Comparing the Composition and Bond Strength of a Cost-Effective against Mass-Market Dental Adhesive

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INTRODUCTION

The growing demand for simplified and time-efficient adhesive protocols has led to significant developments in dental materials [1]. In particular, less technique-sensitive adhesive protocols have become a key focus, as they help minimize operator-dependent variability and promote more predictable outcomes [2,3]. This trend has prompted manufacturers to develop and optimize single bottle universal adhesive systems [4]. However, the clinical effectiveness and precise chemical composition of many of these systems remain unclear [5].

AIMS

This study aimed to evaluate a novel cost-effective universal adhesive – Maxima® Natural Elegance 7 Universal (MNU, Henry Schein) - by comparing its immediate microtensile bond strength to dentin and its ATR-FTIR spectra to a popular universal adhesive control, Scotchbond Universal® Plus (SU, 3M ESPE).

MATERIALS AND METHODS

To evaluate the chemical composition of a dental adhesive, the FTIR-ATR protocol includes the following steps:

1. Determine FTIR-ATR spectra of the inorganic filler, after separation of the organic matrix from the adhesive, to identify the filler present, as well as its percentagem (Fig. 1a);

2. Determine FTIR-ATR spectra of the adhesive, solvents, and monomers to identify the composition of the adhesive. This process is performed with a database in *Microsoft Excel Tools 16.35* (Microsoft, USA) (Fig. 1b);

3. Determine FTIR-ATR spectra before, during, and after adhesive drying to calculate the degree of conversion (Fig. 1c).

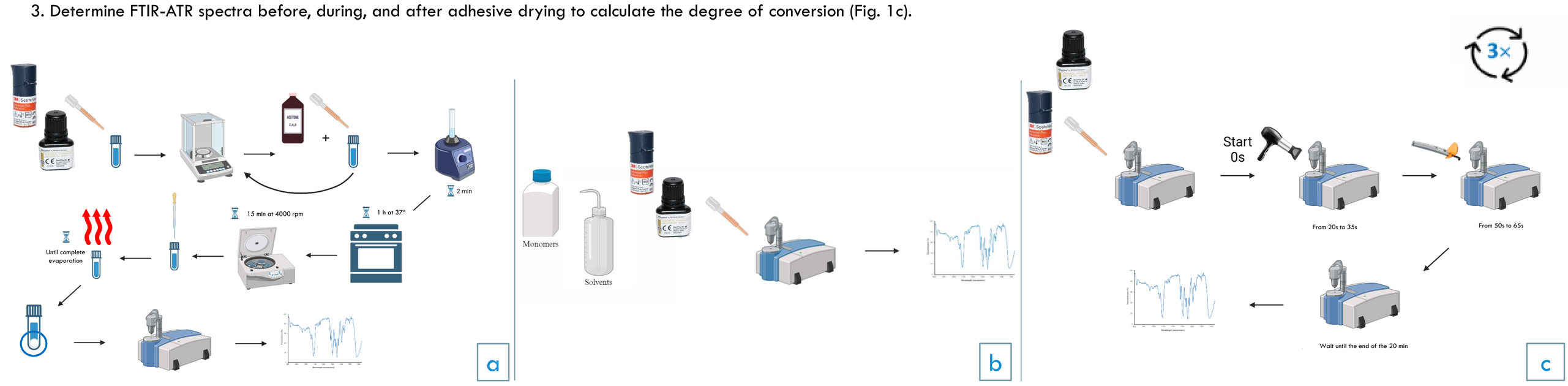

Figure 1. FTIR-ATR protocol: (a) Procedure for separation of inorganic fillers from dental adhesives, (b) FTIR analysis of monomers, solvents and adhesives, (c) Drying and polymerization protocol of dental adhesives.

For data processing (analysis of the resulting spectra and the respective calculations of kinetic parameters), Spectrum TimeBase v. 3.1.4 software is used (Perkin-Elmer, Beaconsfield, United Kingdom).

To evaluate the immediate microtensile bond strength to dentin, the protocol includes the following steps (Fig. 2):

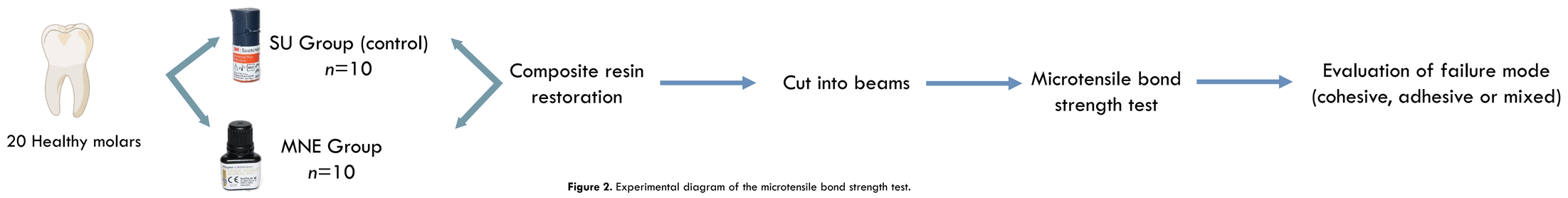

Figure 2. Experimental diagram of the microtensile bond strength test.

RESULTS & DISCUSSION

FTIR modelling suggested that both adhesives shared similar chemical compositions, including TEGDMA, HEMA, 10-MDP, water, and ethanol. The cost-effective adhesive, as suggested by the formulation, contained UDMA instead of Bis-GMA and presented a slightly lower degree of conversion (48 % vs. 67 %) (Fig. 3). Regarding the percentage of filler particles (w_t %) (12.4 % for SU and 9.9 % for MNE) (Fig. 4) and the conversion rate, there were no significant differences (t-test, $p > 0.05$) (Fig. 5).

