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Clinician preferences for orthodontic bracket bonding materials: a quantitative analysis

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Background and objectives: Many orthodontic bracket-bonding materials are available for clinical use. The current study aimed to assess the preferences and factors contributing to the clinical choice of bracket bonding material.
Methods: Eight bracket bonding materials were trialled by 15 participants. The handling properties and overall ease of use of each material were scored by the participants on a Visual Analogue Scale (VAS). The participants also responded to a questionnaire regarding the use and perceptions of resin-modified glass ionomer cements (RMGICs) for bracket bonding. A quantitative analysis was conducted on the responses to the questionnaire.
Results: Of all materials trialled, there was a consistent preference for the handling of resin composite (RC) materials. Fuji® II LC was the highest rated RMGIC material and was considered similar to RC materials for ease of handling.
Conclusions: Fuji® II LC may be a suitable alternative to RC materials for orthodontic bracket bonding. Further research is required to assess and produce bonding materials possessing anti-cariogenic properties along with comparable handling properties to bracket bonding materials that are currently preferred.
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Introduction

To allow the transmission of mechanical forces to a tooth, contemporary orthodontic brackets are attached onto the enamel surfaces using a bonding material. Variables essential for successful bonding include the surface treatment of the tooth, the bonding material type and properties of the bracket bonding surface.[1–3] The ideal bonding material should have sufficient strength to withstand the oral environment during use and be easily removed without causing iatrogenic enamel damage.

Resin composite (RC) materials are currently the conventional choice for bracket bonding.[4] Following setting polymerisation, resin composite adheres to tooth structure via micromechanical interlocking of component monomers to the etched enamel.[5] Attachment occurs by the engagement of the composite material into undercuts of the bracket base. The properties of high bond strength and good aesthetics make resin composite suitable for orthodontic bracket bonding. However, white spot lesions may form during treatment and damage to the underlying enamel may occur during bracket removal,[6] which can significantly affect the quality of the final orthodontic outcome.

Glass ionomer cements (GICs) provide adhesion via a chemical bond to tooth structure through an acid-base reaction of a carboxyl group of a polyacid component and the calcium ions in the hydroxyapatite of tooth structure.[7] The past two decades have seen the development of resin-modified GICs (RMGICs) that combine the fluoride-releasing properties of GIC with the superior structural stability of composite materials. The acid-base reaction of RMGIC is combined with the polymerisation of methacrylate monomers, which produces a superior bond strength compared with conventional GICs.[8] RMGIC materials show promise as orthodontic adhesives by displaying clinically acceptable bond strengths when pre-bonding tooth surface treatments are used,[9,10] and a secondary advantageous ability to decrease demineralisation around orthodontic brackets.[11–13] To date however, resin composite remains the most commonly used bracket bonding material in orthodontic practice.[4]

There is little available evidence regarding the clinical preferences for different orthodontic bracket bonding adhesives. The current study therefore aimed to assess the preferences of clinicians and the contributing factors regarding their choice of currently available orthodontic bracket bonding materials. This study is the first of a two-part series, with a focus on the quantitative analysis of clinician preferences for the use of bonding materials.

Materials and methods

Ethics approval (Ethics ID 1851438.1) was obtained from the Human Research Ethics Committee of the University of Melbourne for the research project.

The participants were recruited from the Melbourne Dental School via convenience sampling and were either registered orthodontists or postgraduate orthodontic students. The participants were invited to trial eight different materials using identical brackets (Victory Series™ Bracket System, 3M Unitek, Monrovia, California, USA). Following the manufacturer's instructions, the brackets were attached to bovine teeth mounted in plaster in a stock tray which mimicked a human arch form. The bovine teeth were sanitised by soaking in 0.5% Chloramine T solution for 1 week prior to assembly and mounting.

The eight materials trialled were Fuji® II LC (GC corporation, Tokyo, Japan), Ortholy glass bond (GC corporation, Tokyo, Japan), Fuji Ortho™ LC (capsule) (GC corporation, Tokyo, Japan), Light Bond™ thin paste (Reliance orthodontic products, Itasca, Illinois), Fuji Ortho™ LC (paste pak) (GC corporation, Tokyo, Japan), Transbond™ XT (Transbond™ XT light cure adhesive (white); 3M Unitek, Monrovia, California), F2A-10-2 (trial material) (GC corporation, Tokyo, Japan) and APC™ Flash-Free Adhesive Coated Appliance System (3M Unitek, Monrovia, California). These materials were labelled from A to H, respectively (Table I).

