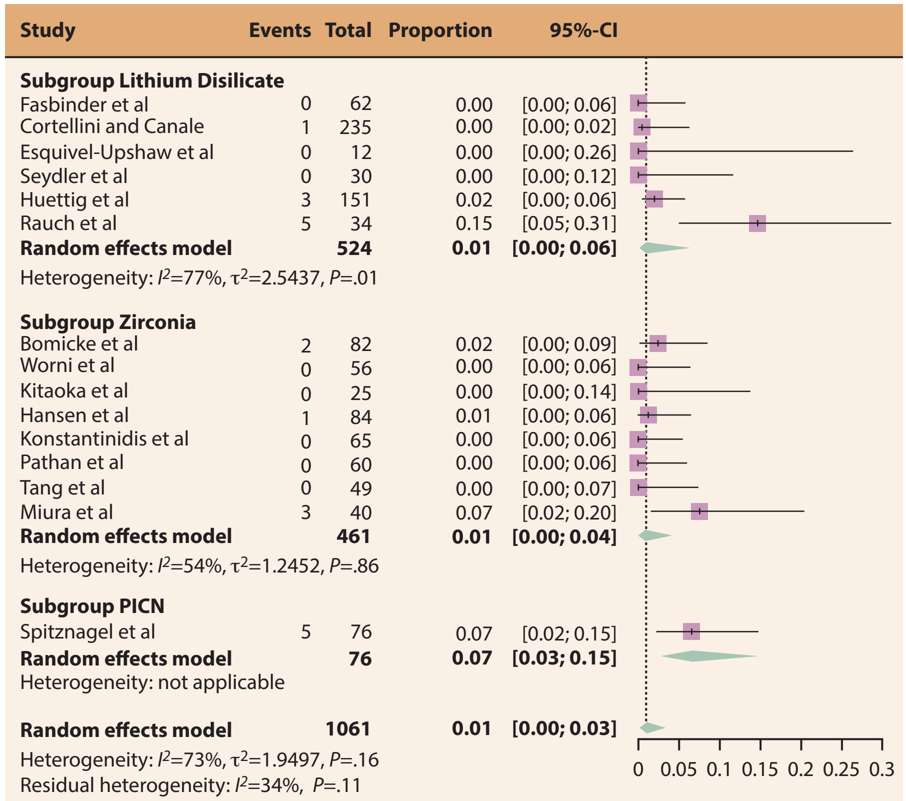


Figure 2. Meta-analysis of survival rates for monolithic single crowns. PICN, polymer-infiltrated ceramic network.

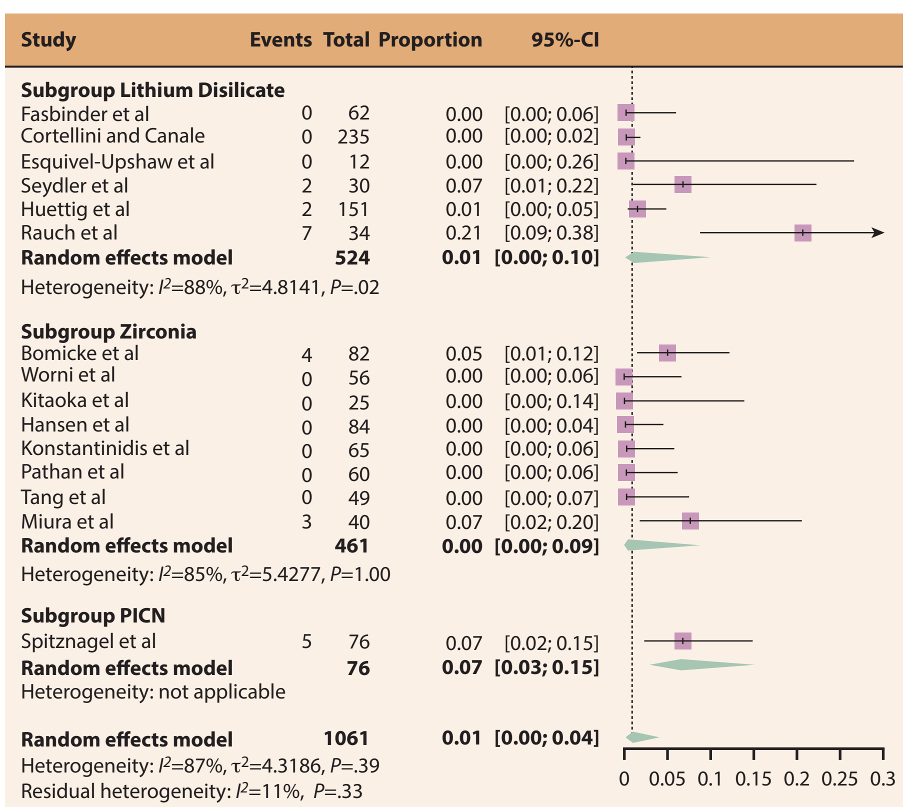


Figure 3. Meta-analysis of biological complications for monolithic single crowns. PICN, polymer-infiltrated ceramic network.