There were no statistically significant differences (t-test, $p > 0.05$) in dentin bond strength between the two adhesives tested.

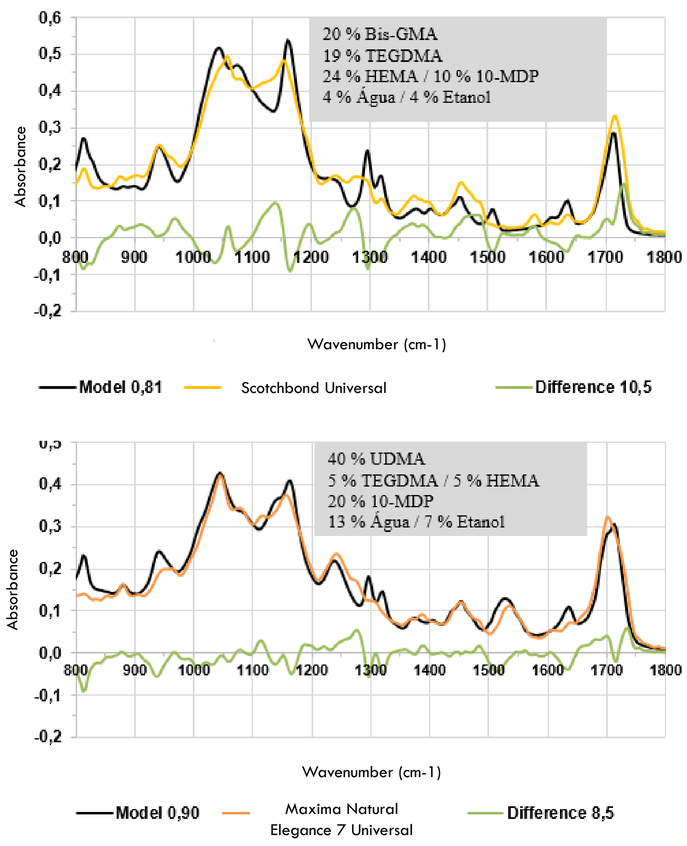

Figure 3. FTIR spectra of universal adhesive systems, model spectra, and spectra of the difference between the actual and model spectra.
a) Scotchbond Universal spectrum; b) Maxima Natural Elegance 7 Universal spectrum.

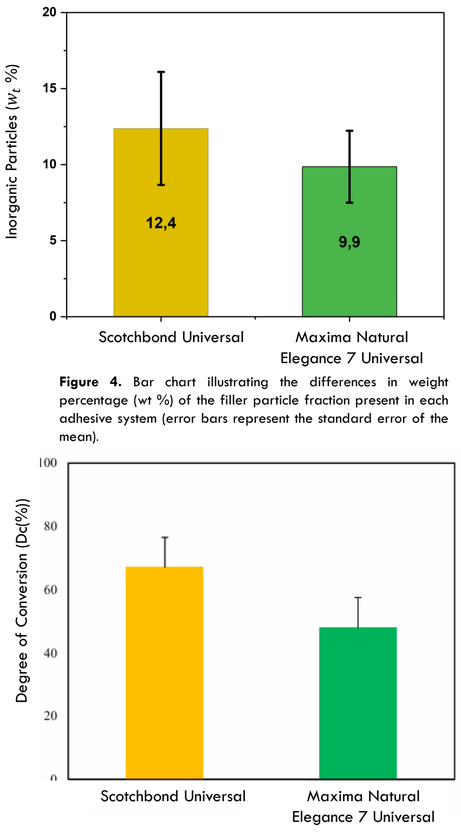

Figure 4. Bar chart illustrating the differences in weight percentage (wt %) of the filler particle fraction present in each adhesive system (error bars represent the standard error of the mean).

Figure 5. Bar chart illustrating the differences in conversion rate (Dc %) present in each adhesive system (error bars represent the standard error of the mean).

CONCLUSIONS

The novel cost-effective universal adhesive demonstrated comparable bonding performance and similar chemical characteristics to Scotchbond™ Universal Plus, supporting its potential as an effective and economically advantageous alternative for clinical application.

REFERENCES:

1. Van Meerbeek, B., Yoshihara, K., Van Landuyt, K., Yoshida, Y., & Peumans, M. (2020). From Buonocore's Pioneering Acid-Etch Technique to Self-Adhering Restoratives. A Status Perspective of Rapidly Advancing Dental Adhesive Technology. *The Journal of Adhesive Dentistry*, 22(1), 7–34. https://doi.org/10.3290/j.jad.a43994
2. Delgado, A. H. S., Jamal, H., Young, A., & Ashley, P. (2021). Scoping review of trials evaluating adhesive strategies in pediatric dentistry: where do simplified strategies lie? BMC Oral Health, 21(1). https://doi.org/10.1186/s12903-021-01395-5
3. *Nagarkar, S., Theis-Mahon, N., & Perdigão, J. (2019). Universal dental adhesives: Current status, laboratory testing, and clinical performance. In Journal of Biomedical Materials Research - Part B Applied Biomaterials (Vol. 107, Issue 6, pp. 2121–2131). John Wiley and Sons Inc. https://doi.org/10.1002/jbm.b.34305*
4. Arinelli, A. M. D., Pereira, K. F., Prado, N. A. S., & Rabello, T. B. (2016). SistemasAdesivos Atuais. Revista Brasileira de Odontologia, 73(3), 242–246.
5. Delgado, A. H. S., & Young, A. M. (2021). Modelling ATR-FTIR spectra of dental bonding systems to investigate composition and polymerisation kinetics. Materials, 14(4), 1–18. https://doi.org/10.3390/ma14040760