

Objective

Evaluate flexural strength of various CAD-CAM denture base materials with and without thermocycling.

Introduction

Digital and novel manufacturing technologies have become a major trend in dentistry. Registering the three-dimensional (3D) topography of dental tissue by conventional impression techniques has a number of drawbacks, including volumetric changes of impression material and expansion of dental stone.¹ To overcome these variables, the intraoral scanner (IOS) was developed.² IOSs have numerous over conventional impressions; they eliminate the need for plaster models, save advantages time and space, and allow for better communication with dental technicians.² Assessment of IOS accuracy with superimposition to a control 3D model is vital to ensure the deviation from the standard model; however, it doesn't present how the deviation may impact the clinical outcome. Therefore, evaluating the clinical outcome of definitive restorations produced with different digital workflow becomes crucial.

Materials and Methods

One-hundred-twenty specimens were fabricated following ISO-20795-1 from 6 various denture base materials (Fig.1 Table). Specimens were stored in distilled water at 37 °C for 48 ±3 hours. They were then divided into 2 subgroups (with or without thermocycling, n=10/subgroup). Specimens in thermocycling subgroups were subjected to thermocycling (Fig. 2), followed by immersing in distilled water at 37 °C for 2 weeks. Specimens were subjected to a 3-point bend test (Fig.3) to measure the flexural strength of a material (Fig.4). Two-way ANOVA and post hoc multiple comparison tests were used to assess the impact of materials and thermocycling on the flexural strength of materials ($\alpha=0.05$).