In chronological order from material A to material H, each material was individually trialled by following the same repeated process from the start (dispensing) to the finish (curing, followed by the questionnaire section (A)). Each material was dispensed onto a Victory Series™ bracket (3M, St Paul, MN, USA), except for the APC™ Flash-Free Adhesive Coated Appliance System (3M Unitek, Monrovia, California, USA), which utilised a bracket pre-coated with resin composite. After material dispensing, each bracket was positioned onto the tooth, excess flash was removed, and the curing process completed using a conventional LED curing light at 1200 $mW/cm^2 \pm 10\%$ to bond each bracket according to manufacturer's instructions. The participants were verbally informed of the manufacturers' recommended curing times for each material.

The participants also completed a questionnaire containing two sections: (A) questions rating the properties of the eight different materials (Table II); and (B) questions regarding the circumstances in which they would consider using an RMGIC bracket adhesive. In this section, the participants were provided with a list of seven clinical scenarios for consideration regarding the use of a RMGIC bracket bonding material. In addition, the participants were provided with an open-ended space to list other clinical situations when they might choose to use a RMGIC bracket adhesive. The following question was also included in the questionnaire: "If pre-treatment includes applying 5% sodium hypochlorite for 60 sec, then rinsing prior to acid etching to improve RMGIC bond strength to enamel, would this deter you from using RMGIC?". After trialling all materials and their handling properties, the participants were asked to indicate their most and least preferred material.

A Visual Analog Scale (VAS) was utilised (Figure 1) to record each participant's rating of the assessed material properties.

Table I. Materials trialled in the study and corresponding labels, dispensing system of each material, material category, manufacturers' instructions for material cure times with conventional light curing units.

Material label	Material	Dispensing system	Material category	Required cure time (with conventional light curing unit)
A	Fuji® II LC	Ketac applicator	Resin-modified glass ionomer cement (RMGIC)	10 sec each, mesial and distal surfaces
B	Ortholy glass bond	Hand dispenser with mixing tip	RMGIC	20 sec each, mesial and distal surfaces
C	Fuji Ortho™ LC (capsule)	Ketac applicator	RMGIC	10 sec each, mesial, distal, incisal and apical surfaces
D	Light Bond™ thin paste	Push syringe	Resin composite (RC)	10 sec from incisal and 10 sec from any other surface
E	Fuji Ortho™ LC (paste pak)	Hand dispenser with mixing tip	RMGIC	20 sec each, mesial and distal surfaces
F	Transbond™ XT	Push syringe	RC	5 sec each, mesial and distal surfaces
G	F2A-10-2 (trial material)	Hand dispenser with mixing tip	RMGIC	20 sec each, mesial and distal surfaces
H	APC™ Flash-Free Adhesive Coated Appliance System	Pre-coated bracket	RC	10 sec each, mesial and distal surfaces, without cleaning excess

Table II. Material properties rated by participants. The property 'vertical drift' refers to the ease of product handling relative to undesirable movement of the bracket along the long axis of the tooth during bracket positioning.

Question number	Material properties assessed
1	Dispensing system
2	Bracket stability during placement
3	Material viscosity
4	Ease of clean up
5	Bracket stability during clean up
6	Vertical drift
7	Working time
8	Overall ease of use

A non-parametric method for hypothesis testing was applied because of the asymmetric results. Data were analysed using a Friedman test (one-way ANOVA) at a 95% confidence interval. Median, 25th and 75th percentile VAS scores of each material and for each assessed property, were reported.

Results

The study involved 15 participants, of whom nine were orthodontists and six were orthodontic postgraduate students. No other demographic data were collected.

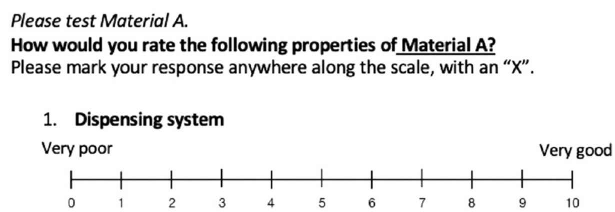

Figure 1. An example of the 10 cm Visual Analogue Scale (VAS) utilised for the questionnaire.

