Comparison of Shear Bond Strength Between Uncoated and Precoated Orthodontic Brackets: A Systematic Review

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Abstract

Adhesive precoated brackets in orthodontics have been used over the last 20 years. This technique has been played as the topic of numerous studies with good support deeming it ready to assess their properties compared to conventional brackets. In this systematic review, we compared the differences of shear bond strength between precoated and uncoated brackets.

Electronic databases (The PubMed, Scopus, Springer, Cochrane library, and Web of Science) were explored without language restriction. The correlated orthodontic articles and reference records were confirmed for all eligible studies. Two journal reviewers individually retrieved the data and evaluated the quality of the primary studies.

A total of 152 articles were extracted in the initial search. However, only 15 articles met the inclusion criteria. Outcomes of shear bond strength between two systems of bracket were similar. The result was inconclusive, precoated bracket was not proven to be superior to the conventional bracket. There is no clinical agreement that can be made concerning the type of bracket systems.

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Introduction

In the last few decades, the orthodontic field has shown large attention in adhesive precoated brackets. Precoated brackets or adhesive precoated orthodontic brackets have been in continuous development.

According to its pros over the conventional, precoated brackets have gained much more reputation. Reduction of bonding time and failure rate have been claimed for adhesive precoated brackets.[1] On the other hand, bond strength of precoated and uncoated brackets is still controversial.[2-9]

To gain more understanding of appliance selection, the procedure should be dependent on clinical evidence. The aim of this systematic review is to compare shear bond strength between precoated and uncoated orthodontic brackets.

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Materials and methods

Search strategy

The PubMed, Scopus, Springer, Cochrane library, and Web of Science electronic databases were searched for published literature from 1993 – December 2020 according to the following keywords in all fields: (orthodontic) and (uncoated bracket or conventional bracket) and (precoated bracket or adhesive precoated bracket) and (shear bond strength) and (mode of failure). Table 1 and Figure 1 shows the keywords used for each database search.

Data extraction

The published studies were evaluated for eligible criteria based on title and abstracts by both two authors separately, consensus was made by discussion until disagreement was disappeared. Studies that were not correlated to the issue were excluded. Full text of entire related publications with inadequate information were required.

Essential data tables were employed to gather the extracted conclusions from involved studies. Study design, sample size, type of sample, materials used in the studies and outcome of each study were chosen to represent each of them.

The outcome of this review was the optimal shear bond strength between uncoated and precoated orthodontic brackets.

Inclusion criteria

The trials that met the following criteria were included:

- The study was retrospective or prospective randomized controlled trial or controlled clinical trial.
- The study investigated the shear bond strength of uncoated and precoated orthodontic brackets.
- The study was written in English language.

Exclusion criteria

- Studies with irrelevant study title or study design or study protocol.
- The case reports, commentaries, systematic reviews or meta-analyses descriptive studies, opinion articles, or abstract.

Results

Study inclusion

Primary electronic search found 152 related publications. After duplicate records were eradicated, 132 studies were examined by viewing titles and abstracts and 44 studies were eliminated. The remaining 17 articles were read in full text for suitability following the inclusion criteria and finally, 15 publications were incorporated in this review. The details are shown in PRISMA flow chart.

Study characteristics

The data of the involved studies is described in Table 2. From 15 studies, all studies were were randomly controlled trials (RCTs). Fourteen articles used parallel group designs and the remaining one used split-mouth design. These studies focused on comparison of uncoated (conventional) brackets and precoated (adhesive precoated) brackets in one interesting outcome which is shear bond strength.

Shear bond strength

In 1997, Bishara et al.[1] compared the shear bond strength and adhesive remnant index of both uncoated and precoated ceramic and metal brackets. 85 human molars joined in a randomized controlled trial. Shear bond strength was tested at 24 hours after bonded. Uncoated metal brackets showed statistically significant higher shear bond strength than that of precoated metal brackets. However, precoated ceramic brackets showed higher but not statistically significant shear bond strength.

Cal-Netoa et al.[10] in 2006 used 46 human upper first and second premolars to compare the shear bond strength of uncoated and precoated orthodontic brackets in a randomized controlled study. The outcomes were calculated 1 month after bonding procedure and the results indicated higher statistically significant shear bond strength in the uncoated group compared to that of the precoated group.

Another study in 2006 was from Parks[11], the study divided 60 human premolars into 4 groups and compared the shear bond strength. Results showed that group 1 (uncoated and 30 mins debonding) was 7.538 MPa, group 2 (uncoated and 24 hours debonding) was 14.895 MPa, group 3 (precoated and 30 mins debonding) was 8.654 MPa and group 4 (precoated and 24 hours debonding) was 8.303 MPa. Only groups of uncoated brackets with 24 hours thermocycling before debonding showed statistically significant higher shear bond strength than the other groups.

In contrast, Bishara et al. in 2005, [12] investigated the shear bond strength and bonding time between uncoated and precoated brackets in 80 human molars. The results revealed the controversy from the abovementioned studies. The precoated brackets showed higher statistically significant shear bond strength than that of uncoated brackets (9.4 and 6.2 MPa respectively).