Fig. 1: Materials assessed in this study

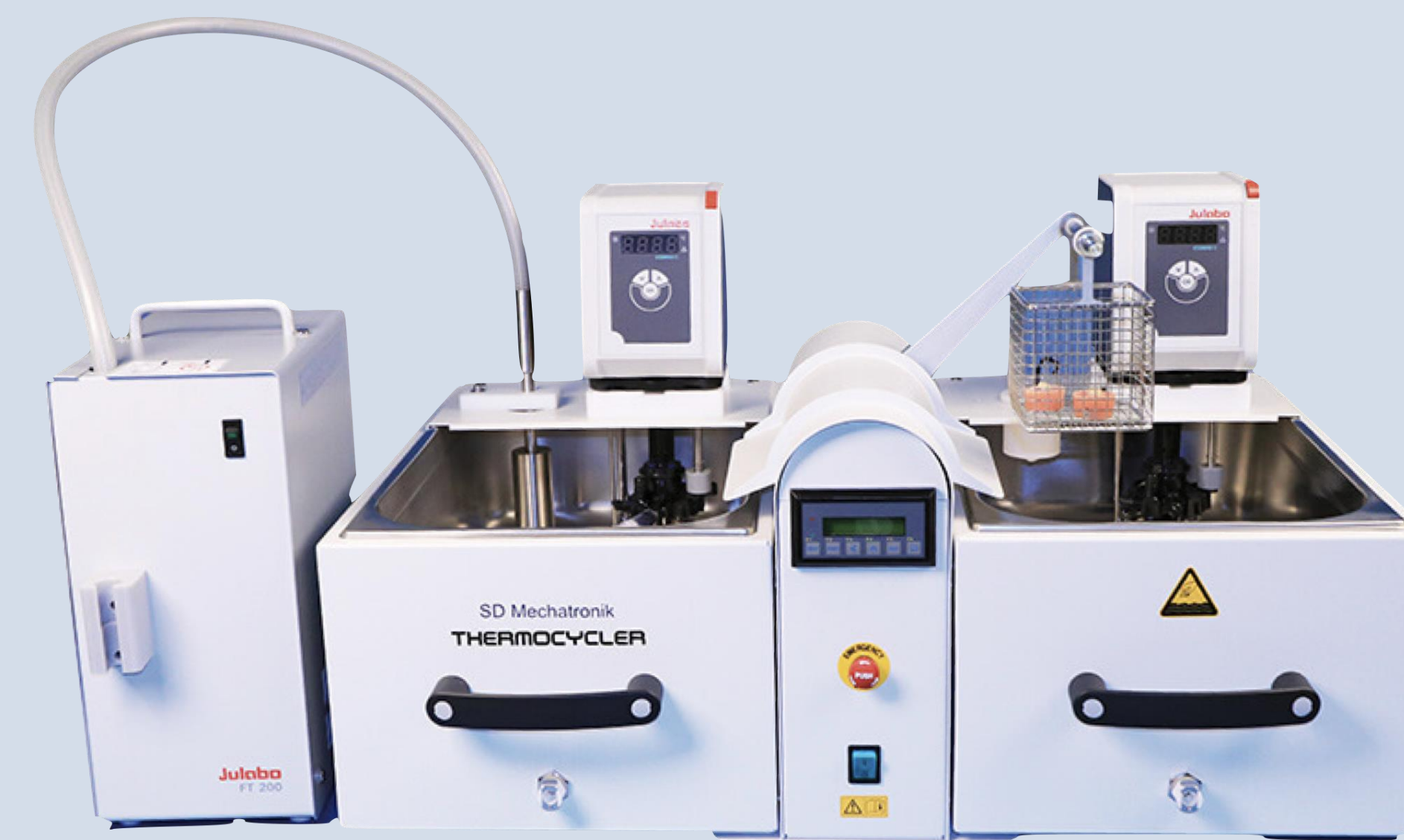


Fig. 2: Thermocycling machine (5,000 cycles at 5–55°C)



F (B) = maximum force exerted on specimen
D (A-C) = distance between specimen supports (50 mm)
W = specimen width (10 mm)
H = specimen thickness (3 mm)

