

Impact absorption of conventional, reinforced-EVA and 3D-printed sports mouthguards

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(I declare that there are no conflicts of interest in carrying out this work)



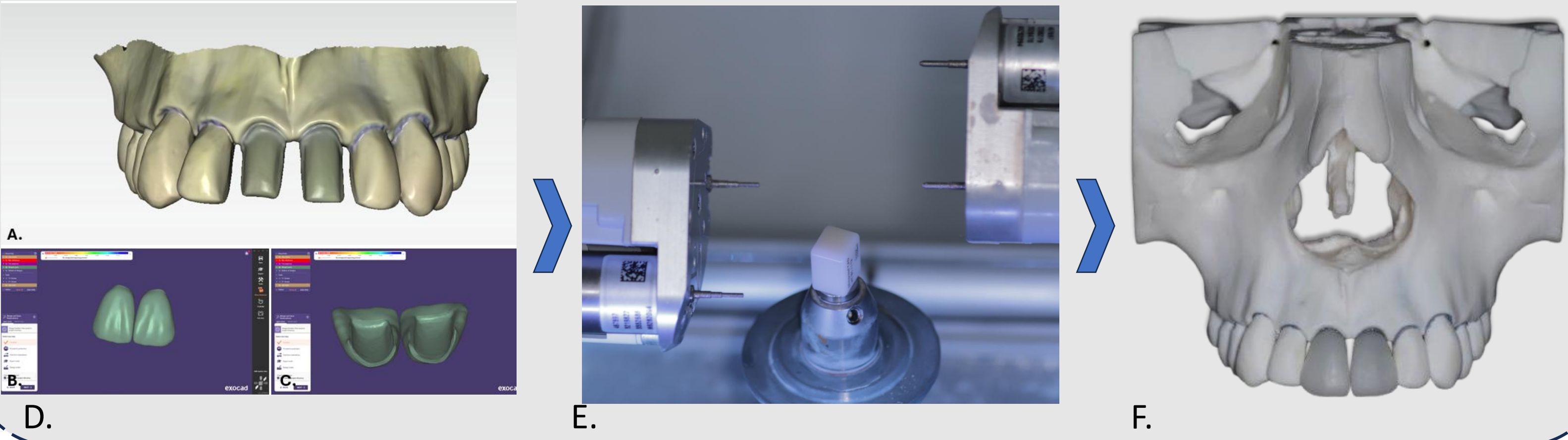
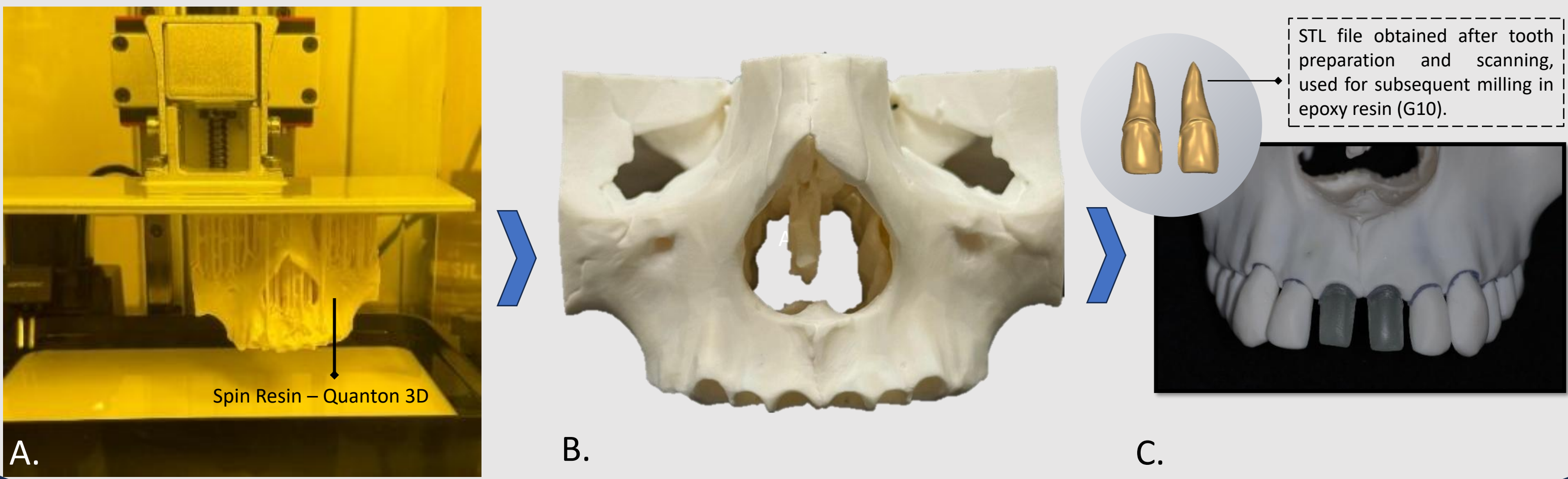
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Purpose

This *in vitro* study evaluated the impact-absorbing behavior of three mouthguards groups (MGs): conventional EVA (CV), EVA reinforced with a polyamide mesh (RF), and a 3D-printed MG (3D-P) on the dentoalveolar region of upper central incisors restored with ceramic veneers, before and after thermocycling.