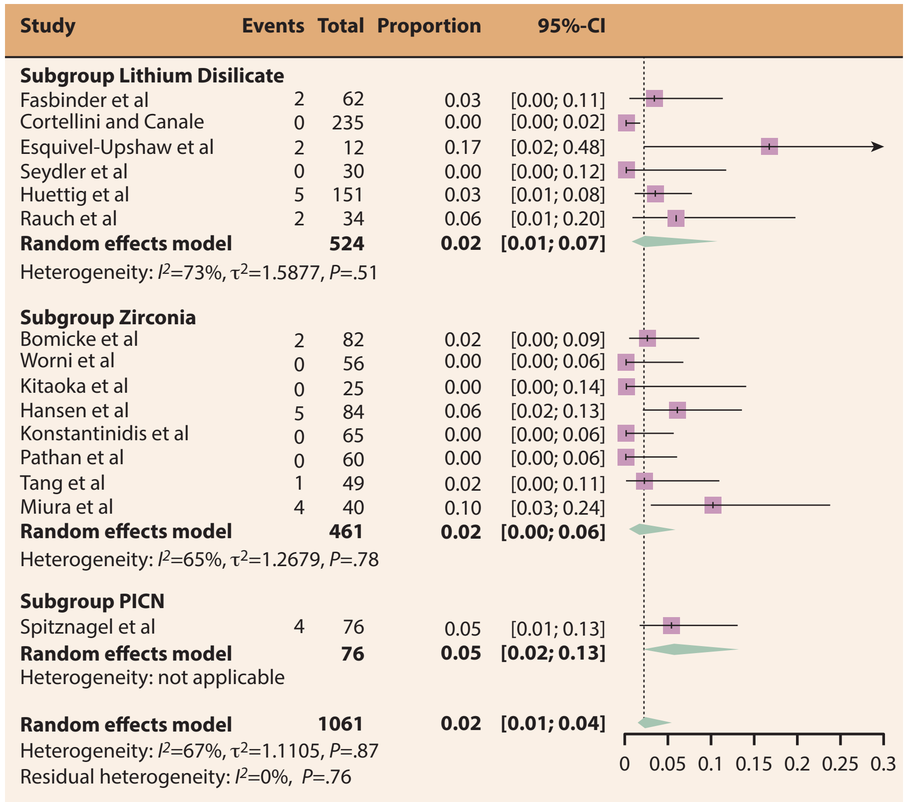


Figure 4. Meta-analysis of technical complications for monolithic single crowns. PICN, polymer-infiltrated ceramic network

possible publication bias. The asymmetry of reported failures could be attributed to the longer follow-up period for these studies. In addition, the funnel plot of direct comparison between monolithic and veneered crowns showed symmetry with low heterogeneity (Supplemental Fig. 1 available online).

DISCUSSION

The first research hypothesis was accepted because high survival and low complication rates were observed for monolithic restorations, independent of the restorative ceramic material. These results are consistent with those of a previous systematic review that evaluated monolithic implant-supported restorations.[49]

The estimated survival of monolithic crowns evaluated in this systematic review was close to that in a previous systematic review that compared ceramic (not only monolithic) and metal-ceramic restorations.[50] The same study group performed another systematic review comparing ceramic FPDs, reporting high failure rates for ceramic FPDs.[51] Such data were also observed in the present systematic review because for the monolithic single crowns, the prevalence of failure rates was lower (1%; CI: 0% to 3%) than that of FPDs (5%; 1% to 21%). However, these results should be interpreted with caution because only 4 studies evaluated monolithic FPDs, and 1 of these reported the longest follow-up period of the included studies. Consequently, despite the difference in prosthetic rehabilitation, this could contribute to increasing the incidence of failure rates. Therefore, further well-designed studies that evaluate FPDs are recommended.

Minor biological and technical complications were reported. Most of the complications are related to endodontic problems, secondary caries, chipping, and debonding. Although previous in vitro studies have reported that the use of monolithic restorations could be considered to avoid chipping,[27,28,31] 8 studies reported chipping or fracture of restorations. Therefore, the dentist should be aware that factors such as endodontically treated teeth,[18] insufficient thickness of the material,[19] parafunctional habits (such as bruxism),[29] and incorrect occlusal adjustment could contribute to increased complications or failures in monolithic ceramic restorations.

