European Journal of Prosthodontics and Restorative Dentistry (2025) 34 (7s), 1269-1274

Keywords
Zirconia, Resin-bonded bridge, Cantilever, No-prep, Adhesive dentistry, Minimally invasive prosthodontics.

Survival of zirconia resin retained bridges without tooth preparation

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Abstract

Purpose: To evaluate the 5-year clinical performance of no-preparation zirconia cantilever resin-bonded fixed dentalprostheses (RBFDPs) and assess their viability as a non-invasivealternative to conventional tooth replacement strategies.

Materials and Methods: Thirty patients received single-unitcantilever RBFDPs fabricated from 3Y-TZP zirconia using astandardized digital workflow. No enamel reduction wasperformed on abutment teeth. Prostheses were bonded usingMDP-containing adhesive systems following airborne-particleabrasion at 2.5 bar pressure. Clinical assessments wereconducted at baseline, 3 months, and 5 years. Survival analysiswas performed using Kaplan–Meier methodology. Patient demographics, technical complications, biological integrity, andsatisfaction were recorded.

Results: At a median follow-up of 63 months, the survival ratewas 97%. One failure occurred due to connector fracture in acanine replacement. No debonding, marginal staining, secondarycaries, or chipping was observed. Composite bonding was usedin 63% of cases to optimize guide planes and aesthetics. Seatingjigs were employed in selected cases to facilitate accurateplacement.

Conclusion: No-prep zirconia cantilever RBFDPs demonstratepromising mid-term survival and technical reliability,comparable to prepared zirconia and metal-ceramic alternatives.These findings support the feasibility of a non-invasiverestorative approach, aligning with contemporary principles ofenamel preservation and patient-centred care.

Clinical Significance: This study provides clinical evidence thatzirconia RBFDPs can be successfully delivered withoutabutment tooth preparation, offering a minimally invasive,aesthetically favourable, and cost-effective alternative toimplants and conventional fixed prostheses.

Received-17-06-2026
Revised-20-07-2026
Accepted-23-07-20.26
Doi: 10.1922/ejprd.v34i7s.1782

INTRODUCTION

Resin-bonded fixed dental prostheses (RBFDPs) have long been established as a conservative and cost-effective solution for replacing single missing teeth, particularly in young patients or those contraindicated for implant therapy. Metal-ceramic RBFDPs have demonstrated robust long-term outcomes, with survival rates exceeding 80% over 10 years.(1,2) The clinical performance of RBFDPs is comparable to that of conventional fixed partial dentures (FPDs) and implant-supported crowns, with a 10- year success rate of 80% for metal RBFDPs.(2) However, the aesthetic limitations and technical demands of metal frameworks have prompted a shift toward all-ceramic alternatives, notably zirconia-based prostheses. Ceramic RBFDPs, introduced by Kern et al. in the early 1990s.(3)

The majority of the published literature on RRB survival reports on metal-ceramic bridges. The development of digital manufacturing techniques and ceramic materials has seen increasing utilisation of zirconia ceramic resin retained bridges.(4,5) Meta-analyses report single-retainer anterior zirconia RBFDPs as having a 92% 5-year success rate.(6) Kern et al. report 10- year survival and success rates of 98% and 92%, respectively.(7)

The published data on this type of prosthodontic replacement typically includes preparation of the abutment tooth. This is expected at this stage of technological development as the optimal treatment provision protocols continue to develop. The consequence of this is, however, that treatment methods vary widely.

The proposed contraindications to zirconia RBFDPs are:(8)

Bonding surface area of less than 30mm2 enamel

Less than 0.7mm occlusal space

Insufficient connector height (minimum 3mm)

Unable to avoid guidance on the pontic

Bruxism not managed with a stabilisation splint

Yttria-stabilized tetragonal zirconia polycrystal (3Y-TZP) offers high flexural strength and favourable biocompatibility, making it suitable for minimally invasive restorations. Historically, bonding to zirconia was considered unreliable due to its inert surface chemistry. Recent advances in adhesive protocols—particularly airborne-particle abrasion followed by application of 10-MDP-containing primers—have significantly improved bond durability.(9,10)

One area of consistency amongst the evidence base, and indeed amongst manufacturers recommended treatment protocols, involves the preparation of abutment teeth for receipt of a zirconia retainer wing. The preparation type varies between manufacturer with regard to depth of preparation, design of preparation, and the utilisation of additional retentive elements such as slots, and rounded pinholes.

The concept of preparing abutment teeth to support and retain a resin retain bridge contradicts the available published literature reporting on metal-ceramic bridges. Indeed, some studies indicate that even attempts to perform enameloplasty can result in increased incidence of loss of retention of RRBs.

