Dual Dental Matrix Band

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Problem Statement

- Matrix bands separate adjacent teeth during Class II cavity restorations [1].
- Two adjacent cavities are slower and more complex to restore separately [2].
- This increases chair time and workflow inefficiency.
- Goal: Develop a device that enables simultaneous restoration of two adjacent teeth in one preparation step.

Figure 1. Dental matrix in tooth [2].

Background and Motivation

- Dental caries is a widespread disease characterized by the gradual breakdown of tooth surfaces [3].
- Caused by microbial activity [3].
- Untreated caries are associated with a 26% increased risk of all-cause mortality, and a 48% increased risk of heart disease mortality [4].

Market Impact

- Market Size
  - The global restorative dentistry market valued at $24.60B (2025), projected to reach $48.93B by 2034 [5]
  - ~202,000 active dentists in the U.S. according to the ADA [6]
- Demand
  - Half of all restorative dental procedures are class II fillings [7]
  - Composite fillings cost $200 - $335 per tooth [8] with a majority of the cost coming from labor and not materials [9]
- Design Justification
  - Cuts procedure time consolidating two full matrix setups into one
- Pricing
  - Halo Sectional Matrix Band have a unit price around $1.34 for a pack of 100.
  - Dual Dental Matrix material cost for one unit, is $0.19.
  - If produced using bulk material stock, the material cost for one unit would go to $0.10

Figure 2. Current market matrix model [10].

Design Criteria

- Function similarly to existing surface matrices
- Dimensions 4-6 mm ht, 12-18 mm wt, <0.05 mm thick
- Maintain tight proximal contact
- Improve filling work flow
- Compatibility with existing process and tooling
- Budget ~$200

Figure 3. Matrix with tension ring and wedge [11].

Final Design

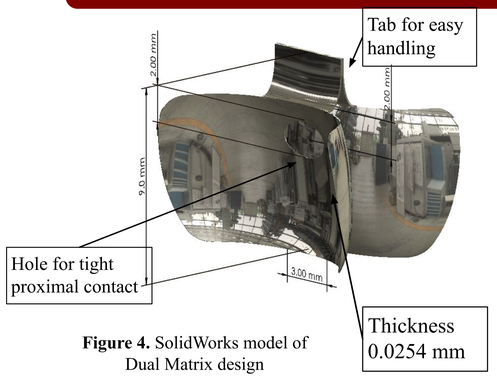

Figure 4. SolidWorks model of Dual Matrix design

- Two-sided design allows for parallel fillings
- Similar shape to traditional sectional matrices
- Hole allows for single thickness at interproximal contact
- Used templates to cut flats
- Molded flats with 3D printed mold
- 0.0254 mm thick fully annealed 316 SS

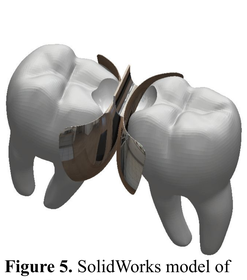

Figure 5. SolidWorks model of Dual Matrix in teeth

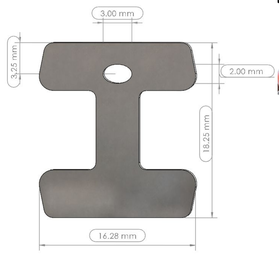

Figure 6. Flat cutout of matrix

Figure 7. Dual Matrix with filling in tooth model

Testing

- Conducted in-person clinical simulation testing on adjacent tooth restorations
  - Timed key workflow steps
  - Evaluated ease of placement, removal, and overall efficiency of design
  - Force of removal was measured after each filling using a strain gauge
- Testing limitations with tooth model considered
- SolidWorks FEA analysis using the average force obtained during measured removal
- MTS machine used to test material properties of the different matrices
- Tensile testing:
  - 3 sample matrices currently used in the field
  - 3 304 Full Hard stainless steel test sample fillets
  - 3 301 Half Hard stainless steel steel test fillets

Figure 8. Interproximal cavity prep using current model matrix.

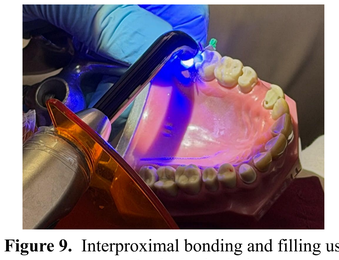

Figure 9. Interproximal bonding and filling using new Dual Matrix design.