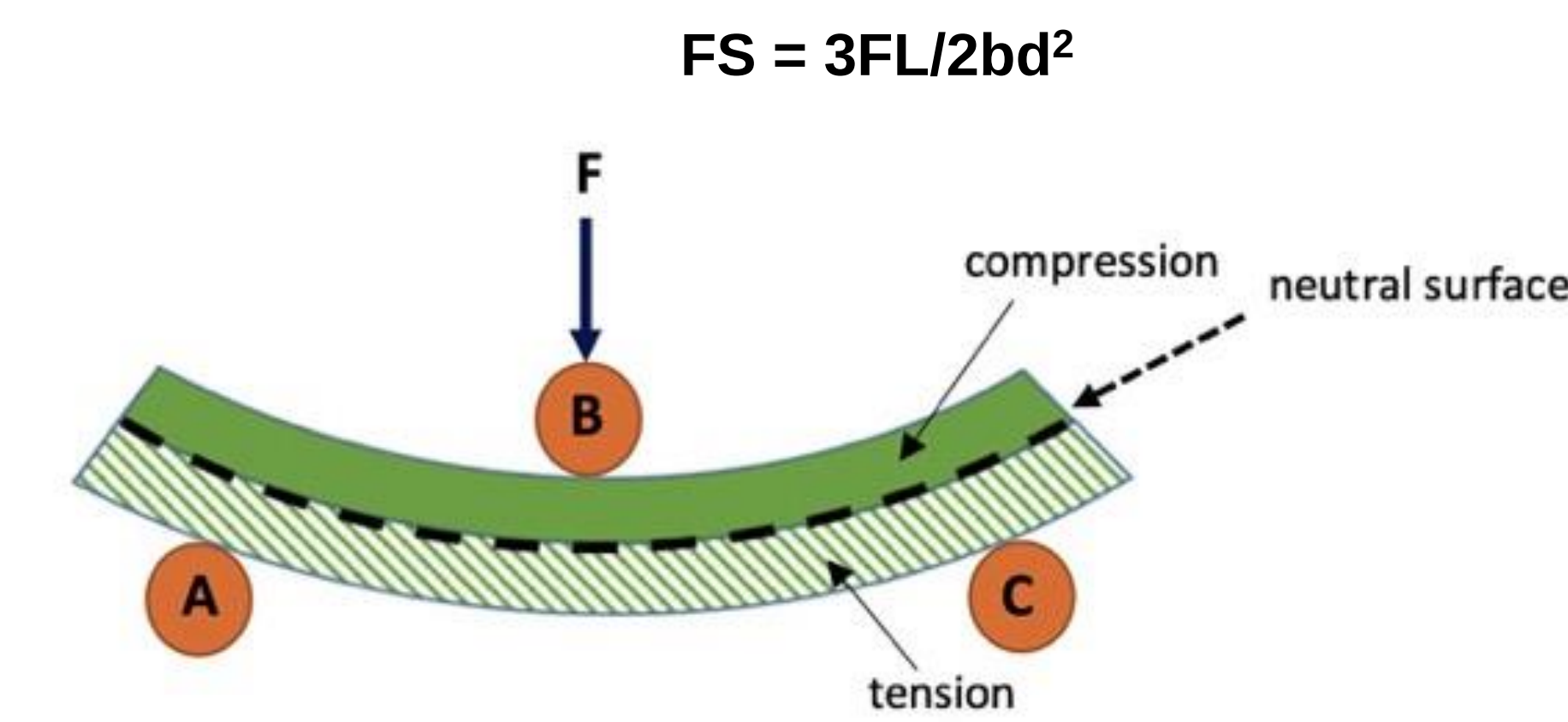


Figure 3: 3-point flexural strength test

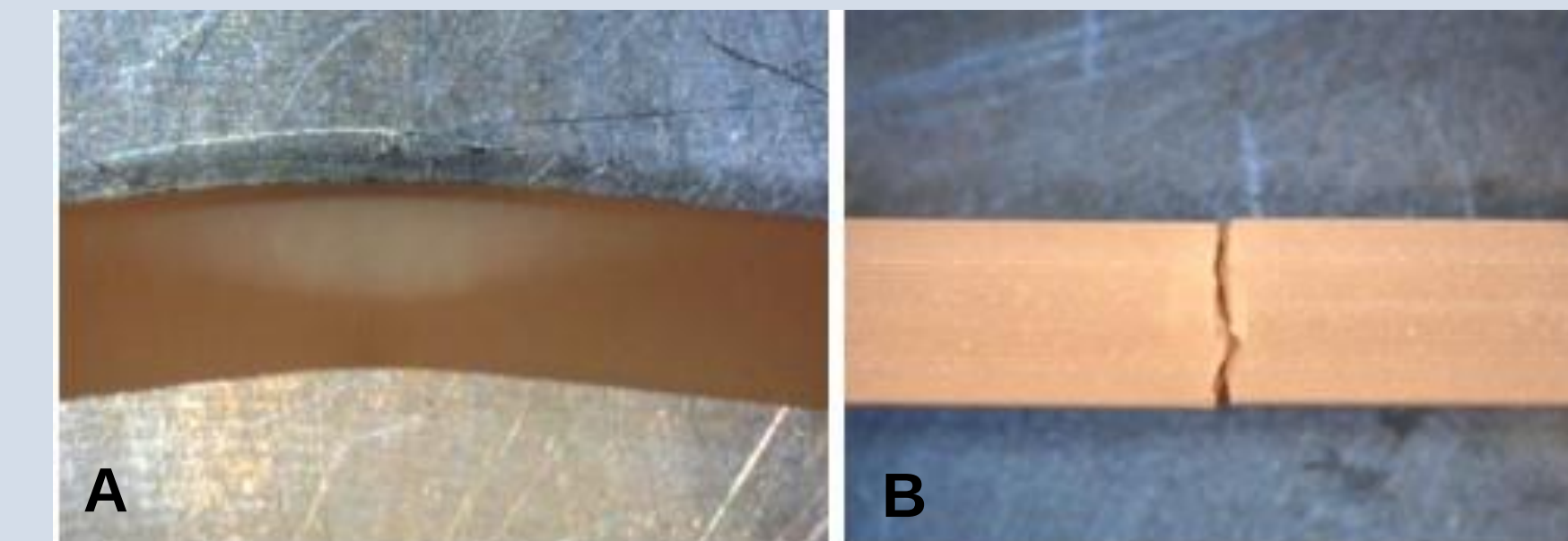


