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Survival Rate of Biomimetic Anterior Resin Bonded Fixed Partial Dentures with and Without Tooth Preparation for the Restoration of Single Missing Maxillary Incisor for Adolescents: A Randomized Clinical Trial

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Resin-Bonded fixed partial denture; Teeth Preparation; Survival; Patient Satisfaction; Adolescence.

Abstract

Background: In particular, for adolescents who need to have their lost anterior teeth restored, tooth replacement is essential for function, appearance, and overall quality of life. Resin-bonded fixed partial dentures (RBFPDs) offer a conservative option, yet there is ongoing discussion on the need for tooth preparation.

Methods: A single maxillary incisor was lost in twenty-four subjects (16 males and 8 females) with ages ranging from 12 to 18 years old that were part of a randomised controlled trial. Two groups were assigned to the participants: Group I received dental preparation, and Group II received no dental preparation to receive unilateral zirconia RBFDP. Over 12 months, the Visual Analogue Scale (VAS) including its impact on the patient's speech, esthetics, and thermal sensitivity and Papillary Bleeding Index (PBI) were used to measure survival, and patient satisfaction.

Results: No statistically significant differences were found in retention and survival rates between the two groups ($p = 0.705$). Both groups exhibited high patient satisfaction, with VAS scores showing no significant differences at any follow-up point ($p > .05$). The PBI indicated variations in periodontal health over time, notably in Group II, but no significant differences were observed between groups at 12 months ($p = 0.355$).

Conclusion: This study indicates that regardless of tooth preparation, RBFPDs can be used successfully in adolescents with a single maxillary incisor missing.

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1 Introduction

For patients, tooth replacement poses a serious challenge to their appearance, functionality, and quality of life [1]. When it comes to the replacement of anterior teeth in early adolescents, it is also a significant concern [1]. For individuals who need to replace one lost tooth, fixed partial dentures (FPD) have become a common option [2]. Nonetheless, from a conservative standpoint, teeth preparation frequently necessitates a large amount of enamel and dentin removal, which might jeopardise the teeth's structural integrity and raise the possibility of sensitivity or subsequent caries [3]. From a biological standpoint, FPDs have the ability to modify the normal environment of the periodontal ligament, which may result in problems including plaque buildup at the margins, a higher chance of periodontal disease, and difficulties with maintaining proper dental hygiene [4].

Adhesively bonded to the tooth's outer enamel layer, resin-bonded fixed partial dentures (RBFPDs) are a

conservative and affordable alternative to dental implants that require little preparation of the tooth. [5] These prostheses have some of the longest lifespans and best success rates in the dental literature, according to clinical studies. [6,7] They are considered a reversible treatment because they require less invasive preparation. [7]

Pediatric patients that might have the choice later when reaching an adult stage to do dental implant and conservation of tooth enamel will be an asset and advantage for those patients instead of having to go for a removable prosthetic option that usually does not satisfy a teenage patients. Resin bonded restoration provide the high quality of life required to those patients. [8, 9]

The development of zirconia has been a significant improvement in dental material science as it is a highly biocompatible material with excellent esthetics and superior mechanical properties. [10] Different abutment preparation approaches are considered when viewing the literature [11, 12]. Research revealed differing opinions on the necessary tooth preparation before placing resin bonded fixed partial dentures. To ensure the seating and retention of prostheses, the majority of evaluated research discussed creating proximal boxes, chamfers, pits, grooves, and slots on the lingual/palatal aspect of the abutment teeth. [11, 12]

However, some of the authors reviewed the "no preparation" option. It was stated that when preparation pierced the enamel, failure rates increased threefold. [13] Nevertheless, several surface treatment procedures, including alumina air abrasion, tribochemical silica coating, hydrofluoric acid etching, silanization, ultrasonic cleaning, metal primers, and zirconia primers, were covered in the articles under evaluation before bonding. [14,15] "No preparation" unilateral retainer dental bridges are not the standard of treatment and have not been studied in many clinical studies before. [16, 17]

