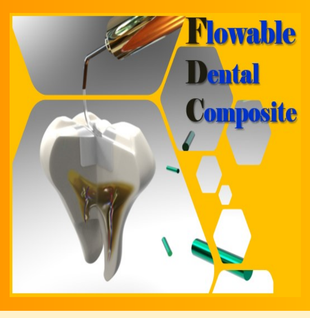

Amalgam Alternative Materials: A Comparative Study of Physical Properties

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BACKGROUND & OBJECTIVES

Mercury-based amalgam material systems are being replaced by resin-based composites due to their aesthetics, minimally invasive procedure, fast setting process and strong mechanical-physical-handling characteristics. Chemically cured (self-cured) 'amalgam alternative' composite materials are being used as direct restorative materials due to their low shrinkage stress (low shrinkage, longer pre-gel phase, and slower polymerisation) and infinite depth of cure.

The purpose of this study was to compare the 24-hour strength, bonding, wear, and optical properties of an experimental composite restorative material to three market-leading amalgam alternative materials (AAMs). The experimental product was evaluated in two delivery system forms (capsule and syringe).

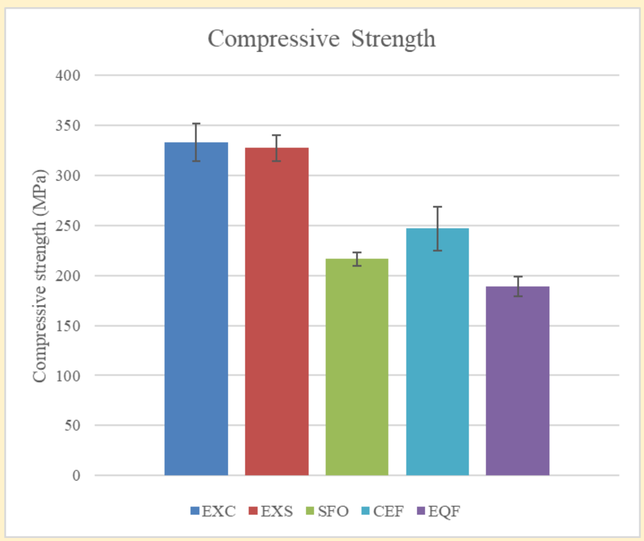
MATERIALS

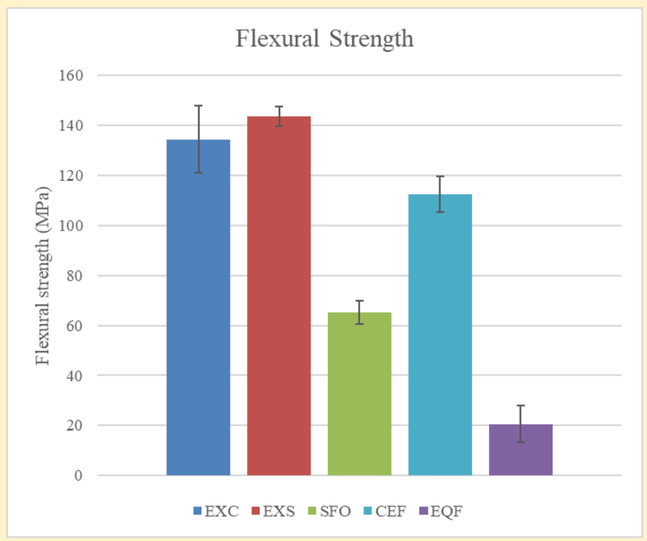
Product	Experimental AAM capsules	Experimental AAM syringe	Surefil one™	Cention® Forte	EQUIA Forte™ HT
Abbreviation	**EXC**	**EXS**	**SFO**	**CEF**	**EQF**
Manufacturer	SDI Limited	SDI Limited	Dentsply Sirona	Ivoclar	GC Dental
Delivery					