Median Visual Analogue Scale (VAS) scores for each material in each category of handling were recorded (Figure 2). APC™ Flash-Free Adhesive Coated Appliance system and Transbond™ XT were rated with the highest median VAS values (Table III) in five out of eight assessed material properties. Light Bond™ thin paste was rated the highest median VAS value in two out of the eight assessed properties. Light Bond™ thin paste and Transbond™ XT shared the highest median VAS score for "bracket stability during placement" (median VAS = 7.9) and "vertical drift" (median VAS = 9.0), while the APC™ Flash-Free Adhesive Coated Appliance System and Transbond™ XT resin shared the highest median VAS score for

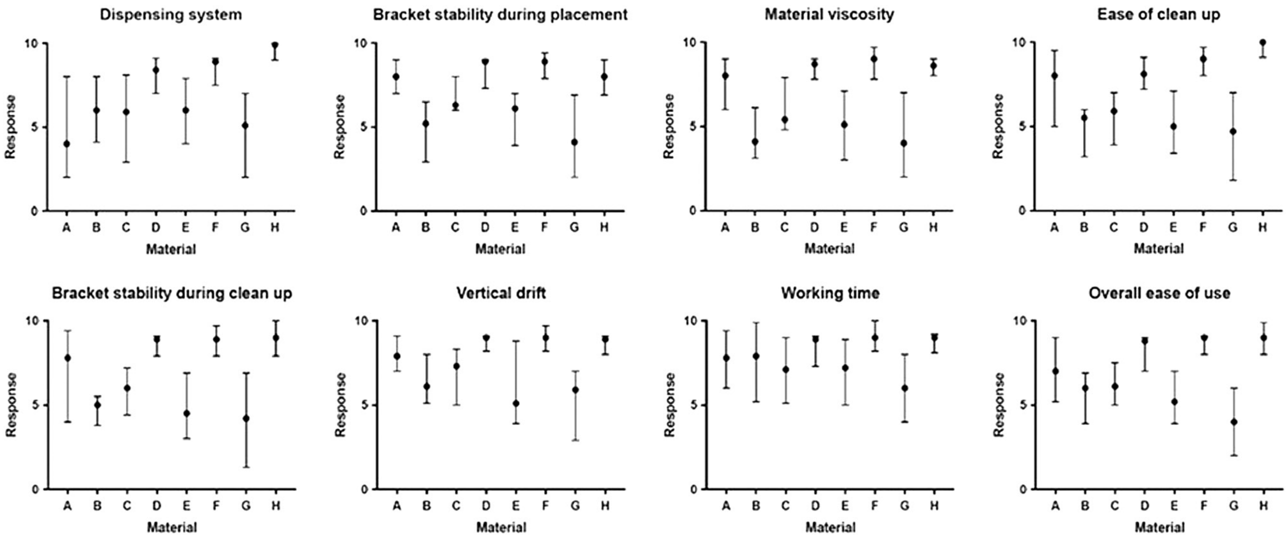

Figure 2. Line graphs depicting median, 25th and 75th percentile Visual Analogue Scale (VAS) responses. Material key—A: Fuji® II LC, B: Ortholy Glass Bond, C: Fuji Ortho™ LC (capsule), D: Light Bond™ thin paste, E: Fuji Ortho™ LC (paste pak), F: Transbond™ XT, G: F2A-10-2 (trial material), H: APC™ Flash-Free Adhesive Coated Appliance System.

Table III. All materials were rated using a 10.0 cm visual analogue scale (VAS), for each handling property assessed. Highest median VAS scores with corresponding materials of all materials trialled, highest median VAS scores with corresponding materials of all RMGIC materials, lowest median VAS scores with corresponding materials of all materials trialled, for each handling property assessed.

Handling property	Highest rated	Median VAS	Highest rated RMGIC	Median VAS	Lowest rated	Median VAS
Dispensing system	APC™ Flash-Free Adhesive Coated Appliance System	9.9	Ortholy Glass Bond, Fuji Ortho™ LC (paste pak)	6.0	Fuji II LC	4.0
Bracket stability during placement	Light Bond™ thin paste, Transbond™ XT	7.9	Fuji® II LC	8.0	F2A-10-2	2.0
Material viscosity	Transbond™ XT	9.0	Fuji® II LC	8.0	F2A-10-2	4.0
Ease of clean up	APC™ Flash-Free Adhesive Coated Appliance System	10.0	Fuji® II LC	8.0	F2A-10-2	4.7
Bracket stability during clean up	APC™ Flash-Free Adhesive Coated Appliance System	9.0	Fuji® II LC	7.8	F2A-10-2	4.2
Vertical drift	Light Bond™ thin paste, Transbond™ XT	9.0	Fuji® II LC	7.9	Fuji Ortho LC	5.1
Working time	APC™ Flash-Free Adhesive Coated Appliance System, Transbond™ XT	9.0	Ortholy Glass Bond	7.9	F2A-10-2	6.0
Overall ease of use	APC™ Flash-Free Adhesive Coated Appliance System, Transbond™ XT	9.0	Fuji® II LC	7.0	F2A-10-2	4.0

