Evaluation of surrogate soft tissue candidates for biofidelity and durability

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INTRODUCTION

- Current Anthropomorphic Test Devices (ATDs) use materials with high repeatability and low biofidelity [1]
- Soft tissue analogues with higher innate stiffness do not capture the viscoelasticity of flesh properly, altering the load measured at the “skeleton”
- This can result in overestimations of the protective capacity of devices and equipment

OBJECTIVE

To subject synthetic materials to repeated dynamic impacts to identify any that may improve surrogate biofidelity

METHODS

- Silicone 10A, 20A, urethane 25A, and current ATD soft tissue foam and vinyl (n=3 per material) were cut or casted to a thickness of 10mm

Dynamic Loading

- 40 J impacts performed using a pneumatic impactor; ten repetitions per material (Fig 1a)
  - Load transmission of each material was calculated from force sensor mounted behind the material

Quasistatic Loading

- Quasistatic characterization was performed using a material testing machine (Fig 1b), to quantify potential changed to material behaviours, pre- and post-dynamic impacts
  - Ramp load was applied at 12 mm/min to 25% strain

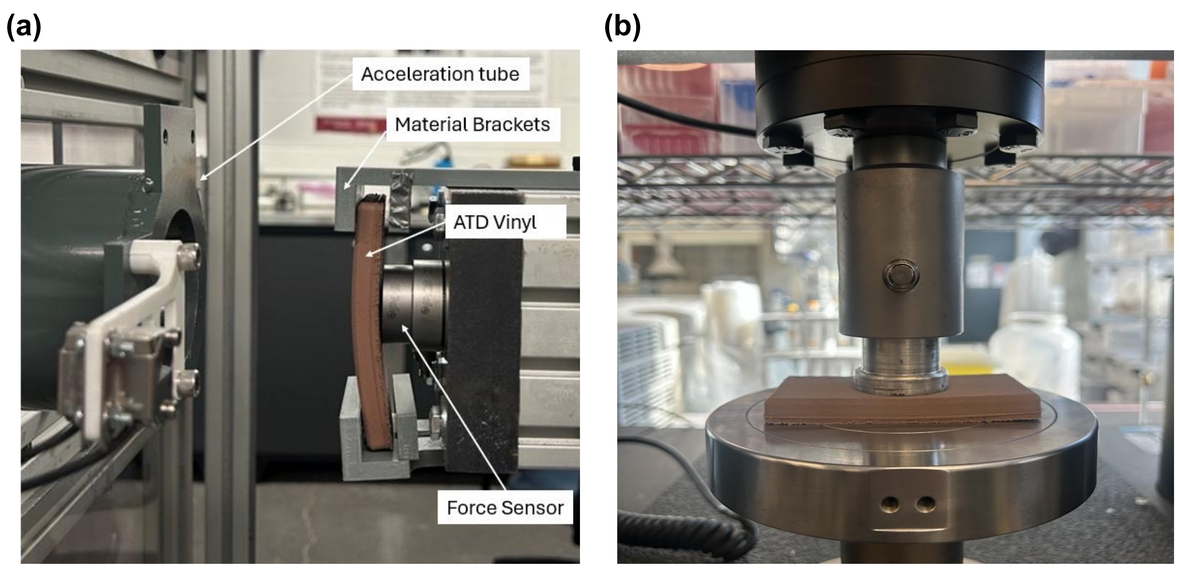

Fig. 1 (a) dynamic loading set-up in pneumatic testing device and **(b)** quasistatic testing machine performing compression testing on ATD vinyl

RESULTS

No visible damage was noted on any sample tested

Dynamic Loading

- ATD foam transmitted significantly higher forces than all other materials, mean peak force: 9,255N ($p<0.012$)

Quasistatic Loading

- The elastic modulus of all materials was not affected by the application of dynamic loads
- Silicone 10A, 20A, and urethane 25A’s elastic moduli fell within a previously reported range of human tissue (118.6 – 867.2 kPa) [2]

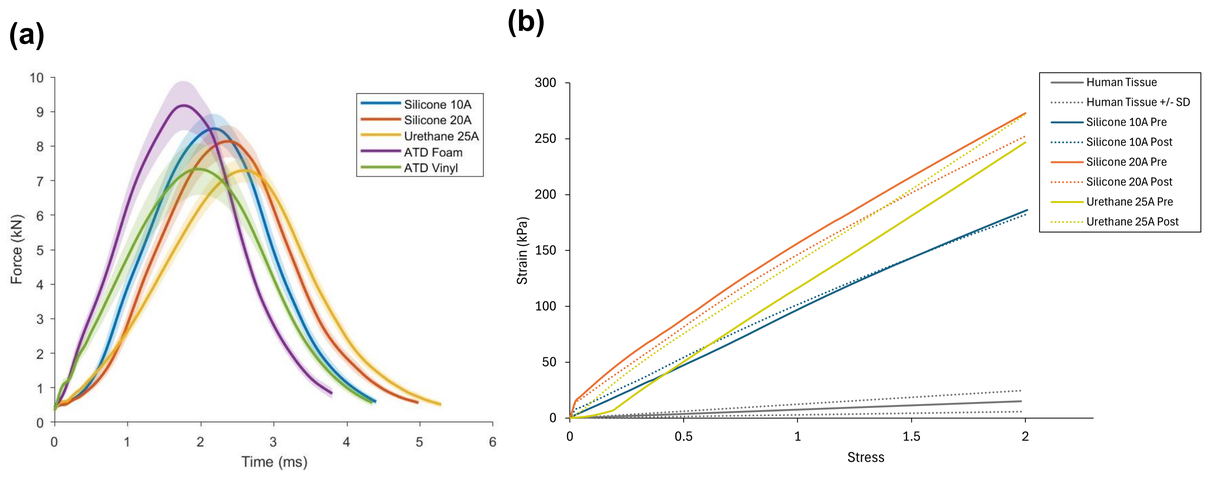

Fig. 3 (a) force-time response for dynamic impacts for each soft tissue candidate, with SD represented in the shaded regions, and **(b)** stress-strain for quasistatic loading of the casted soft tissue candidates, pre- (solid line) and post (dashed line) dynamic impact testing

CONCLUSIONS

- Silicone 10A, 20A, and urethane 25A were identified as viable for candidates for a soft tissue analogue
- Results will contribute to determining a durable biofidelic soft tissue analogue ideal for evaluation of protective devices and equipment
- Ongoing testing is investigating the durability of the materials with additional impact testing at different thicknesses and impact energies

REFERENCES

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