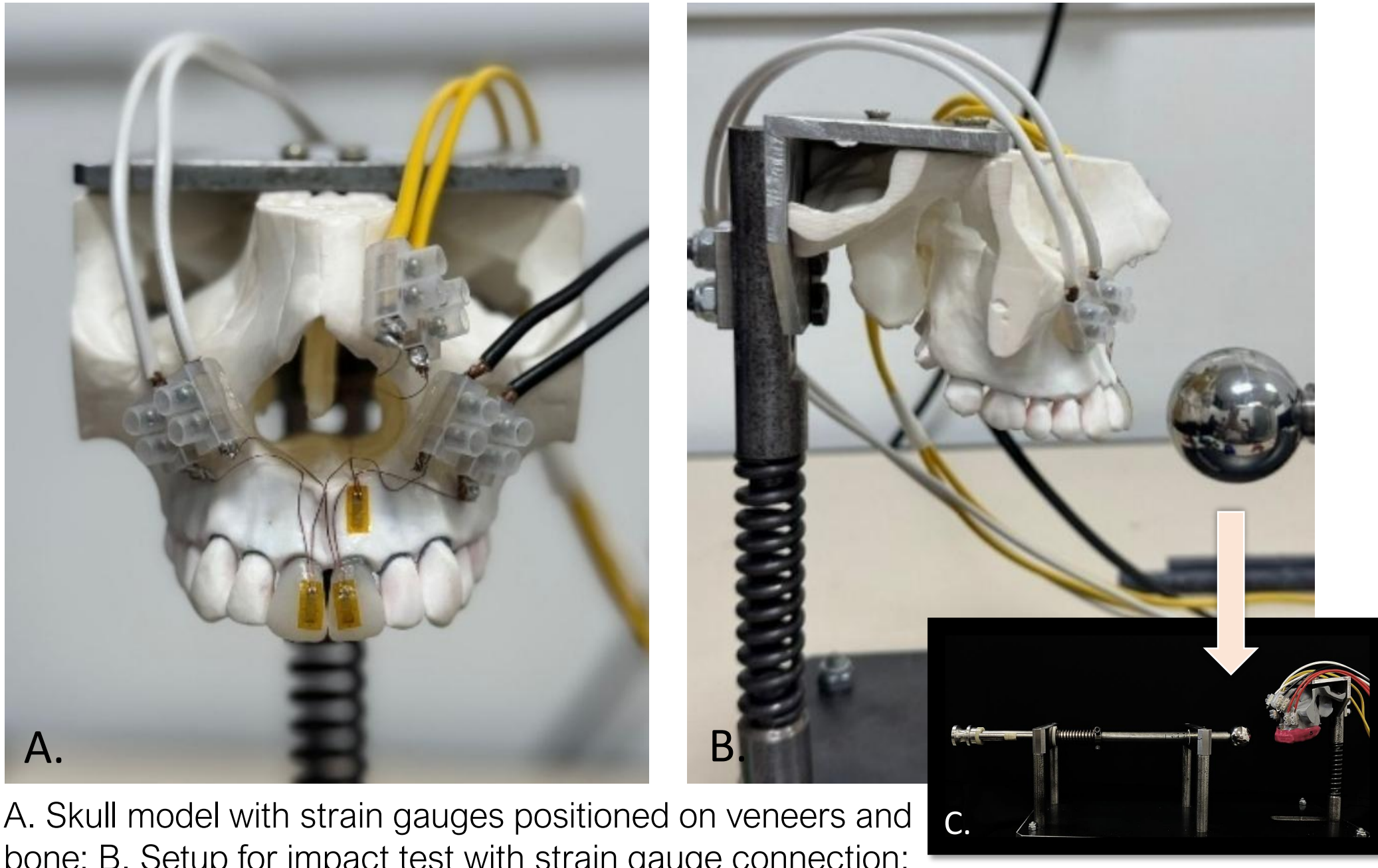
Materials and Methods

Workflow for 3D-printed skull and tooth preparation



A. 3D printing of skull model; B. Printed skull with alveolar preparation; C. Prepared tooth (G10) included in the alveolar bone of skull model; D. Digital design (CAD) of restorations; E. Milling process (CAM) of *Empress CAD* ceramic blocks; F. Final aspect after the cemented veneers with Panavia V5 in the G10 prepared tooth at the printed skull.