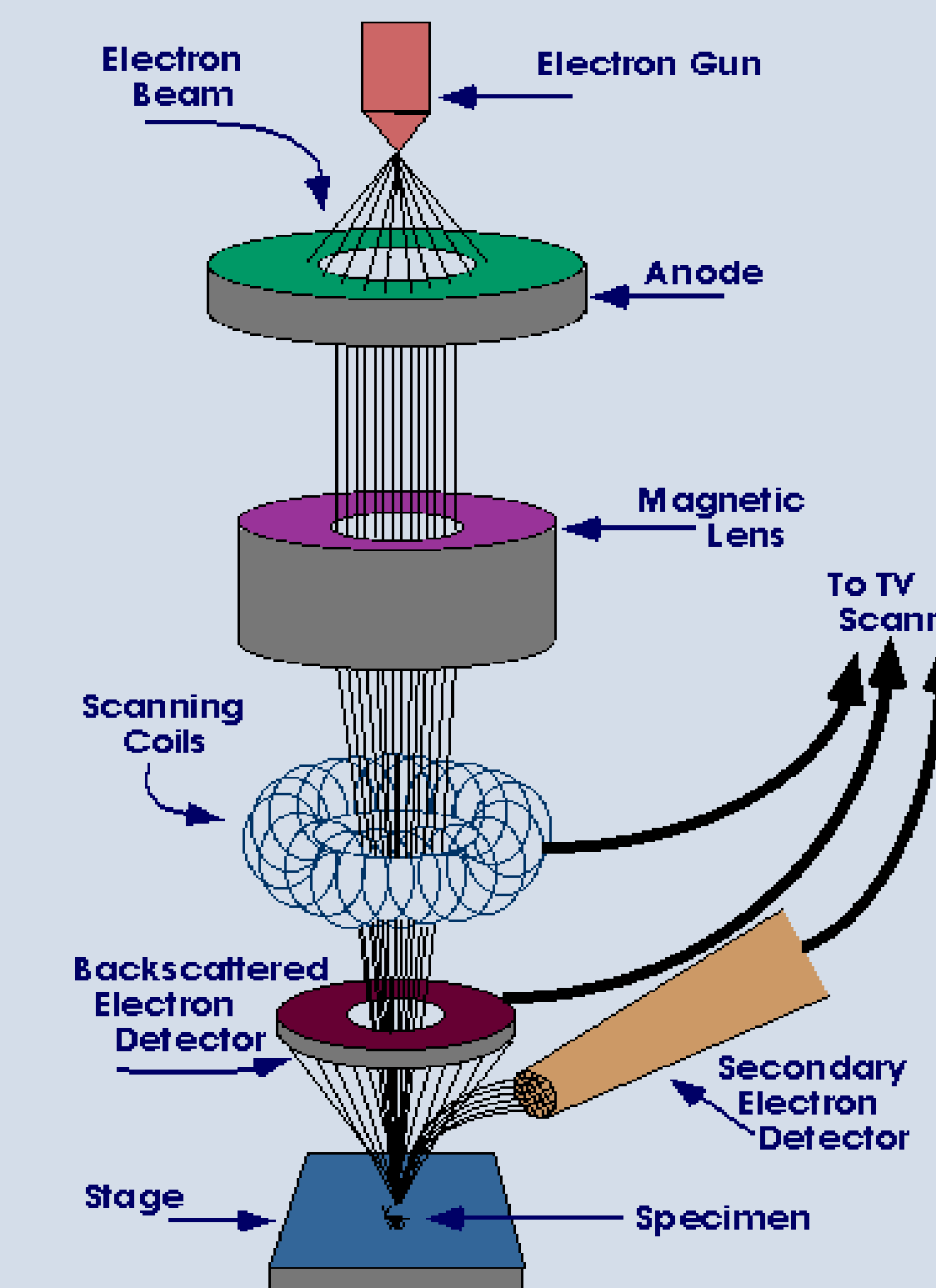
Fig. 4: Failure patterns observed after flexural strength test; bent (A) and fractured (B)