Resin bonded fixed partial dentures (RBFPDs') have become a popular treatment option for the restoration of single missing incisors due to their minimally invasive nature and favorable aesthetic outcomes. [18-20] However, there is an ongoing debate regarding the need for tooth preparation to improve the long-term success of these restorations. Different materials are used in resin-bonded fixed partial dentures (RBFPDs), and each has unique benefits and drawbacks. Metal, zirconia, and lithium disilicate glass ceramic are common materials. Metal is preferred for posterior applications due to its mechanical qualities and biocompatibility. However, to improve its adhesive qualities, it needs surface treatments like sandblasting and primer application, which can make bonding more difficult. [2,5] Ceramics made of lithium disilicate glass are frequently utilised in anterior restorations and are renowned for their exceptional aesthetic features. Its reduced flexural strength, however, renders it less appropriate for the RBFPD minimum connector thickness. [17-20]

Zirconia, on the other hand, boasts superior strength and durability, making it ideal for this type of restorations. Its opacity can be a disadvantage in aesthetic applications; although newer translucent variants have improved its appearance [7, 8]. The objective of this randomized controlled trial was to compare the clinical outcomes of zirconia resin-bonded fixed partial denture with and without tooth preparation for the restoration of single missing maxillary incisors for adolescent patients in terms of retention, survival, and patient satisfaction. The null hypothesis of this study was that there would be no difference in the clinical outcomes of zirconia resin bonded unilateral fixed partial dentures with and without tooth preparation for adolescent patients.

2 Materials and Methods

2.1 Ethical Approval

The Ethical Committee of Scientific Research in the Faculty of Dentistry, October University for Modern Sciences and Arts approved the study with number REC-D124-2. This RCT has been described according to the CONSORT checklist for RCT writing and publishing guidelines [21]. The study has been registered on ClinicalTrials.gov (NCT05362591).

2.2 Sample size calculation

Based on a recent study by Anweigi.et al., 2013 [22], the predicted difference between the two groups is 20±13.7. Studying eight in each group will be necessary at a power of 80% and a significance level of 5%. The sample size will be increased to 9 in order to account for the nonparametric test. To make up for losses during follow-up (20% higher than the anticipated sample size), the number will be increased one again to a sample size of 12. The PS: Power and Sample Size Calculation software, Version 3.1.2, from Vanderbilt University in Nashville, Tennessee, USA, was used to calculate the sample size.

2.3 Study Design

This is an interventional clinical trial The study used a single-blinded, randomized, having two arms parallel design with a 1:1 allocation ratio. The study design followed the (CONSORT 2010 Flow Diagram) shown in **(Fig. 1)**. The institutional review board approved the study protocol.

2.4 Eligibility criteria

This clinical trial enrolled 24 participants aged between 12 to 18 years old.

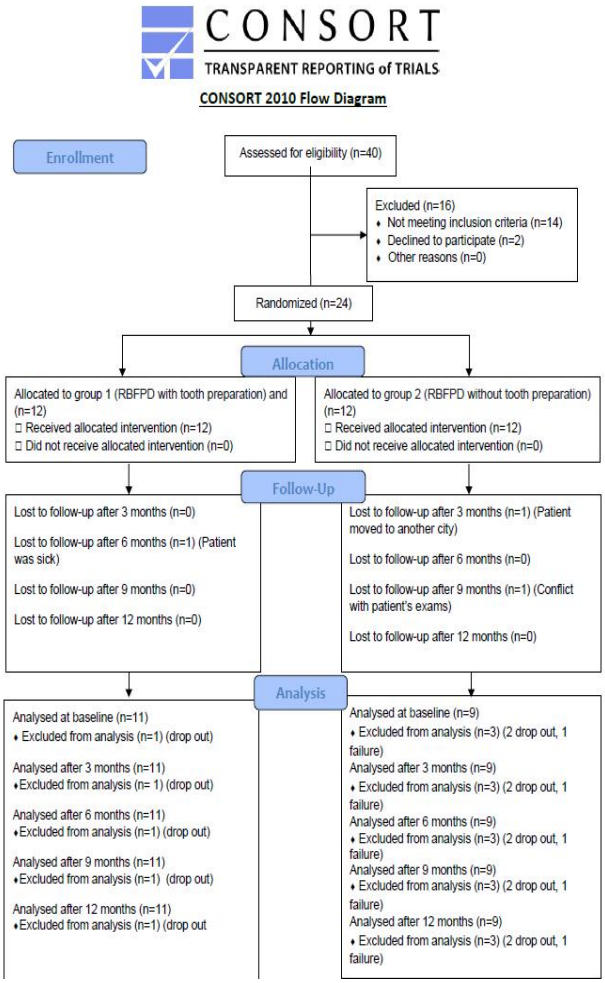

Figure 1. Consort flow diagram representing study design.