The ceramic materials evaluated in the included studies were lithium disilicate, zirconia, and PICN. Thus, a subanalysis considering this difference could be performed for the single crowns. Although an in vitro study[28] reported that monolithic high-translucent Y-TZP presented a higher fracture resistance than lithium disilicate crowns, no difference was observed clinically in the survival and complication rates between these materials. However, PICN presented a slightly higher proportion prevalence of failures and complications, which could be related to the fact that only 1 study[18] performed the evaluation after 3 years. Therefore,

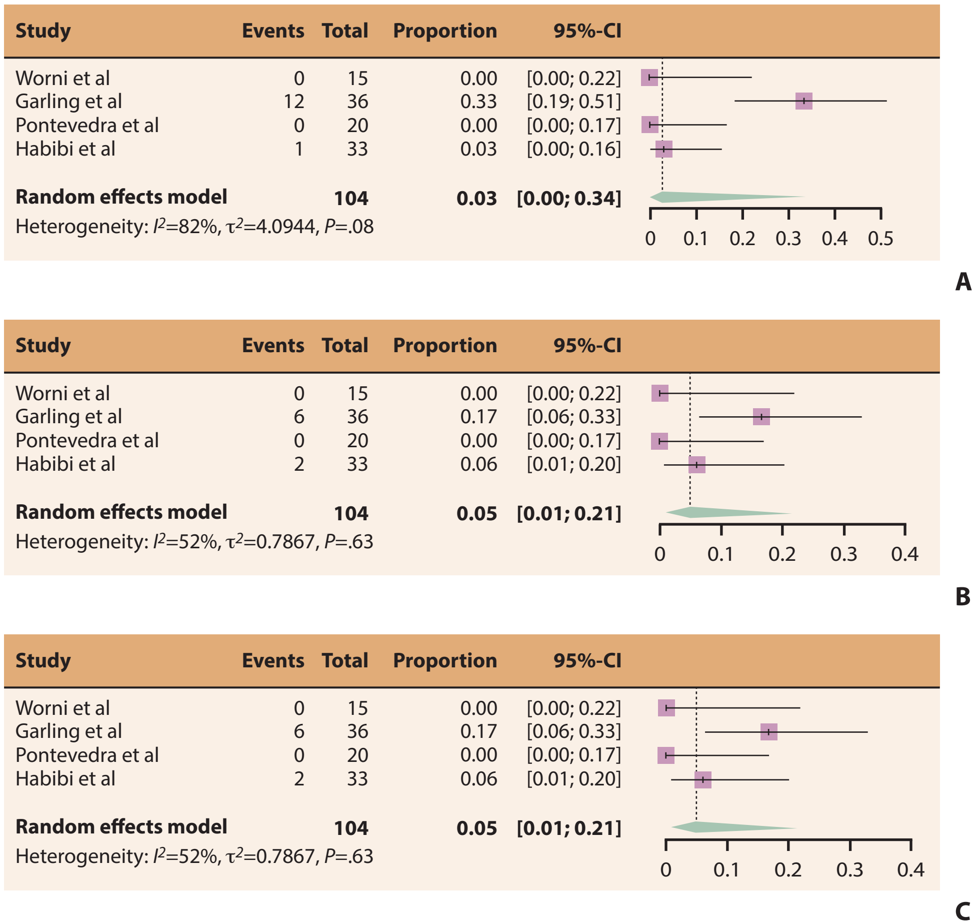


Figure 5. Meta-analysis of survival rate (A) and biological (B) and technical complications (C) for monolithic FPDs.

studies that compared PICN with other ceramic materials with a longer follow-up period are encouraged.

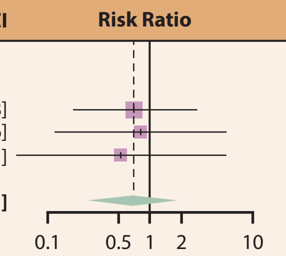
Monolithic restorations are expected to present a lower number of failures and complications than veneered ceramics. They avoid the presence of a thin ceramic veneer,[52] residual stress due to the incompatibility of the thermal expansion coefficient during the cooling process,[53] and the possibility of weak bonds at the adhesion interface between the framework and ceramic veneer of the veneered restoration.[54] However, no significant difference was observed in the survival and complications rates between the monolithic and veneered restorations; hence, the second research hypothesis was accepted. The results should be interpreted with caution because only 5 studies with a follow-up period up to 36 months performed a direct comparison. Consequently, RCTs with a long-term follow-up are recommended to verify the direct effect of the restorative type.