EXPERIMENTAL METHODS

- The 24-hour Compressive Strength test was adapted for AAMs from ISO-9917-1:2007 Annex D method and tested using an INSTRON #5566
- The 24-hour Flexural Strength and Shear Bond Strength (SBS) were evaluated according to ISO-4049:2019(E) and ISO/FDIS-29022:2013(E) respectively, using an INSTRON #5942
- For Radiopacity and Opacity, discs were prepared according to ISO-4049:2019(E)
  - Radiopacity was measured according to ISO-4049:2019(E) using a Kodak 2200 digital Xray unit and Kodak RVG 6100 imaging sensor
  - Opacity was measured using an X-Rite SP-64 spectrophotometer
- Wear was measured using an ACTA occlusal wear simulator (200,000 cycles)
- AAMs were dispensed according to manufacturers' instructions, including light-cure for dual-cured materials (SFO, CEF). Specimens were stored in humidor (37°C/60min) before demoulding, and immersed in deionised water (37°C/24h) prior to testing
- Data were analysed using an unpaired t-test
- (Surefil one™ is a registered trademark of Dentsply Sirona, Inc., Cention® Forte is a registered trademark of Ivoclar Vivadent Inc., EQUIA Forte™ HT is a registered trademark of GC Australasia Pty Ltd.)