Inclusion criteria

Treatment strategy for anterior RBFPD with a 2-unit cantilever.

A maintained steady oral health and finished any ongoing treatments.

Adolescent patients between the ages of 12 and 18 years old with missing with full set of natural permanent dentition

Participants must have a full set of permanent teeth, with a missing upper central or lateral incisor.

Participants must be available for clinical review for up to 1 year.

Exclusion criteria

Uncontrolled or active dental diseases.

Heavily restored abutment teeth unsuitable for the restoration.

Mobility according to Miller's rating of grade 2 or above.

Alveolar bone support on the abutment is less than 30%.

Non-vital or root canal-treated abutment tooth.

2.5 Recruitment

All participants who fulfilled the eligibility criteria were recruited from the University Pediatric Dentistry Department outpatient clinic. Participants were divided into two groups: group 1 (RBFPD with tooth preparation) and group 2 (RBFPD without tooth preparation)

The parents/ guardian of the eligible participants who agreed to take part in the current study and committed to the follow-up appointments read and signed the informed consent document. This document explained all the steps, benefits, and risks involved in the study. The participants were recruited from February 2022 until June 2023. Every participant consented to attend a 3-month assessment for one year following bonding to receive cantilever zirconia RBFPD.

2.6 Allocation of Participants

2.6.1 Randomization and allocation concealment

Computer-generated simple randomization was performed using (Randomness and Integrity Services Ltd http:// www. random. org). The participants were randomly assigned to the two groups using a random sequence generator, with an allocation ratio of 1:1.

2.6.2 Blinding

This study is a single-blinded trial. The participants were blinded as they were notified about the restorative prosthesis used in the research study; however, they didn't know which type of intervention will be selected for their case. The operator and the outcome assessors could not be blinded because of the differences in the preparation techniques and the design of the restorations.

2.7 Treatment protocol

Regarding Group 1 (Tooth preparation), the abutment was prepared in a minimally invasive manner, relying only on the enamel, and following the previously standardized protocol [23]. A thin lingual veneer design and a fine cervical 0.5mm chamfer were used to prepare the retainer. The proximal finish line stopped before the proximal contact **(Fig. 2 a, b, c, d)**.

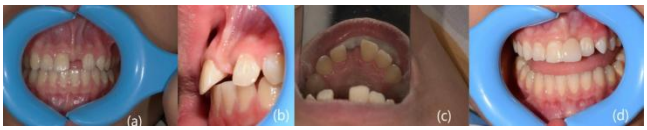

Figure 2. (a): Frontal view before preparation, (b): Profile vi7ew after preparation, (c): Tooth preparation design, and (d): RBFPD after cementation.

As for group II (No tooth preparation); the enamel on the lingual surfaces of the abutment teeth was gently roughened using a fine-grit diamond bur (Smooth cut AR2, GC, Tokyo, Japan) to create a micro-retentive pattern. Care was taken to avoid any excessive removal of tooth structure (Fig. 3 a, b, c a, d).

Figure 3. (a): Frontal view before preparation, (b): Profile view after preparation, (c): No tooth preparation design, and (d): RBFPD after cementation.

After that; the surfaces were etched for 20 seconds using phosphoric acid (Select Etch / BISCO Schaumburg, IL, USA). Before applying Easy Bond, the etched surfaces were sprayed with water and then dried using compressed air (3M ESPE, St. Paul, MN, USA). Next, the adhesive compound was exposed to light for 10 seconds using an Optilux 501 halogen light curing unit (Kerr Demetron, Danbury, CT, USA).