Fig. 5: SEM Machine and its diagram, and QR code guide (the diagram is courtesy of Iowa State University)



Scan the QR code



Results

Material type, thermocycling, and their interaction significantly ($p < 0.0001$) affected the flexural strength value of denture base materials (Fig.6). (Lucitone M) showed the highest value among non-thermocycled subgroups ($p < .05$). There was no significant ($p > .05$) difference between Ivotion, Lucitone P, FotoDent, which were significantly ($p < .05$) higher than Lucitone C, FotoDent. The flexure strength of all tested materials reduced significantly ($p < .05$) after thermocycling, except Fotodent ($P=0.31$). Flexcera had the highest reduction rate (76.7%) in flexural strength value after thermocycling. SEM Machine (Fig.5) was used to obtain images showing different patterns of acroos different materials when subfected to flexural strength test (Fig.7).

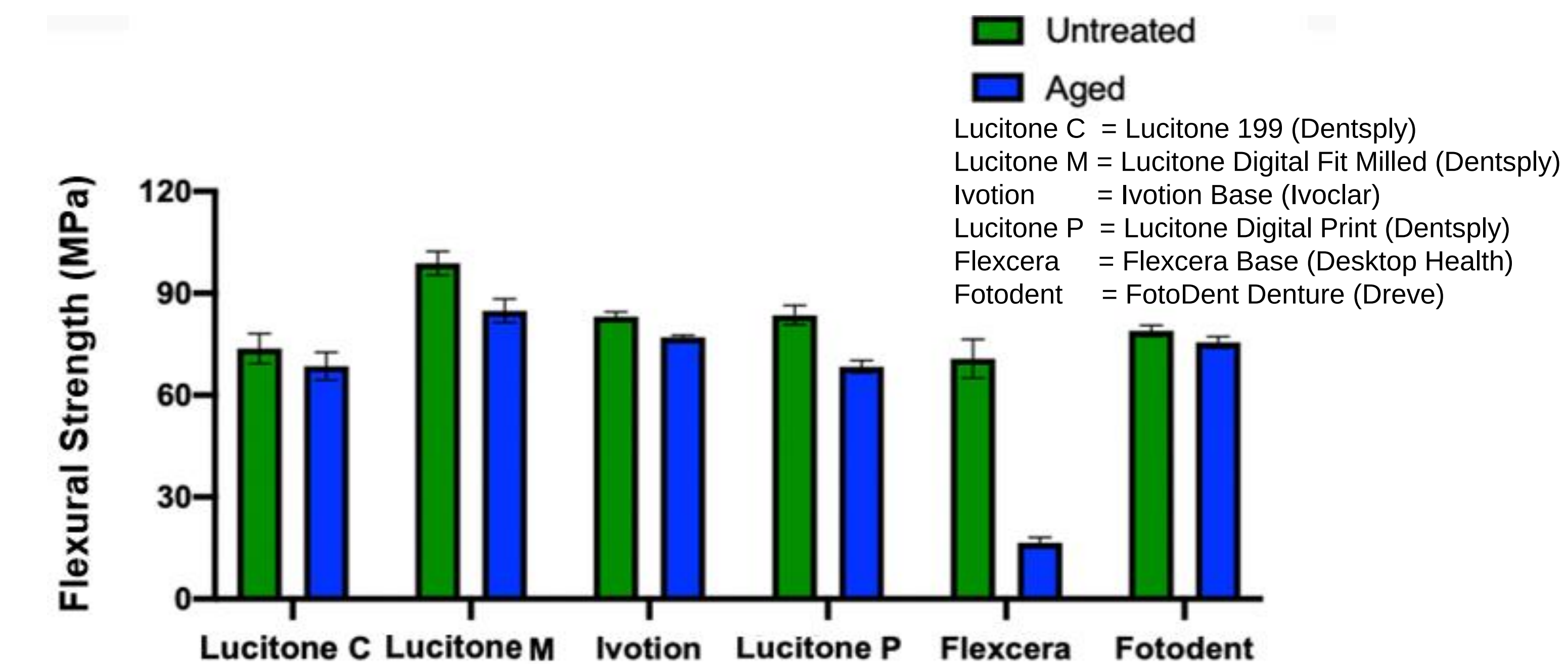


Fig. 6: Flexural strength mean and standard deviation (MPa) for untreated and aged denture based materials used in this study