Regarding biological complications, no significant difference was observed between the 2 types of restorations. In general, ceramic materials exhibit biocompatibility, excellent soft tissue integration,[55] and less bacterial adhesion.[56] In this systematic review, most biological complications were related to endodontic problems or secondary caries; however, none of the authors related this problem to the restorative material type. Although technical complications did not differ between the evaluated groups, only 1 of the comparative studies evaluated FPDs.[22] The authors reported no defects for monolithic ceramic, while a chipping rate of 5.9 % was recorded for the veneered FPDs. The authors reported that the veneer is a risk factor for ceramic complications.[22] However, this difference should be interpreted with caution, and more studies related to the monolithic restorations in comparison with veneered FPDs should be considered.

A meta-analysis with a single arm that evaluated the proportion of occurrence of failures only in the monolithic restorations showed high heterogeneity. This could be attributed to the limitations previously described, such as the difference in the follow-up periods which contributed to discrepancies in the incidence rates of the evaluated studies; it does not represent a publication bias as a longer follow-up period is expected to be associated with a greater failure risk. In addition, the low number of RCTs, differences in the restorative material, and region evaluated could contribute to an increase in heterogeneity. Although a subanalysis was conducted according to different

Study	Monolithic Events	Monolithic Total	Veneered Events	Veneered Total	Weight	RR	95%-CI
Esquivel-Upshaw et al	0	12	0	12	0.0%		
Seydler et al	0	30	0	30	0.0%		
Huettig et al	3	151	5	176	52.4%	0.70	[0.17; 2.88]
Bomicke et al	2	82	2	66	25.2%	0.80	[0.12; 5.56]
Habibi et al	1	33	2	34	22.4%	0.52	[0.05; 5.41]
Fixed effect model		**308**		**318**	**100.0%**	**0.68**	**[0.25; 1.91]**

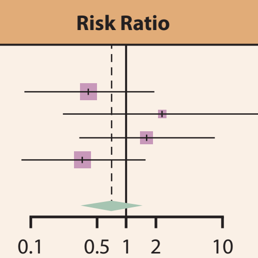
P=.47; Heterogeneity: I^2=0%, τ^2=0, *P*=.96



A

Study	Monolithic Events	Monolithic Total	Veneered Events	Veneered Total	Weight	RR	95%-CI
Esquivel-Upshaw et al	0	12	0	12	0.0%		
Seydler et al	2	30	5	30	35.6%	0.40	[0.08; 1.90]
Huettig et al	2	151	1	176	6.6%	2.33	[0.21; 25.46]
Bomicke et al	4	82	2	66	15.8%	1.61	[0.30; 8.52]
Habibi et al	2	33	6	34	42.1%	0.34	[0.07; 1.58]
Fixed effect model		**308**		**318**	**100.0%**	**0.69**	**[0.31; 1.53]**

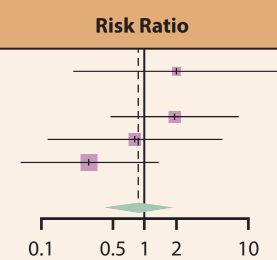
P=.37; Heterogeneity: I^2=8%, τ^2=0.0678, *P*=.35



B

Study	Monolithic Events	Monolithic Total	Veneered Events	Veneered Total	Weight	RR	95%-CI
Esquivel-Upshaw et al	2	12	1	12	7.8%	2.00	[0.21; 19.23]
Seydler et al	0	30	0	30	0.0%		
Huettig et al	5	151	3	176	21.5%	1.94	[0.47; 7.99]
Bomicke et al	2	82	2	66	17.2%	0.80	[0.12; 5.56]
Habibi et al	2	33	7	34	53.5%	0.29	[0.07; 1.31]
Fixed effect model		**308**		**318**	**100.0%**	**0.87**	**[0.40; 1.88]**

P=.72; Heterogeneity: I^2=21%, τ^2=0.2002, *P*=.29



C

Figure 6. Meta-analysis of survival rates (A) and biological (B) and technical complications (C) of direct comparison between monolithic and veneered restorations.

restorative materials, high heterogeneity was observed. Therefore, further RCTs are recommended to evaluate the specific parameters of monolithic single crowns and FPDs, mainly by comparing veneered restorations.

CONCLUSIONS

Based on the findings of this systematic review and meta-analysis, the following conclusions were drawn:

1. The use of monolithic ceramic can be considered a favorable treatment for tooth-supported fixed dental prostheses.
2. The ceramic material did not affect the survival and complication rates of monolithic single crowns.
3. Monolithic FPDs showed slightly higher failure and complication rates than monolithic single crowns.
4. No significant difference was observed between monolithic and veneered restorations in terms of survival and biological and technical complications.

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https://doi.org/10.1016/j.prosdent.2021.01.020