The primary supporting evidence for this difference has related to the proposed difference in adhesive cement-bridge substructure when placing metal substructure vs. zirconia substructure bridges. Historically, there has been a dearth of evidence to support the concept of "bonding" zirconia using resin cements. Increasing evidence however does suggest that a predictable and effective bond to zirconia can be achieved with an appropriate substrate preparation and bonding protocol.

Mainjot et al. (2025)(11) introduced a novel approach using no-preparation zirconia cantilever RBFDPs, reporting a 100% survival rate over a mean follow-up of 3.0 ± 2.6 years.(12) Their findings challenge the conventional necessity of enamel reduction and support a paradigm shift toward non-invasive restorative protocols for the provision of zirconia framework resin retained bridges. This aligns with broader trends in minimally invasive dentistry and patient preference for tissue-preserving treatments.(13)

The present study aims to evaluate the clinical feasibility and 5-year survival of zirconia cantilever RBFDPs placed without any abutment tooth preparation. By building on emerging evidence, this investigation seeks to clarify the role of non-invasive zirconia restorations in contemporary prosthodontic practice.

The aim of the study is to determine whether it is feasible to provide zirconia substructure resin retained bridges without preparation of abutment teeth.

METHODS

This was a prospective cohort study conducted at a university dental hospital. Ethical approval was investigated and deemed to be not necessary for the reporting of outcomes for this clinical intervention. The study was not registered as a clinical trial due to its observational nature.

Patients were recruited from prosthodontic planning clinics. Inclusion criteria were: age ≥18 years, single missing tooth in anterior or premolar region, preference for RBFDP over implant or conventional prosthesis, and adequate enamel for bonding. Exclusion criteria included parafunctional habits, poor oral hygiene, or systemic conditions affecting healing. The cohort included 30 patients (17 female, 13 male), aged 19–62 years (mean: 38.4 ± 11.2 years). Indications included orthodontic space closure, trauma, and congenital absence.

All restorations were single-unit cantilever RBFDPs fabricated from 3Y-TZP zirconia (Lava Plus, 3M ESPE). Mesial cantilever design was prioritized. Connector dimensions adhered to manufacturer guidelines (≥7 mm^2 anterior, ≥12 mm^2 posterior), alongside a minimum connector height of 3mm.(3) Composite bonding was performed to optimize guide planes and pontic emergence profile. No enamel reduction was performed except in 10% of cases for cusp prominence adjustment.

Digital workflow included benchtop scanning (3Shape), CAD wax-up, and 5-axis milling by a specialist lab. Fit surface preparation followed the APC protocol using 50 µm Al_2O_3 at 2.5 bar. Cementation was performed under cotton roll isolation with Optragate retraction(2), using Scotchbond Universal and RelyX Ultimate (3M ESPE). Seating jigs were used in 40% of cases to aid placement.

Patients were reviewed at 3 months and 5 years. Annual recalls were not standardized; recall was managed via a patient-initiated follow-up between the 3 month and 5 year time points. Clinical evaluation included bridge integrity, occlusion (static/dynamic), marginal staining, caries, and patient satisfaction. Survival analysis was performed using Kaplan–Meier.

Patients were identified via prosthodontic planning clinics. In all cases the patient had opted for a resin retained bridge over alternative prosthodontic replacement options. Impressions and diagnostic wax ups were utilised to present the treatment plan to each patient. Material selection was incorporated into this discussion. It is routine practice to not prepare abutment teeth for resin retained bridges, and thus this treatment concept was maintained irrespective of the material choice selected. Patients were informed of the published evidenced regarding survival and complication rates for metal-ceramic and zirconia RRBs, in addition to the relative dearth of evidence relating to the long-term survival of zirconia RRBs. Patients were also informed that the utilisation of zirconia as a material in the provision of RRBs was a new concept to the unit. All patients who opted for utilisation of this option were offered 5-year follow-up to support clinical service development. Any patients who opted for this were recruited to the study.

Thirty patients who opted for provision of zirconia resin retained bridges and 5-year follow-up were recruited to the study. All individuals were treated using the same treatment concepts. All bridges were single unit cantilever bridges. Both mesial and distal cantilever designs were utilised, however mesial cantilever was prioritised where possible. All bridges were constructed utilising 3M Lava Plus, as per 3M instructions for construction and development. 5-axis milling was utilised by a specialist dental milling laboratory (external provider). The treatment process involved:

Composite bonding to the abutment tooth or an adjacent tooth to facilitate optimisation of space, masking of tooth shape (where appropriate), and guide plane development.