"working time" (median VAS = 9.0) and "overall ease of use" (median VAS = 9.0).

In six out of eight assessed properties, F2A-10-2 scored the lowest median VAS value out of all materials trialled.

Dispensing system

A number of materials shared the same dispensing systems (Table I). The "dispensing system" for APC™ Flash-Free Adhesive Coated Appliance System had the highest preferred rating (median VAS = 9.9), while Fuji® II LC (median VAS = 4.0) ranked the lowest.

The dispensing system for APC™ Flash-Free Adhesive Coated Appliance System (median VAS = 9.9) was ranked significantly higher ($p < 0.003$) than that of all RMGIC materials. Transbond™ XT (median VAS = 8.9) was ranked significantly higher than that of all RMGIC materials ($p < 0.049$) except for Ortholy glass bond (median VAS = 6.0, $p = 0.0554$). The dispensing system for Light Bond™ thin paste (median VAS = 8.4) was ranked significantly higher than that of Fuji® II LC (median VAS = 4.0, $p = 0.0026$) and F2A-10-2 (median VAS = 5.1, $p = 0.0047$). No other significant differences between materials were noted.

Bracket stability during placement

Light Bond™ thin paste and Transbond™ XT shared the highest rating (median VAS = 8.9) for bracket stability during placement. F2A-10-2 (median VAS = 4.1) had the lowest VAS median score of all materials tested.

Transbond™ XT had significantly higher bracket stability compared with all RMGIC materials ($p < 0.0084$) except Fuji® II LC (median VAS = 8.0, $p > 0.99$). APC™ Flash-Free Adhesive Coated Appliance System (median VAS = 8.0) was ranked significantly higher ($p < 0.003$) than all RMGIC materials except for Fuji® II LC (median VAS = 8.0, $p > 0.99$) and Fuji Ortho™ LC (capsule) (median VAS = 6.3, $p = 0.31$). Fuji® II LC (median VAS = 8.0) and Light Bond™ thin paste (median VAS = 8.9) had significantly higher bracket stability than F2A-10-2 (median VAS = 4.1, $p < 0.004$) only. No other significant differences were noted.

Material viscosity

Transbond™ XT had the highest rating (median VAS = 9.0) for material viscosity, while F2A-10-2 ranked the lowest (median VAS = 4.0).

The viscosity of Light Bond™ thin paste (median VAS = 8.7), Transbond™ XT (median VAS = 9.0) and APC™ Flash-Free Adhesive Coated Appliance System (median VAS = 8.6) were ranked significantly higher than all RMGIC materials except for Fuji® II LC (median VAS = 8.0, $p > 0.99$). No other significant differences were noted.

Ease of clean-up

APC™ Flash-Free Adhesive Coated Appliance System (H) had the highest rating (median VAS = 10) for ease of clean-up, while F2A-10-2 Trial material ranked the lowest (median VAS = 4.7).

Clean-up was significantly easier ($p < 0.05$) for Transbond™ XT (median VAS = 9.0) and APC™ Flash-Free Adhesive Coated Appliance System (median VAS = 10) than all RMGIC materials except for Fuji® II LC (median VAS = 8.0, $p > 0.09$). Clean-up for Light Bond™ thin paste (median = 8.1) was significantly easier than all RMGIC materials except for Fuji® II LC and Fuji Ortho™ LC (capsule) (median VAS = 5.9, $p > 0.05$). No other significant differences between materials were noted.

Bracket stability during clean-up

APC™ Flash-Free Adhesive Coated Appliance System had the highest rating (median VAS = 9.0) for bracket stability during clean-up and F2A-10-2 ranked the lowest (median VAS = 4.2).

