Approximating Surface Matrix Band for Dentist to Use for Patients

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Abstract

Dental Cavities have been labeled as a silent "epidemic" as they are among the most prevalent and chronic diseases in children and adults in the US [1]. Approximately 175 million people receive at least one dental filling every year [2] and about 27% of adults (20 - 64 years of age) fail to receive any proper treatment for their tooth decay [3]. The implications of untreated decay could lead to severe pain, tooth abscess, or even tooth loss [4]. As dental fillings are the most commonly performed procedure to restore moderate cavities, it is critical that the procedure is optimized to save dentists and patients time and simultaneously preserve accuracy. Current matrix bands, such as the Sectional and Tofflemire bands, are effective in maintaining a tight and flossable tooth contact and providing a sturdy tooth contour, however, they fail to accommodate the concurrent restoration of two adjacent interproximal cavities. Our goal is to create a dual-matrix band system which can provide a sturdy contour for two adjacent teeth undergoing restoration and maintain a tight and flossable contact between them. Our solution will incorporate the general appearance and material basis of the Tofflemire matrix band; however, we will redesign it to accommodate two teeth at a time and account for proper contact between the teeth.

Problem Statement: Motivation & Background

- **Problem(s):**
  - Matrix bands are only capable of surrounding one tooth at a time
  - The thickness of two bands adjacent to one another exceeds the natural tooth contact gap
  - When restoring interproximal cavities, traditional matrix bands unnecessarily increase procedure time
- **Goal: Create a *dual* matrix band system which is ...**
  - Thin enough to fit in between the affected teeth and maintain the appropriate contact gap
  - Rigid enough to securely adapt to the shape of the tooth walls.
- **Background:**
  - A matrix is defined as a properly contoured piece of metal used to support and give form to the material used in restoration during its and hardening.[1]

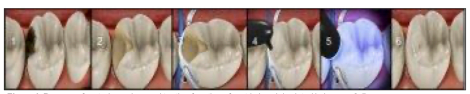
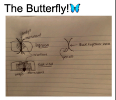
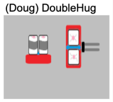
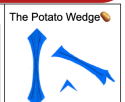


Figure1: Process of restoring a decayed tooth – function of matrix band depicted in images 3-5

Figure2: Existing matrix bands which fail accommodate simultaneous interproximal restoration: Sectional matrix band (left) and Tofflemire band (right)

Design Criteria

	The Butterfly!	(Doug) DoubleHug	The Potato Wedge
			
Safety (30)	24 (4)	30 (5)	18 (3)
Effectiveness (20)	16 (4)	20 (5)	16 (4)
Cost (20)	16 (4)	20 (5)	12 (3)
Adjustability (15)	12 (4)	15 (5)	6 (2)
Patient Comfort (10)	8 (4)	6 (3)	10 (5)
Ergonomics (5)	5 (5)	4 (4)	5 (5)
Total	81	95	67

Manufacturing & Testing

Manufacturing:

1. Mechanical Requirements
- Must meet physical requirements laid out in our testing protocol.

2. Dimensional Requirements
- Thickness: 0.0015 in. with 0.00075 in. center
- Width: For testing consistency, 0.035 in.
- Length: For testing consistency, 0.248 in.

3. Materials
- 18-8 Stainless Steel Shim Stock

4. Methods
- Outsource the manufacturing process, as we do not possess the machining skills required to create something as detailed as this dental instrument.
- Outsourced through Big Blue Saw manufacturing company
  - Waterjet cut from SolidWorks design, see figure 3
- Bought Feeler Gauges with thickness of 0.0015 in. and 0.002 in. as controls for testing
  - 0.0015 in. and 0.002 in. are regular dental matrix band thicknesses

Figure4 : Retainer used to tighten matrix band for functionality testing

Testing:

1. Functionality Testing
- **Premise:**
  - These tests will be used as an assessment to qualitatively determine the overall functionality, structural integrity, and ease of use of the "doublehug" matrix band.
- **Testing targets:**
  - Ease of bending the device
  - Ease of securing and removing the device between the teeth
  - Subjective structural integrity of the band
- **Method of Measurement :**
  - Questionnaire asking the client to assess the various physical characteristics on a scale of 1-5.