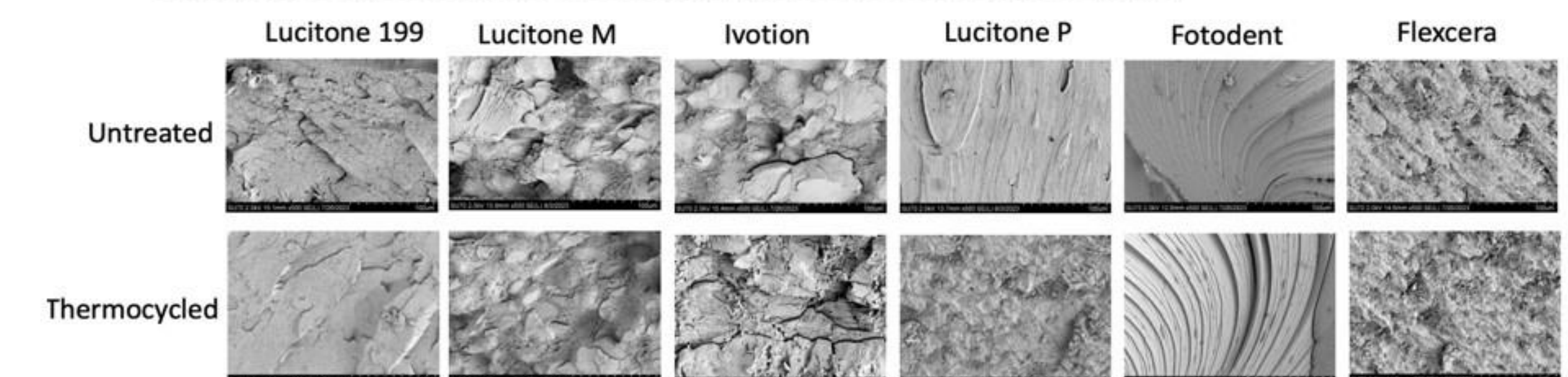


Fig. 7: SEM images (×500 magnification) of cross-sectioned surfaces after flexural strength test

Conclusions

Within the limitations of this study:

- 3D-printed denture base materials {Lucitone Digital Print, Flexcera Base, FotoDent Denture} had similar ($p > 0.05$) flexural strength value lower than milled denture base materials {Ivation Base, Lucitone Digital Fit}.
- 3D-printed denture had significantly ($p < 0.05$) flexural strength value lower than milled denture abase materials.
- Thermocycling had a significant ($p < 0.05$) impact on the flexural strength of denture base materials.

References

- Aguirre BC, Chen JH, Kontogiorgos ED, Murchison DF, Nagy WW. Flexural strength of denture base acrylic resins processed by conventional and CAD-CAM methods. *J Prosthet Dent*.2020;123(4):641-646.
- Diaz-Arnold AM, Vargas MA, Shaull KL, Laffoon JE, Qian F. Flexural and fatigue strengths of denture base resin. *J Prosthet Dent*. 2008;100(1):47-51.

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