APC™ Flash-Free Adhesive Coated Appliance System, Light Bond™ thin paste and Transbond™ XT ranked significantly higher ($p < 0.01$) than all RMGIC materials except Fuji® II LC (median VAS = 7.8, $p > 0.99$) and Fuji Ortho™ LC (capsule) (median VAS = 6.0, $p > 0.09$). No other significant differences between materials were noted.

Vertical drift

Light Bond™ thin paste and Transbond™ XT shared the highest ranking (median VAS = 9.0) regarding vertical drift, while Fuji Ortho™ LC (Paste pak) ranked the lowest (median VAS = 5.1).

Light Bond™ thin paste and Transbond™ XT were ranked significantly better in controlling vertical drift than all RMGIC materials except Fuji® II LC (median VAS = 7.9) and Fuji Ortho™ LC (capsule) (median VAS = 7.3). Fuji® II LC (median VAS = 7.9) and APC™ Flash-Free Adhesive Coated Appliance System (median VAS = 8.9) ranked significantly higher than F2A-10-2 (median VAS = 5.9, $p < 0.017$). No other significant differences between materials were noted.

Working time

Transbond™ XT and APC™ Flash-Free Adhesive Coated Appliance System shared the highest ranking (median VAS = 9.0) for working time, while F2A-10-2 ranked the lowest (median VAS = 6.0).

Working time for Light Bond™ thin paste, Transbond™ XT and APC™ Flash-Free Adhesive Coated Appliance System all ranked significantly higher ($p < 0.0085$) than F2A-10-2 only, with no other significant differences between materials found.

Overall ease of use

Transbond™ XT and APC™ Flash-Free Adhesive Coated Appliance System shared the highest ranking (median VAS = 9.0) for overall ease of use, while F2A-10-2 ranked the lowest (median VAS = 4.0).

Transbond™ XT and APC™ Flash-Free Adhesive Coated Appliance System both ranked significantly higher than all RMGIC materials except Fuji® II LC (median VAS = 7.0, $p > 0.71$). Light Bond™ thin paste (median VAS = 8.8) was ranked significantly higher than Ortholy glass bond (median VAS = 6, $p = 0.049$) and F2A-10-2 (median VAS = 4.0, $p = 0.0084$). No other significant differences between materials were found.

Participants' favourite and least favourite materials

Participants chose APC™ Flash-Free Adhesive Coated Appliance System (60%, $n = 9$), Transbond™ XT (20%, $n = 3$) and Light Bond™ thin paste (20%, $n = 3$) as their most favoured materials, all of which were resin composite materials. In comparison, materials F2A-10-2 (40%, $n = 6$), Ortholy glass bond (26.7%, $n = 4$), Fuji Ortho™ LC (paste pak) (20%, $n = 3$), Fuji Ortho™ LC (capsule) (6.7%, $n = 1$) and Light Bond™ thin paste (6.7%, $n = 1$), four out of five of which were RMGIC materials, were chosen by clinicians as their least favoured.

Clinicians' current clinical usage and perceptions of RMGIC bracket bonding materials

A minority (26.7%, $n = 4$) of the participants stated that they would never use GIC as a bracket adhesive, while 73.3% ($n = 11$) of the participants would use RMGIC bracket adhesives in certain situations.

The reasons listed for not using RMGIC materials included poor perceived bond strength, poor viscosity, a lack of available RMGIC-based materials in the workplace, bracket repositioning issues, long curing times (>10 s), poor working time and poor handling properties.

Several practitioners indicated that they would use RMGIC bracket bonding materials in certain suggested clinical scenarios (Table IV). Other circumstances in which practitioners might use RMGICs included: when bonding ceramic brackets ($n = 5$), in medically compromised and special needs patients ($n = 1$), if bracket removal needed to be easier ($n = 1$) and if the material would serve multiple purposes (e.g., for aligner attachments) ($n = 1$).

Table IV. Suggested hypothetical clinical scenarios, and frequency of these scenarios being chosen, by practitioners, for the use of RMGIC bracket bonding materials.

	Participants	
Hypothetical clinical scenarios	Number	Per cent (%)
Patients with increased caries risk	8	53.3
Patients with enamel defects	7	46.7
If RMGIC is easier to use than their current adhesive	7	46.7
If RMGIC costs less than their current adhesive	3	20
If RMGIC causes less drift than their current adhesive	4	26.7
On specific teeth with increased caries risk	3	20
On specific teeth with enamel defects	2	13.3

Effect of the need for sodium hypochlorite pre-treatment protocols on clinician usage of RMGIC materials

The majority (73.33%, *n* = 11) of the participants indicated that the need to use a 5% sodium hypochlorite pre-treatment for 60 sec prior to acid etching to improve RMGIC bond strength to enamel would deter them from using the material for bracket bonding. The remaining participants either said that they would not be deterred (20%, *n* = 3), or that there was uncertainty (6.67%, *n* = 1).