Silicon impression of the arch (Affinis heavy and medium body), and an alginate impression of the opposing arch

Appropriate interocclusal record (shimstock holds, or BluMousse silicon)

Lab casting and benchtop scanning of the working model (3Shape)

Digital diagnostic wax up of the resin retained bridge with clinician oversight

Manual buccal layering (if appropriate), alongside finished and polishing or glazing (if appropriate) of the resin retained bridge

Try-in and adjustment in the bridge alongside finished and polishing or glazing (if appropriate) of the resin retained bridge

Fit surface preparation as per the APC concept, utilising 50um Al_2O_3 for surface particle abrasion

Adhesive cementation of the resin retained bridge (with a seating jig where appropriate) utilising an MDP containing bonding solution (Scotchbond Universal + Rely.x Ultimate) as per manufacturer instructions. This step was undertaken under cotton isolation supported by bucco-labial retraction (Optragate), and rubber dam was not utilised aligning with treatment concepts at the time.(2)

3-month review to assess occlusion and oral hygiene

Occlusion was assessed at the 3-month review and adjusted where appropriate to avoid excessive occlusal load or guidance on the pontic.

All treatment was undertaken by a specialist trainee in Restorative Dentistry, within a dental hospital setting. Dental loupes with attached lighting were utilised for all treatment, except dental impression taking. All patients had been referred to the service by either primary care practitioners or other specialist services (such as orthodontics).

All patients were reviewed clinically at approximately 5 years, except for failures, who were seen shortly following the time point of failure. Clinical review consisted of a discussion regarding any concerns or problems faced, overall satisfaction with the treatment provided, the oral hygiene protocol utilised, and ongoing access to general dental access in the primary care environment. Clinical examination assessed the integrity of the bridge, and any chipping or fracture, the occlusal relationship (static and dynamic), and the presence of any marginal staining or caries.

RESULTS

Thirty patients (17 female, 13 male; mean age: 38.4 ± 11.2 years) received single-unit cantilever zirconia RBFDPs. All restorations replaced anterior teeth or premolars. The median follow-up duration was 63 months (range: 60–70 months). Annual recalls were not standardized; evaluations were conducted at baseline, 3 months, and 5 years.

One failure occurred at 13 months due to connector fracture in a canine replacement using a premolar abutment. The retainer remained bonded and was removed via sectioning. The bridge was replaced with a metal-ceramic RBFDP. Kaplan–Meier survival analysis is summarised in Figure 1. The survival time is limited by the follow-up and is reported as 71 months (95% CI 67-74 months). These data are summarised in Table 1.

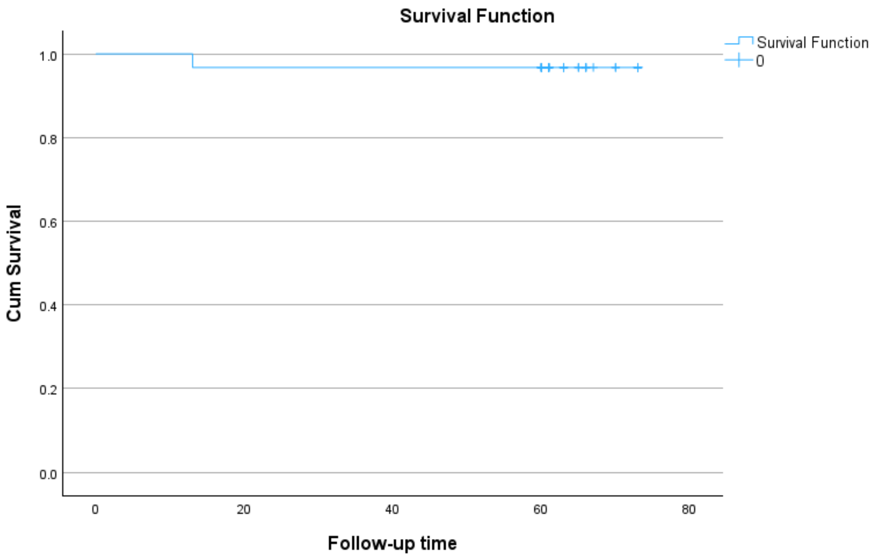

Figure 1: The survival curve of zirconia RBFDPs utilising Kaplan-Meier analysis

No cases exhibited debonding, marginal staining, secondary caries, or chipping. Composite bonding was performed in 63% of cases to optimize guide planes and pontic emergence. Minor enameloplasty was performed in 10% of cases to reduce cusp prominence. Connector dimensions followed manufacturer guidelines (≥7 mm² anterior, ≥12 mm² posterior), though exact measurements were not digitally recorded.

At 3-month review:

93% of abutment teeth had occlusal contact in intercuspal position.
87% of pontics had similar contact.
Guidance was solely on the abutment tooth in 37% of cases; shared guidance was more common.
Pontic guidance was avoided in all cases.