2.8 RBFPD Fabrication and Bonding

All two groups' patients were scanned intraorally using Medit i700 software version 2.5.7 (Medit, Seoul, and Republic of Korea). MCXL (Dentsply Sirona, Wals, Austria) milled monolithic zirconia (Vita YZ HT zirconia, VITA Zahnfabrik, H. Rauter GmbH & Co. KG). After being airborne-particle abraded with 50 μm alumina particles under 2-bar pressure, the retainer's intaglio surface was steam cleaned. Following the manufacturer's instructions, a Clearfil ceramic primer (Kuraray America, Inc.) and resin cement containing phosphate monomers (Panavia F2.0, Kuraray, Osaka, Japan) were used to cement the zirconia restorations. The restoration was carefully seated, and excess cement was removed. The cement was then light-cured for 60 seconds on each surface to ensure complete polymerization.

2.9 Post- Bonding Evaluation

Occlusion was evaluated following cementation to prevent any occlusal interference. The participants were instructed to avoid hard or sticky foods for the first 24 hours and to maintain good oral hygiene practices throughout the study. Regular follow-up appointments **were scheduled at** 3, 6, 9, and 12 months following clinical and radiographic assessment to assess the primary outcome measures for this study were: 1) Survival of the prosthesis (Zirconia resin-bonded fixed partial denture) over a 12-month time frame; and 2) patient-centred outcomes related to the prosthesis, including its impact on the patient's speech, esthetics, and thermal sensitivity, as well as the patient's satisfaction, measured using a visual analogue scale, over 12 months with a 3 months follow-up interval [7, 23]. The secondary outcome measure was: 1) bleeding on probing of the abutment teeth, assessed using the Papillary Bleeding Index [7, 23].

2.10 Statistical Analysis

For every test, the mean and standard deviation were computed for every group. Kolmogorov-Smirnov and Shapiro-Wilk tests were used to examine the normality of the data; the results revealed a non-parametric (non-normal) distribution (scores). When comparing more than two groups in linked samples, the Friedman test was employed. The Wilcoxon test was developed to compare two groups of related samples. Two groups of unrelated samples were compared using the Mann Whitney test. A significant threshold was set at $p \leq .05$. For statistical analysis, IBM® SPSS® Statistics Version 20 for Windows was used.

3 Results

There was no statistically significant difference found between (Group I: TP) and (Group II: NTP) where (p=0.705) **Table 1**. Group I showed no failure cases out of 11 cases (1 dropped out case at 6 months), while Group II showed one failed case out of 10 cases (2 dropped out cases at 3 and 9 months). The failed case was at 8 months due to connector fracture and new restoration was fabricated and delivered to the patient after re-roughening of enamel.

Five complications happened over the observation period, including two instances of debonding at 7 and 8 months, one caries involvement followed debonding at 11 months for group I. In addition, there were two instances of debonding for Group II at 5 and 6 months. **Table 2** displays the list of complications events per group. After all issues were addressed; all five rebonded restorations were monitored, and no further issues were noted.

Table 1. The frequencies of success rate in different groups.

Variables	Success rate			
	Group I (TP)		Group II (NTP)	
	n	%	n	%
Success	11	100%	9	90%
Failure	0	0%	1	10%
p-value	0.705ns			

ns; non-significant (p>0.05)

Table 2. List of complications in different groups.

Group	Debonding	Failure	Drop-outs
Group I	3	0	1
Group II	2	1	2

3.2 Visual Analogue Scale (VAS)

3.2.1 Relation between time periods

a) Group I:

There was no statistically significant difference found between (After 3m), (After 6m), (After 9m), and (After 12m) groups where (p=0.762) **Table 3, Figure 4**. The highest mean score was found in (After 6m), while the lowest mean score was found in (After 12m)

b)Group II:

There was no statistically significant difference found between (After 3m), (After 6m), (After 9m) and (After 12m) groups where (p=0.819) **Table 3, Figure 4**. The highest mean score was found in (After 6m), while the lowest mean score was found in (After 3m).