Discussion

The current study aimed to quantitatively assess clinicians' preferences and contributing factors in choosing orthodontic bracket bonding materials across an array of the currently available resin composite and RMGIC materials.

Resin composite (RC) bracket bonding materials were consistently assessed as the highest ranked materials in all categories. The APC™ Flash-Free Adhesive Coated Appliance System and Transbond™ XT adhesives were the highest ranked materials in five of the eight categories, and Light Bond™ thin paste was the highest ranked material in two of the eight categories. All participants chose an RC material as their favourite bonding agent; 60% of participants selected the APC™ Flash-Free Adhesive Coated Appliance System as their preferred, while the remaining participants chose either Transbond™ XT or Light Bond™ thin paste. The current study suggests that a superior ease of handling of RC materials, compared to that of RMGICs, is a likely contributing factor to the higher rates of routine use of RC materials for bracket bonding. Banks et al. (2010) showed that 58.5% and 23.6% of UK orthodontists routinely used light-and chemical-cured composites, respectively; 16.6% used pre-coated brackets, but only 3.4% routinely used GIC materials.[4] Practitioners may naturally find resin composite materials easier to use than conventional GIC or RMGIC materials, due to previous experience with the materials during orthodontic training or in clinical practice.

Fuji® II LC, an RMGIC material designed for restorative purposes,[14] ranked highest of all RMGIC materials in six of the eight assessed properties, but notably overall ease of use. Interestingly, Fuji® II LC showed no significant differences in median VAS scores when compared to the three trialled resin composite materials in seven of the eight assessed categories, except for the "dispensing system". Fuji Ortho™ LC is a similar RMGIC material designed specifically for bracket bonding and was trialled in the present study in 'paste pak' and capsule dispensing systems. The handling properties of Fuji Ortho™ LC were generally ranked lower than Fuji® II LC in the current study, although differences between rankings were not always significant. Fuji® II LC is a resin modified GIC material that has been manufactured with a higher filler content compared to other RMGIC products.[14] This may contribute to an increased viscosity and therefore create easier material handling properties when used as a bracket bonding adhesive. The increased viscosity of Fuji® II LC may also mimic RC-based materials more closely than other RMGIC materials, which may then increase its perceived ease of use. The majority of current literature reporting RMGIC as orthodontic bracket adhesives has assessed Fuji Ortho™ LC as the trial RMGIC material against resin composite materials.[15–18] There are few studies that have assessed Fuji® II LC as an orthodontic bracket bonding material against resin composite materials.[19–22] Fricker (1994) reported no significant differences in bracket failure rates when attached using Fuji® II LC compared with System I + resin composite after 12 months.[19] Hegarty and Macfarlane (2002) and Ireland and Sherriff (2002) reported significantly higher bracket failure rates associated with Fuji® II LC at 12 and 18 months in vivo, respectively, when compared to composite resin materials (Rely-a-bond and Right On, respectively).[20,21] Hegarty and Macfarlane (2002), however, also reported that, after bracket removal, significantly more enamel demineralisation was found around composite resin bracket-bonding materials than around Fuji® II LC. In addition, it was further determined that both types of materials demonstrated acceptable failure rates for routine clinical use.[20] Shirazi et al. (2019) investigated the addition of bioactive glass (BAG) to Fuji® II LC and compared the enamel demineralisation around brackets bonded with the modified Fuji® II LC, plain Fuji® II LC and Transbond™ XT resin composite material.[22] Significant differences were reported between the three materials, with enamel around brackets bonded with Transbond™ XT experiencing the greatest depth of demineralisation, followed by that caused by Fuji® II LC and then BAG-modified Fuji® II LC. The current study suggests that Fuji® II LC is an available RMGIC material with comparable handling properties compared to resin composite materials, and further research is required to assess the adequacy of Fuji® II LC as an orthodontic bracket adhesive for routine clinical use.