Results & Discussion

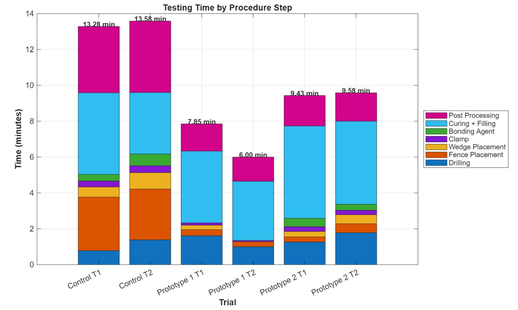

Figure 10. Testing time by procedural testing for different conditions.

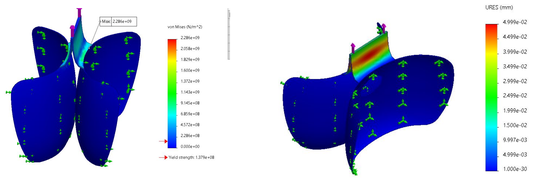

Figure 11. Solidworks FEA analysis of the 316 stainless steel for tensile forces, with deflection and Von Mises stress outputs

- An independent samples t-test revealed that the prototype filling was significantly faster than the control, reducing total procedure time by an average of 3.9 minutes (29%)
- Significant time reduction for fence placement and post-processing
- Maximum stress achieved in the simulation exceeds the tensile stress significantly
  - fixed testing apparatus used inflates this value

Future Work

- Improving the ease of matrix removal after curing the filling material:
  - Material surface coatings to reduce the coefficient of friction
  - Perforations inferior to the hole for tearing
- Fabrication methods should be improved:
  - Ensure consistent dimensions and smooth edges
  - Metal laser cutter

Acknowledgements

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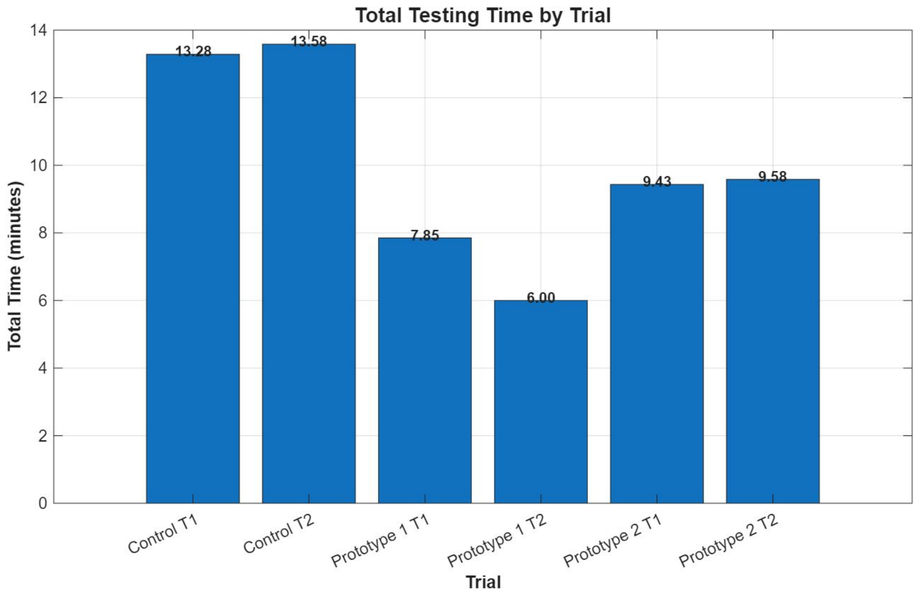