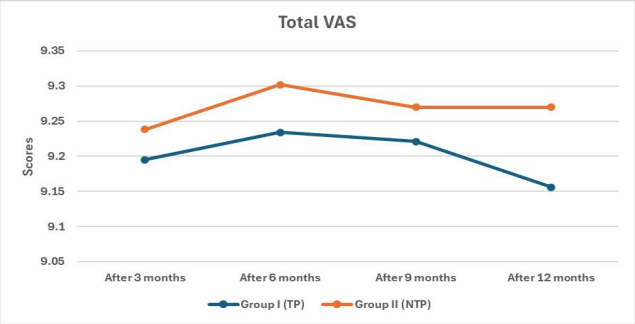

Figure 4. Line Chart representing VAS for different groups.

3.2.2 Relation between groups:

There was no statistically significant difference found between (Group I) and (Group II) after 3, 6, 9 and 12 months, where (p=0.637, 0.489, 0.642, and 0.731) respectively.

Table 3. The mean, SD and median values of total VAS in different groups.

Variables	Total VAS						
	Group I (TP)			Group II (NTP)			p-value
	Mean	SD	Median	Mean	SD	Median	
After 3 months	9.195	0.462	9.143	9.238	0.446	9.143	0.637 ns
After 6 months	9.234	0.448	9.286	9.302	0.400	9.429	0.489 ns
After 9 months	9.221	0.496	9.286	9.270	0.454	9.429	0.641 ns
After 12 months	9.156	0.653	9.286	9.270	0.532	9.571	0.731 ns
p-value	0.762ns			0.819ns			

ns; non-significant (p> .05)

3.3 Papillary bleeding Index

3.3.1 Relation between time periods

a) Group I:

A statistically significant difference was found between (After 3m), (After 6m), (After 9m) and (After 12m) groups where (p=0.072) **Table 4**.

b)Group II:

Between the (After 3m), (After 6m), (After 9m), and (After 12m) groups, there was a statistically significant difference (p=0.006). While there was a statistically significant difference between the (After 3m) and (After 12m) groups (p=0.014), there was no statistically significant difference between the (After 3m) and each of the (After 6m) and (After 9m) groups (p=0.317) and (p=0.083). Between the (After 6 m) and (After 12 m) groups, there was a statistically significant difference (p=0.025). The groups (After 9 m), (After 6 m), and (After 12 m) did not differ statistically significantly from one another (p=0.157 and p=0.083) **Table 4**.

3.3.2 Relation between groups:

There was no statistically significant difference found between (Group I) and (Group II) after 3, 6, 9 and 12 months,

where (p=1, 0.381, 0.890, and 0.355) respectively.

Table 4. The frequencies of Papillary bleeding Index in different groups.

Variables		Papillary bleeding Index				
		Group I (TP)		Group II (NTP)		p-value
		n	%	n	%	
After 3 months	Score 0	11	100%	9	100%	1ns
	Score 1	0	0%	0	0%	
	Score 2	0	0%	0	0%	
	Score 3	0	0%	0	0%	
	Score 4	0	0%	0	0%	
After 6 months	Score 0	8	72.7%	8	88.9%	0.381ns
	Score 1	3	27.3%	1	11.1%	
	Score 2	0	0%	0	0%	
	Score 3	0	0%	0	0%	
	Score 4	0	0%	0	0%	
After 9 months	Score 0	7	63.6%	6	66.7%	0.890ns
	Score 1	4	36.4%	3	33.3%	
	Score 2	0	0%	0	0%	
	Score 3	0	0%	0	0%	
	Score 4	0	0%	0	0%	
After 12 months	Score 0	6	54.5%	3	33.3%	0.355ns
	Score 1	5	45.5%	6	66.7%	
	Score 2	0	0%	0	0%	
	Score 3	0	0%	0	0%	
	Score 4	0	0%	0	0%	
p-value		0.072ns		0.006*		

*; significant (p<0.05) ns; non-significant (p>0.05)

4 Discussion

The primary aim of this randomized controlled trial was to evaluate the clinical outcomes of resin-bonded fixed partial dentures (RBFPDs) with and without tooth preparation in adolescents with single missing maxillary incisors. The hypothesis of this study was accepted as no statistically significant differences in survival or patient satisfaction was found between the two groups over the 12-month follow-up period. The results support the fact that less invasive treatment options can be effective for young patients.