Most participants (93.3%, *n* = 14) chose an RMGIC material as their least preferred material. F2A-10-2 was chosen by 40% of participants as their least favourite material indicated by the lowest median VAS score for six of the eight assessed categories, including overall ease of use. The present study identified important handling properties considered to be significantly suitable for bracket-bonding materials in clinical use and, accordingly, suggests that materials that perform poorly in the assessed categories are unlikely to be popular choices for clinical use. Future product development might be directed at these parameters to improve RMGIC ease of handling, to increase their clinical attractiveness as a choice of material for orthodontic bracket attachment.

The requirement of the suggested 60-sec pre-treatment protocol with sodium hypochlorite was a significant deterrent for the majority (73.3%, *n* = 11) of the participants. The literature showing increased shear bond strengths of RMGIC bonded brackets using the sodium hypochlorite pre-treatment is mixed.[23–25] Pereira et al. (2012), following a randomised clinical trial, demonstrated that brackets bonded with Fuji Ortho™ LC using 10% polyacrylic acid, with or without sodium hypochlorite pre-treatment, showed clinically acceptable bonding strengths.[26,27] Further research is needed to standardise pre-treatment protocols that both facilitate the clinical application and provide adequate adhesive strength for RMGIC bonded brackets.

The most common reason cited by the participants for not using RMGIC materials for bracket bonding was a perception of poor bonding strength of GIC-based materials. A systematic review comparing the retention of brackets bonded with RMGIC against RC materials concluded that there was no difference between the types of materials after 12 months, but favoured RC-based materials after a 14-month period.[15] It was, however, also noted that the analysed trials had high risks of selection and detection and/or performance biases.[19] More recent studies have shown that the currently available RMGIC bracket bonding materials display bond strengths similar to RC materials and are acceptable for clinical use,[15,27–29] especially after enamel surface treatment procedures that increase the bond strength of RMGIC materials.[30,31]

When assessing the use of RMGIC bracket bonding materials in their clinical practice, 73.3% (*n* = 11) of the participants agreed that they would use RMGIC materials in certain situations. These included the treatment of patients who had an increased caries risk and/or enamel defects, and if the RMGIC material was easier to use than their current adhesive. This firstly suggests that the ease of use of a material may contribute to the clinicians' material choices to a similar extent as disease factors, and secondly, that several participants perceived RMGIC materials to have a clinically significant beneficial effect on defective enamel or on patients with an increased caries risk. A Cochrane systematic review of six studies reporting enamel demineralisation after using different types of bracket adhesives identified mixed results. Three studies showed that GIC materials significantly reduced the amount of demineralisation around brackets when compared to RC materials, while the remaining three showed no significant differences between the two materials.[32] It is noteworthy, however, that the latter studies were assessed to have higher risks of bias compared to the positive studies.[32] More recent literature shows a reduction in white spot lesions following the use of RMGIC compared to resin bracket bonding materials, after a long-term follow up.[33] A recent systematic review and meta-analysis concluded that higher quality evidence is needed to confirm the benefit of RMGIC in reducing white spot lesions around orthodontic brackets.[29] Using RMGIC based materials with ceramic brackets was the only clinical scenario that was not listed in the questionnaire (Table IV), but repeatedly listed by practitioners. Ceramic brackets cause more damage to enamel surfaces than metal brackets upon debonding when RC materials are used. Using RMGIC materials with ceramic brackets leads to a significant reduction in enamel damage.[6]

The current study had a small sample size, thereby limiting its power. However, the consistency of participant responses and the magnitude of the differences in scores between the different materials enabled statistically significant results to be obtained.

Non-standardised bovine teeth were used, and participants bonded single brackets for each material, which limited the study's similarity to true clinical circumstances. Finally, due to the visibly different dispensing systems of the materials trialled, there was difficulty in fully blinding participants to the identity of the materials. Future studies may benefit from the recruitment of a larger sample of orthodontists and the use of standardised dental models or live patients to replicate clinical scenarios more accurately.

Conclusions

The results of the present study confirm that the ease of handling contributed significantly to clinical preferences regarding the use of bracket bonding materials. The handling of currently available RMGIC based materials was noted to be generally inferior to that of available resin composite (RC) materials. Of the RMGIC materials trialled, Fuji® II LC displayed superior handling properties that were similar to those of RC materials. Further research is required to assess the suitability of Fuji® II LC as a bracket bonding material, to incorporate the handling properties of Fuji® II LC or RC materials into other RMGIC products, and to provide anti-cariogenic alternatives to RC-based materials.

Conflict of Interest

The authors declare that there is no conflict of interest.

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