2. Mechanical Testing
- Goal: Check if cutting the thickness of the band in half is reasonable
- Model two designs in SolidWorks
  - Regular matrix band (control)
  - Band with half thickness in the center
- Controlled variables
  - 1.2 lbs. Of force (factor of safety: 2)
  - Sides fixed
  - Elastic support on side that is in contact with tooth

Final Design

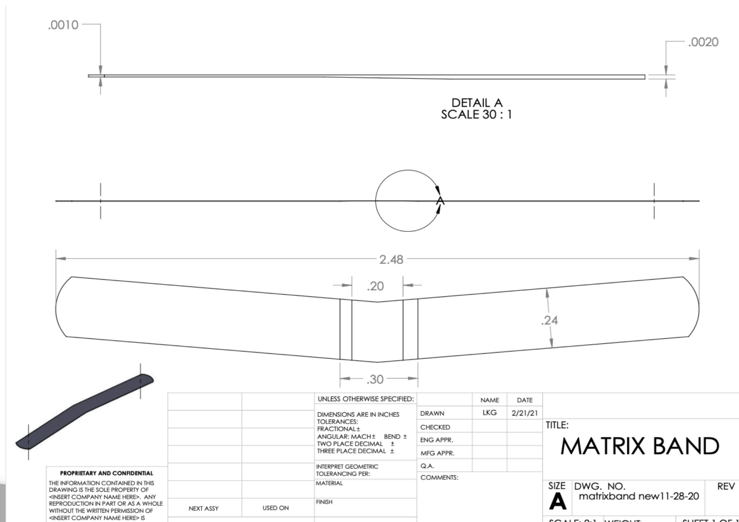


Figure3: Solid Works schematic of our final design, the Doug.

Results

1. Functionality Testing
- Done on bands of 0.003 in. and 0.0015 in. feeler gauges to mimic the prototype design while waiting for device to arrive

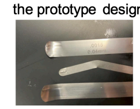


Figure5: Feeler gage (0.0015 in) Tofflemire band (0.0015in), and feeler gage (0.002in) used in testing

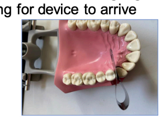


Figure6: Tofflemire band/ Doug functionality testing set up

2. Mechanical Testing
- Due to delays in the shipping process, we were unable to perform mechanical testing on our prototype
- In order to predict the behavior of our prototype under these conditions, we ran feeler gauges with various thicknesses through the MTS machine to see the pattern of stress/strain with varying dimensions.
- We failed to get true stress/strain curves from the gauges due to the metal slipping in the jaws, possibly due to the oil coating the steel.

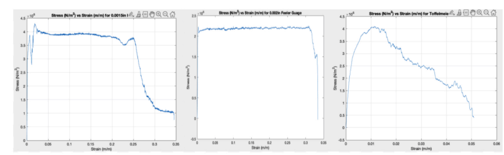


Figure7 : Stress/Strain curves for 0.0015in thick feeler gage, 0.002in thick feeler gage, and 0.0015in thick Tofflemire band

Conclusion

In conclusion, due to delays in shipping and access to our prototype design, the team was not able to see how our prototype functionally or mechanically worked. Based off of the testing with the feeler gauges we conclude that until the design is received from the manufacturers, it is impossible to determine if the thickness in the design would pose an issue mechanically. The design fits all of the requirements put forth by the client and will need testing and practice by our client and physicians to determine the viability of the prototype design in the field.

Future Work

- Find new way to mechanically test bands without slip
- Test prototype with both functionality and mechanical tests
- Design new retainer if needed
- Find more efficient means of fabrication
- Test design with the retainer to better understand how to articulate both bands with the retainer design.

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