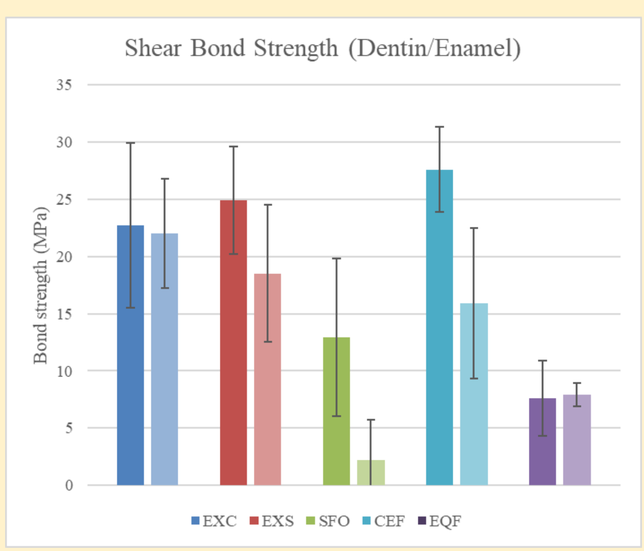
RESULTS & DISCUSSION

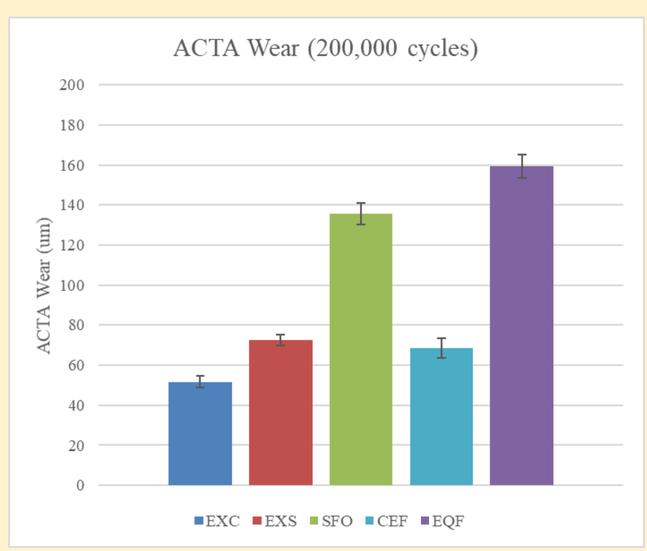


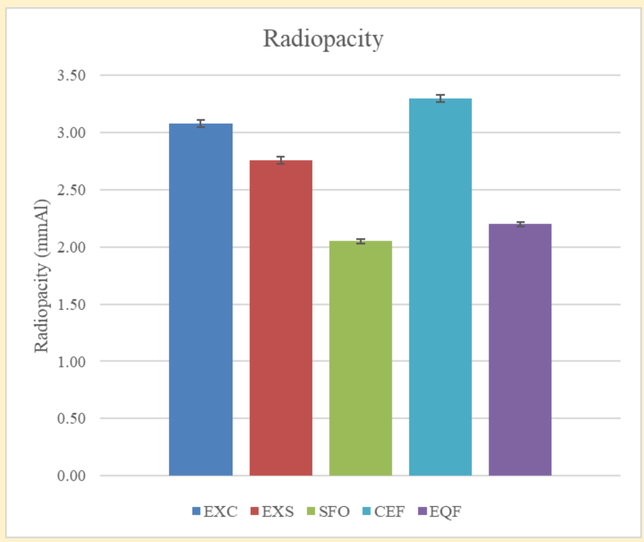


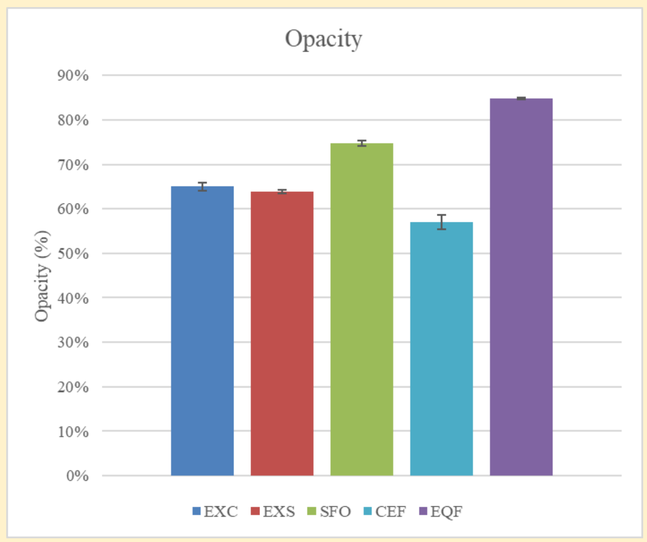
	EXC	**EXS**	**SFO**	**CEF**	**EQF**
	SDI Limited	*SDI Limited*	*Dentsply Sirona*	*Ivoclar*	*GC Dental*
Compressive Strength (MPa) n=6	333.0±18.7[a]	327.4±12.8[a]	216.3±7.1	246.8±21.7	188.8±9.9
Flexural Strength (MPa) n=5	134.4±13.5[b]	143.6±4.1[b]	65.2±4.7	112.4±7.2	20.5±7.4
SBS/Dentin (MPa) n=6	22.7±7.2[c]	24.9±4.7[c]	12.9±6.9[d]	27.6±3.7[c]	7.6±3.3[d]
SBS/Enamel (MPa) n=6	22.0±4.8[e]	18.5±6.0[e]	2.2±3.5	15.9±6.6[e]	7.9±1.0
ACTA Wear (µm) n=20	51.7±3.0	72.6±2.8	135.7±5.4	68.6±4.9	159.2±5.8
Radiopacity (mmAl) n=3	3.08±0.03	2.76±0.03	2.05±0.02	3.30±0.03	2.20±0.02
Opacity (%) n=2	65.0±0.9[f]	63.9±0.4[f]	74.7±0.6	57.0±1.6	84.9±0.2

Mean with the same letters are not statistically different ($p<0.05$)









Compressive strength

- The compressive strength of both Experimental AAMs is significantly higher ($p<0.05$) than the market-leading AAMs evaluated.

Flexural strength

- The flexural strength of both Experimental AAMs is significantly higher ($p<0.05$) than the market-leading AAMs evaluated.
- Results for EXC and EXS are approximately 68% and 80% higher, respectively, than the minimum required flexural strength of 80MPa for polymer-based restoratives (ISO-4049:2019, Type 1, Class 1).

Shear bond strength

- The shear bond strengths of both Experimental AAMs are statistically similar to market leader Cention Forte for both dentin and enamel bonding.
- Experimental AAMs show statistically higher dentin and enamel bond strengths than market-leading AAMs Surefil One and Equia Forte HT.

ACTA Wear (µm at 200,000 cycles)

- The wear resistance of Experimental AAMs is comparable to that of market-leader Cention Forte.
- Experimental AAMs showed approximately half the wear depth of market-leading AAMs Surefil One and Equia Forte HT.

Radiopacity

- The radiopacity of all evaluated AAMs is clinically acceptable with a value greater than dentin (equivalent to 1 mmAl, according to ISO-4049:2019).

Opacity

- The opacity of the Experimental AAMs was comparable to market-leading AAMs and within ranges of human enamel and dentine [Yu B, Ahn JS, Lee YK. Measurement of translucency of tooth enamel and dentin. Acta Odontol Scand. 2009;67(1):57-64. doi: 10.1080/00016350802577818].

CONCLUSION

When comparing the clinically relevant physical properties tested in this study, the Experimental AAM products evaluated demonstrated significantly higher compressive and flexural strength than market-leading AAMs. In other properties investigated, the Experimental AAM products performed as well or better than market-leading AAMs. This provides support for the use of the Experimental AAM in clinical situations.

ACKNOWLEDGEMENT

This research is supported by the Australian Government Cooperative Research Centre Project (CRC-P) Grant CRCPSEVEN000013.

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