Table 1: Sample characteristics including survival and treatment strategy

Parameter	Value
Total patients	30
Gender (F/M)	17 / 13
Mean age	38.4 ± 11.2 years
Survival rate at 5 years	97%
Failures	1 (connector fracture)
Debonding	0
Marginal staining	0
Secondary caries	0
Chipping	0
Composite bonding performed	63%
Enameloplasty performed	10%
Occlusal contact on abutment	93%
Occlusal contact on pontic	87%
Pontic guidance	0%

DISCUSSION

This study supports the clinical feasibility of no-preparation zirconia cantilever RBFDPs, demonstrating a 5-year survival rate of 97%, consistent with previous reports on metal-ceramic and zirconia restorations. The absence of biological complications and technical failures (except one connector fracture) reinforces the reliability of adhesive bonding to zirconia when appropriate protocols are followed.

The single failure highlights the importance of respecting minimum connector dimensions, especially in high-load areas. Mainjot et al. (2025)(12) and Kern et al. (2025)(4) emphasize the need for adequate bucco-palatal and occluso-gingival dimensions to prevent stress concentration. However, this study did not digitally record connector dimensions, limiting retrospective analysis.

Our methodology lacked annual follow-up and standardized biological assessments (e.g. USPHS criteria), which restricts evaluation of long-term complications. Future studies should incorporate structured recall protocols and validated assessment tools. Long-term data on zirconia RBFDPs are available, with survival rates exceeding 90% over 10–15 years, however studies reporting on the survival of no-preparation zirconia RBFDPs are scarce.
The present study was not performed in a manner informed by statistical power calculation and therefore carries a risk of a type 1 error.

The continued evolution of materials science has resulted in changes to the mechanical properties of available zirconia products, as well as the chemical properties of available bonding solutions and adhesive cements. These are yet to be investigated in the published literature.

Several challenges were faced in the provision of zirconia bridges during this study. The primary challenge related to the provision of sufficient connector height and width to align with the manufacturers recommendations (7mm2 for anterior bridges and 12mm2 for posterior bridges)(4). The factors limiting the bucco-palatal width related to either the potential for bridge design to be unhygienic, or the connector area becoming prominent in the occlusion. The primary factor limiting the occluso-gingival height of the connector was the height of the abutment tooth. This was more common when planning resin retained bridges with premolar abutments.

Zirconia bridges were found to have poorer marginal contour when compared to metal-ceramic bridges. This was primarily attributed to the ability to feather the margins of metal substructures. We are not able to report on oral hygiene outcomes as this was not formally supported by a standardised pre-treatment and post-treatment classification system, or a standardised oral hygiene protocol (this was individually tailored). The influence of bridge substructure on oral hygiene is an area for further investigation.

All bridges were surface particle abraded using Al2O3. Alternative products are available to support tribochemical preparation of the surface. Further research is required to assess the relative effectiveness of these preparation protocols in relation to no preparation zirconia RBFDPs.

Seating of zirconia bridges presents a technical challenge, as this bridge type of less suitable for cementation in conjunction with a seating lug. Seating jigs can be utilised to overcome this challenge, particularly when utilising an unprepared anterior tooth as an abutment (i.e. without retention features). The effectiveness of seating jigs, or the influence of jig design remains an area for further investigation.
While the study was conducted in a specialist setting and lacks randomization, the results contribute to a growing body of literature advocating for non-invasive zirconia restorations. The absence of debonding, marginal staining, or biological complications across the cohort supports the technical feasibility of this approach.
Future research should focus on randomized controlled trials, posterior applications, and long-term biological outcomes. Additionally, comparative studies evaluating different zirconia grades (e.g., 3Y vs. 4Y-TZP) and bonding systems may further refine clinical protocols.

CONCLUSION

This prospective cohort study demonstrates that no-preparation zirconia cantilever resin-bonded fixed dental prostheses (RBFDPs) can achieve high mid-term survival rates and minimal biological or technical complications when appropriate adhesive protocols are followed. The 5-year survival rate of 97% supports the feasibility of a minimally invasive approach to tooth replacement, consistent with contemporary principles of enamel preservation and patient-centred care.
However, limitations such as the absence of standardized annual follow-up, lack of statistical power calculation, and omission of connector dimension data restrict the generalizability of findings. The use of relative isolation and reliance on manufacturer guidelines also highlight areas for protocol refinement.
Future research should focus on randomized controlled trials with standardized evaluation criteria, long-term biological outcomes, and comparative analyses of zirconia grades and bonding systems. Incorporating absolute isolation, digital measurement of connector dimensions, and clinical photography will enhance the scientific validity and reproducibility of future studies.
Our research suggests that the no-preparation zirconia framework resin retained bridges are likely to have comparable medium term survival when compared to other alternatives, including metal-ceramic resin retained bridges. Further research is required to explore method to optimise connector dimensions and stress distribution throughout frameworks, particularly for teeth with reduce occluso-gingival and bucco-palatal dimension. Furthermore, research is required to explore the mechanical properties of contemporary zirconia dental materials in the provision of resin retained bridges.

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