Guzman et al. in 2013[13] conducted a randomized controlled study of the shear bond strength and mode of failure between uncoated and precoated brackets in 90 bovine permanent mandibular incisors. The shear bond strengths were assessed at 15 minutes, 24 hours and after thermocycling after bonded. The shear bond strength of 24 hours and thermocycling group showed no statistically significant difference between uncoated and precoated brackets, but, in the 15 minutes group, precoated brackets showed a statistically significant difference than that of precoated brackets.

Recently, in studies conducted by Szuhanek et al. in 2018[14] and Dewi et al. in 2019[15], the results of RCTs on human premolars using conventional and self-etching bonding procedures, respectively, showed statistically significant higher shear bond strength in precoated bracket groups than that of uncoated groups.

The eight remaining articles from the mentioned studies, moreover, showed no statistically significant difference of shear bond strength between uncoated and precoated orthodontic brackets.[2-9]

Discussion

From all 15 studies, 3 studies reported that the shear bond strength was significantly stronger with uncoated brackets. 4 of the studies reported that the shear bond strength was significantly stronger with precoated brackets and 8 studies concluded that both uncoated and precoated brackets had no significant differences. From their perspective, it can be concluded that uncoated or precoated brackets have little effect on shear bond strength.

Further studies should be conducted to reach a conclusion to control the force of pressing the brackets equally in each group. In a group of uncoated standard brackets, the amount must be the same as the pre-coated bracket group and should be controlled during loading of the adhesive into the brackets.

Appropriate randomization, blinding of treatment groups, masking of outcome evaluations, rigid eligibility criteria, and appropriate analyses to reduce bias should be included in future study designs.

There are currently studies that are similar to this systematic review and quite interesting. For example, how does the addition of silver nanoparticles to orthodontic adhesive affect tensile bond strength, and a comparative study of shear bond strengths between metal brackets manufactured in different countries.[16, 17] If there are studies are conducted in the future, it would be fascinating to compile them for a systematic review.

Limitations

It was noted in the literature that a direct comparison of results between investigations testing identical materials should be interpreted with caution because, as a result of the variation in the number of operators, bonding techniques, research designs, and observation period, it is difficult to make direct comparisons of the shear bond strength between studies.

Conclusions

From the view of the studies included in this systematic review, it can be concluded that adhesive precoated brackets do not grant any special advantages over uncoated or conventional brackets in terms of shear bond strength. However, it is ambiguous to make a final decision. Based on current available data, weak evidence supports that adhesive precoated brackets have superior shear bond strength to conventional bracket system. More high-quality clinical trials to verify the long-term effects are needed to draw a more reliable conclusion.

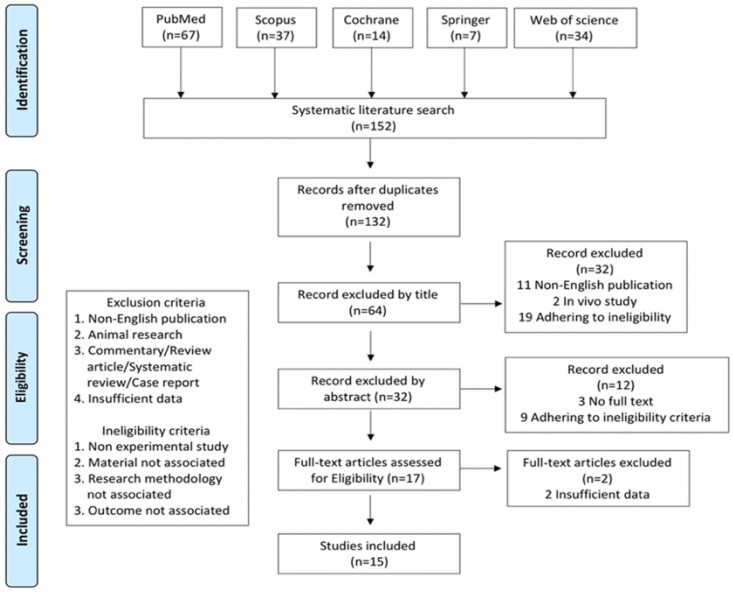

Figure 1. PRISMA Flow diagram.

Data base	Search term
Pubmed	(''Dental bonding'' OR ''dental cements'' OR ''Orthodontic adhesives'' OR ''Orthodontic brackets'') AND ("Precoated" OR "Pre-coated" OR ''Pre coated'') AND ("shear bond")
Web of science	(Shear bond) and (precoated brackets or precoated adhesive brackets or adhesive precoated brackets)
Scopus	ALL (Shear AND bond AND precoated AND brackets AND orthodontic AND brackets
Cochrane	(Shear bond) and (precoated brackets or precoated adhesive brackets or adhesive precoated brackets)
Springer	"Shear bond" AND "precoated" AND "brackets"

Table 1. Keywords used for each database search.