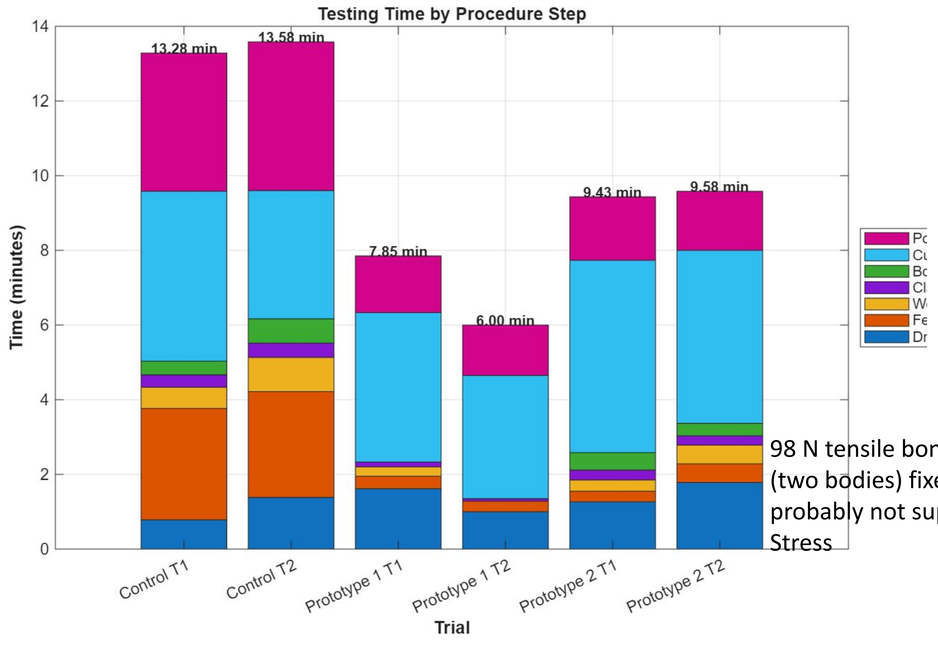

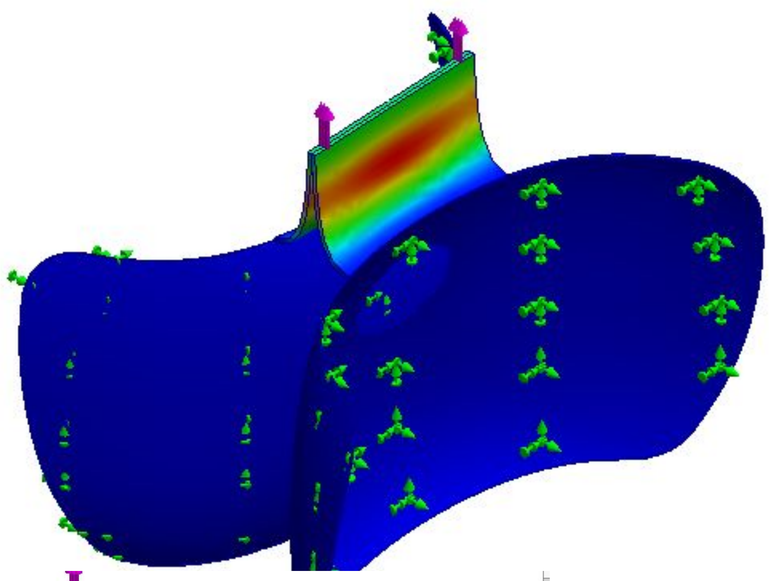

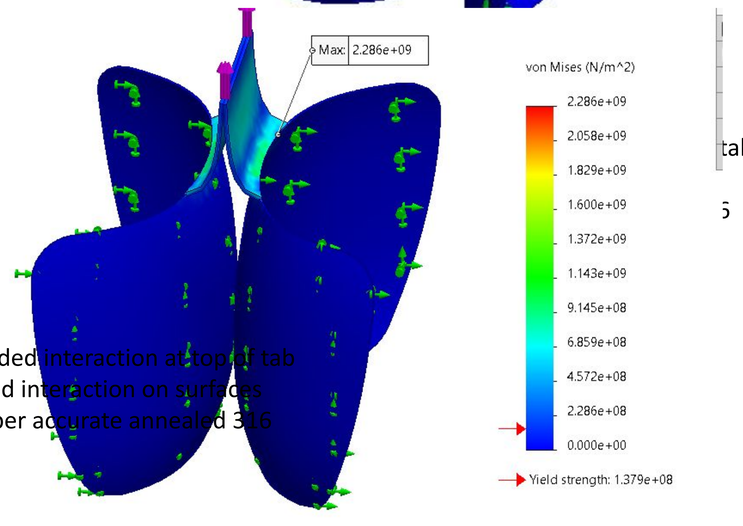

tab

5

98 N tensile bonded interaction at top of tab
(two bodies) fixed interaction on surfaces
probably not super accurate annealed 316
Stress