Strain Gauge Setup + Impact Test



A. Skull model with strain gauges positioned on veneers and bone; B. Setup for impact test with strain gauge connection; C. Complete impact testing apparatus.

Sports Mouthguards Groups

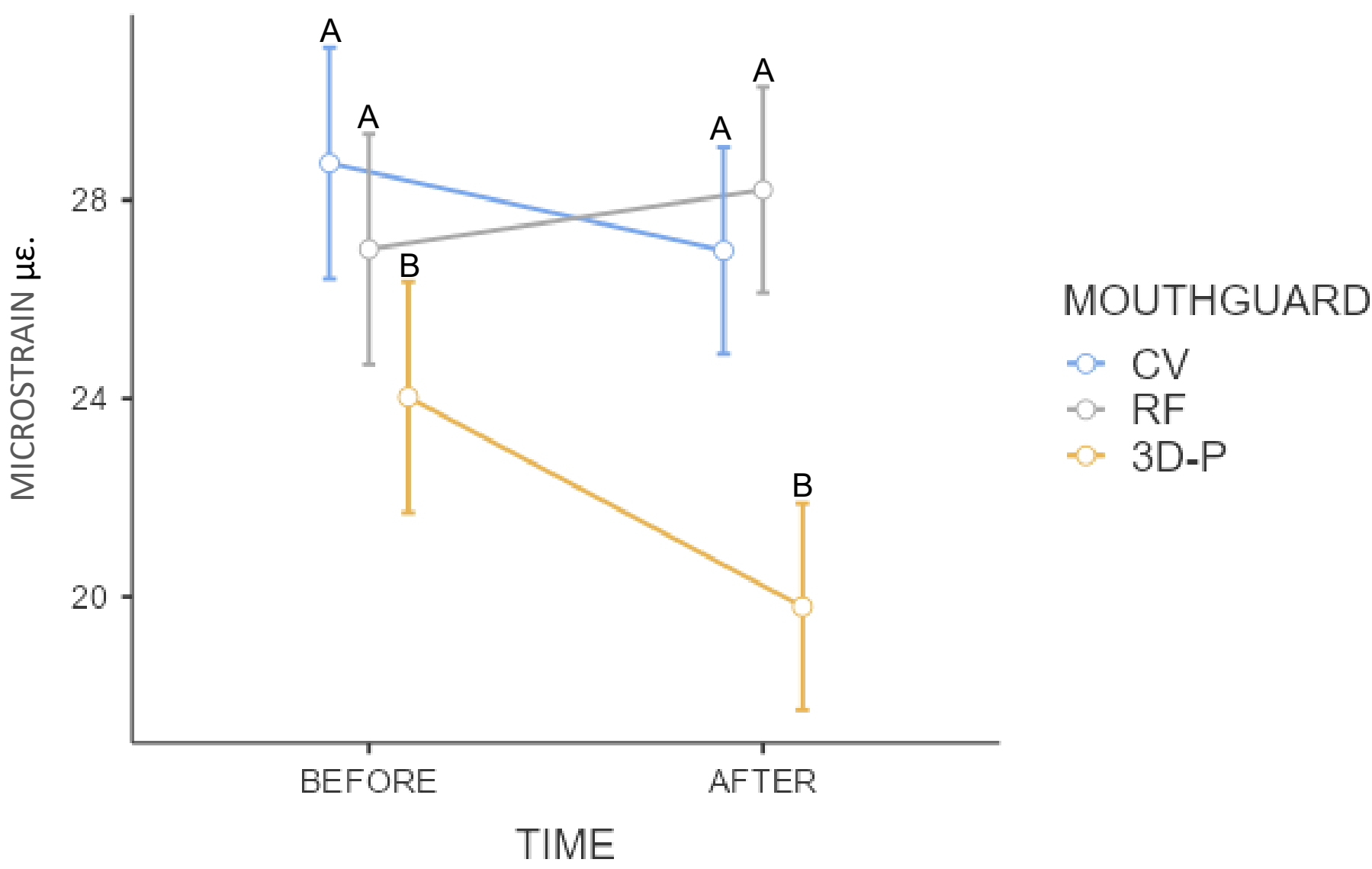


*Impact Test before and after thermocycling (5.000 cycles, 5-55°C).