Author/Year		S E Bishara et al., 1997	S. Sunna and W. P. Rock, 1999	S E Bishara et al., 2002	S E Bishara et al., 2005	J P Cal-Netoa et al., 2006
Design		RCT	RCT	RCT	RCT	RCT
N		85	20	60	80	46
Sample		Human molars	Human premolars	Human molars	Human molars	Human upper premolars
Etching		37% Phosphoric acid, 30s	35% Phosphoric acid, 30s	37% Phosphoric acid, 30s	37% Phosphoric acid, 15s	37% Phosphoric acid
Bonding		Transbond XT	-	Transbond XT	Transbond XT MIP	Transbond XT & Transbond Plus SEP
Adhesive		Transbond XT	Transbond XT	Transbond XT	Transbond XT	Transbond XT
Curing Unit		20s	Ortholux XT light unit (3M Unitek), 40s	Halogen light (Ortholux XT, 3M Unitek), 20s (10s for each side)	Halogen light (Ortholux XT, 3M Unitek), 20s (10s for each side)	Halogen light (Ortholux XT, 3M Unitek), 20s (10s for each side
Timing		24 hrs	24 hrs after stored in distilled water	30 mins after	30 mins after	1 month after
SBS	Uncoated	M: 7.2 (3.1)* C: 10.4 (3.6)	22.32(1.6)	5.7 (2.4)	6.2 (4.4)	11.35 (2.36)*
	Precoated	M: 5.4 (2.5) C: 12.7 (4.5)	22.08(3.41)	APC: 5.1 (1.7) APC II: 4.9 (2.1)	9.4 (3.7)*	9.77 (2.49)

Author/Year		S Hirani and M Sherriff, 2006	M S Parks, 2006	A Vicente and L A Bravo, 2006	A. Vicente, L.A. Bravo, 2007	A H Hassan, 2010
Design		RCT	RCT	RCT	RCT	RCT
N		86	60	55	40	218
Sample		Human premolars	Human premolars	Human premolars	Human premolars	Split mouth
Etching		Transbond Plus Self Etching Primer	Transbond Plus SEP	37% o-phosphoric, 30s	Transbond Plus SEP	37% Phosphoric acid, 20s
Bonding		Transbond Plus Self Etching Primer	Transbond Plus SEP	Transbond XT	Transbond Plus SEP	Transbond XT
Adhesive		Transbond XT	Transbond XT	Transbond XT	Transbond XT	Transbond XT
Curing Unit		Ortholux XT	Ortholux LED Curing Light (3M Unitek,), 10s	Ortholux XT, 20s	A LED unit (Elipar S10, 3M ESPE), 40s	EliparTM S10 LED Curing Light, 30s
Timing		-	30 mins (1) After 24 hours of thermocycling (2)	24 hrs after stored in distilled water at 37°C	24 hrs after stored in distilled water at 37°C	1 hour after (1) 2 weeks after (2)
SBS	Uncoated	75.4(21.3)	7.538(2.841) (1) 14.895(3.283) (2) *	12.27(5.01)	12.20(4.27)	1: 4.1 (0.84) 2: 4.27 (1.3)
	Precoated	APC1 68.4(19.1) APC2 74.9(17.2)	8.654(1.965) (1) 8.303(3.158) (2)	14.13(3.35)	14.28(3.41)	1: 3.96 (1.0) 2: 3.96 (0.96)

Author/Year		U A Guzman et al., 2013	M G Marc et al., 2018	C Szuhanek et al., 2018	L D P Dewi et al., 2019	C G Serrano et al., 2019
Design		RCT	RCT	RCT	RCT	RCT
N		90	45	10	30	60
Sample		Bovine mandibular incisors	Human premolars	Human premolars	Human upper first premolars	Human premolars
Etching		35% Phosphoric acid, 20s	36% Phosphoric acid, 15s	37% Phosphoric acid, 30s	Self – etching primer	35% Phosphoric acid, 30s
Bonding		Transbond XT	Transbond XT	Transbond XT	Self – etching	Transbond XT
Adhesive		Transbond XT	Transbond XT	Transbond XT	Transbond XT	Transbond PLUS
Curing Unit		Ortholux LED (3 M Unitek) for a total of 10 s	LED Valo® lamp (Ultradent), 12s	-	20s (10s for each side)	A LED unit (Elipar S10, 3M ESPE, St Paul, MN, USA), 40s
Timing		(T1): 15 min after (T2): 24 hrs after (T3): thermocycling	24 hrs after stored in distilled water	24 hrs	30 mins after	24 hrs (1) 10,000 cycles (2) 20,000 cycles (3)
SBS	Uncoated	T1: 5.37 (1.62) T2: 6.82 (2.24) T3: 6.54 (3.08)	26.26(10.33)	8.23(0.8147)	10.0610 (0.75)	1: 23.7 (4) 2: 20.1 (7.6) 3: 17.3 (8.1)
	Precoated	T1: 6.27 (1.43) * T2: 7.19 (2.13) T3: 7.39 (2.36)	27.11(9.38)	10.97(2.865) *	11.5750 (1.08) *	1: 24.0 (5.4) 2: 18.1 (5.9) 3: 20.0 (6.3)

Table 2. Overview of included studies.

Declaration of Interest

The authors report no conflict of interest.

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