**Finite-Element Analysis of Rhomboid Flap Biomechanics in an Anisotropic Environment**

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**Abstract**

**Objective:** To gain a better understanding of the biomechanics of the rhomboid flap under anisotropic conditions

**Methods:** 2D finite element model based on prior validated 2D, nonlinear hyperelastic human skin models of a rhomboid (Limberg) surgical flap was parameterized for reconstruction of a 1.5 x 2.6 cm facial defect. Internal angles of the flap were varied and ANSYS 14.5 was used to compute the x- and y-directional strain and overall resultant strain.

**Results:** Varying in the internal angles of a standard Limberg rhomboid flap can either add or decrease strain. While the magnitude of stress is highly dependent on patient and anatomical location, the general governing rule of orienting high strain regions perpendicular to RSTLs is easier to follow by viewing directional strain patterns.

**Conclusions:** The utility of finite element models for analyzing and planning pre-surgical endeavors have been well-documented. Our study is the first anisotropic local flap FEA model.

**Methods**

- **What is an Anisotropic Material?**
  - Material that behaves differently in different directions
  - Skin- RSTLs

**Figure 1:** A: Rhomboid flap with internal angles labelled, B: Proposed flap closure of forehead defect. The y-axis is always in the direction of the defect height

- 2-D Non-Linear Hyperelastic Finite-Element Model based on human facial skin (Lapeer)
- ANSYS 14.5
  - Compute stress/strain & displacements
- Varying alpha and beta angles

<table>
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<th>Alpha</th>
<th>Beta</th>
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**X- Direction Strain**

**Y- Direction Strain**

**Resultant Strain**

**Application**

- Forehead defect repair
  - Skin stiffness along RSTLs can be up to twice that perpendicular (Flynn, 2013)

- Orientation changes based on chosen flap parameters
  - See two variations below
  - Approximately 30° difference in rhomboid orientation

**Conclusions**

- Increasing α to 30° adds strain
- Decreasing β to 30° decreases strain
- Magnitude of stress/strain is highly dependent on patient and anatomical location
- General Governing Rule: Orient high strain regions perpendicular to RSTLs
- For complex flap placements, finite element analysis can be used to predict the orientation of the resulting strain field after flap closure.

**References**