Results

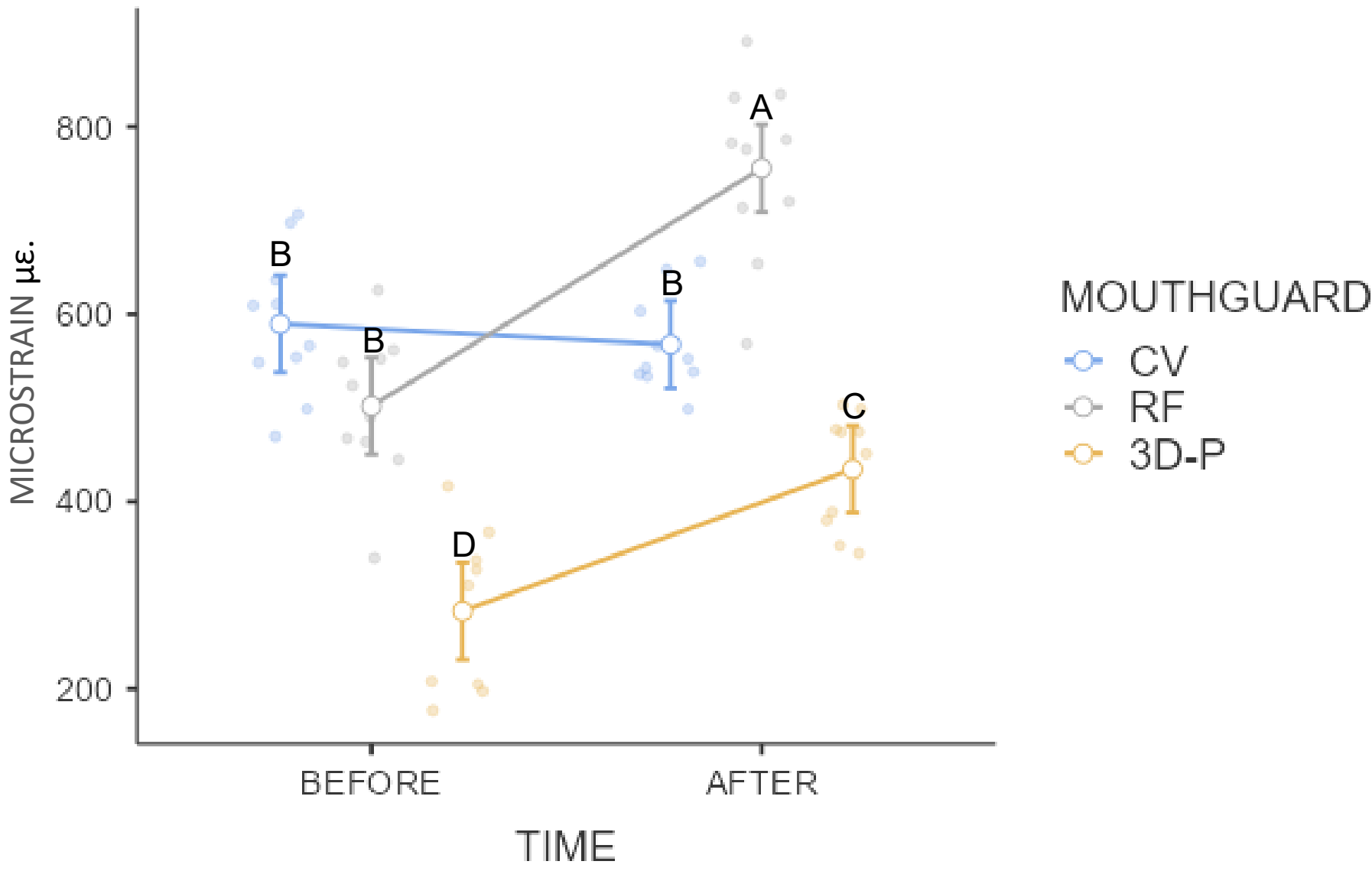
Data were analyzed using a repeated measures ANOVA (3×2), followed by Tukey's post-hoc test. The assumptions of normality (Shapiro-Wilk), homogeneity of variances (Levene), and sphericity (Mauchly) were verified and met.

Tooth



ANOVA: Mouthguard $p < 0.001$; Time $p = 0.103$; Interaction $p = 0.082$.
Tukey: 3D-printed < Conventional and Reinforced ($p < 0.001$). No significant differences between before and after thermocycling.

Bone



ANOVA: Mouthguard $p < 0.001$; Time $p < 0.001$; Interaction $p < 0.001$.
Tukey: Reinforced-After > Conventional and 3D-printed before and after ($p < 0.001$).
3D-printed before and after significantly lower than the other groups ($p < 0.001$).
* Tukey: After CV and After 3D-P $p=0.004$

Conclusion

The 3D-printed mouthguard provided superior protection, although its performance diminished after aging. Conventional EVA, despite offering intermediate protection, remained stable over time. Further studies are required to confirm the long-term safety of digitally manufactured mouthguards.

Acknowledgements

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References