Significant queries concerning the requirement of tooth reduction in RBFPDs are raised by the lack of a significant difference in success rates between the tooth preparation (TP) and no tooth preparation (NTP) groups. Although conventional methods frequently recommend some degree of tooth preparation to improve stability and retention, our results are consistent with a prior study that suggested that excessive preparation might not be necessary because of weakened enamel integrity and decreased structural support. [18] The "no preparation" strategy used in Group II places a strong emphasis on maintaining the natural tooth structure, which is especially important for teenage patients who might require restorative procedures in the future. [24]

Both groups showed steady survival rates over the course of the follow-up periods; Group I (tooth preparation) had no failures, while Group II (no tooth preparation) had just one failure. The failed case was restoring missing upper central at 8 months due to connector fracture and new restoration was fabricated and delivered to the patient after re-roughening of enamel. This suggests that RBFPDs can continue to operate over time even in the absence of conventional tooth preparation. Examining the VAS scores, however, showed that little variations happened at various times, even while satisfaction levels stayed constant. The highest mean satisfaction was found in Groups I and II at 6 months, which may have been related to the early prosthesis adaptation phase. It then slightly decreased in Group I by 12 months, while it was lowest in Group II at 3 months, which may have been related to ongoing adjustments or difficulties with oral hygiene.

Patient-centred outcomes, including satisfaction measured via the Visual Analogue Scale (VAS), indicated consistent satisfaction points across both groups. This finding underscores the potential of RBFPDs to meet aesthetic and functional needs without the invasiveness associated with traditional fixed prostheses. Previous literature has highlighted the importance of maintaining tooth structure for improving the quality of life in pediatric patients. [25,26] This is consistent with previous studies that

reported high patient satisfaction scores for zirconia Resin-Bonded fixed partial dentures. The aesthetic outcome of the bridges was a significant factor contributing to patient satisfaction, as zirconia has excellent translucency and colour matching properties. The favorable outcomes observed in this study suggest that RBFPDs can provide a high quality of life for adolescents, minimizing the need for more invasive options. [10,11,16]

The Papillary Bleeding Index (PBI) results indicated significant differences over time in Group II, suggesting variations in periodontal health that warrant further exploration. While both groups exhibited no significant differences in bleeding on probing at the 12-month mark, the initial increase in bleeding in the NTP group may reflect adaptation to the new prosthesis or changes in oral hygiene practices especially that it is over contoured compared to the TP group. This aligns with findings from a previous study that noted the importance of monitoring periodontal health in patients receiving fixed prostheses. [27] "No preparation" majority of problems are usually associated with supra occluding restorations and debonding. [28] Maintaining optimal oral hygiene practices is essential in moderating the risks associated with plaque accumulation, particularly in younger patients who may struggle with compliance. [29, 30] Despite the good outcomes, this study has limitations. The limited sample size, while suitable for initial comparisons, may limit the generalizability of the findings. Moreover, the 12-month follow-up period is too short to record long-term success rates or any problems that might develop later. Larger samples and longer follow-up times should be taken into account in future studies to confirm these results and investigate the long-term impacts of tooth preservation techniques on the effectiveness of RBFPDs.

The outcomes of this study will have a substantial impact on clinical pediatric prosthodontics patients. Patients will receive a dental prosthesis that does not require preparation or local anesthesia and can last for long periods. As a result, more young patients may choose tooth replacement treatment with this conservative treatment choice as a substitute for removable prosthesis in the upcoming era.

5 Conclusion

Within the limitations of this study:

1. Zirconia resin bonded fixed partial dentures can be successfully utilized in adolescent patients with single missing maxillary incisors, regardless of tooth preparation.
2. The results advocate for a conservative approach to tooth restoration, highlighting the balance between functional needs and the preservation of natural tooth structure.
3. The results provide evidence to guide clinicians in the selection of the optimal Resin-Bonded fixed partial denture technique for single incisor replacement.

Authors' Contributions

Aya A. Salama managed the methodology, Manuscript Writing.

Sherif Samir managed the resources and manuscript writing.

Naglaa Ibrahim managed the methodology, Review & Editing, and Supervision.

Conflict of interest

The authors declare that they hold no competing interests.

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