The Impact of 3D Stereopsis and Hand-Tool Alignment on Effectiveness of a VR-based Simulator for Dental Training

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Introduction

- Proliferation of VR-based dental simulators
  - High-fidelity, reusable, configurable
  - Record and analyze data on performance and outcome
- Wide variety of VR configurations used
- Display
  - 2D monitors
  - 3D monitors
  - Half-mirrored displays
  - HMDs
- Instrument manipulation
  - With and without haptic feedback

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Introduction

- Each new simulator typically has an associated evaluation study

- Only few comparative studies to determine benefits of VR technologies

- None that examine impact on transferability

- In this work seek to determine the impact on teaching effectiveness of
 - 3D stereoscopic rendering
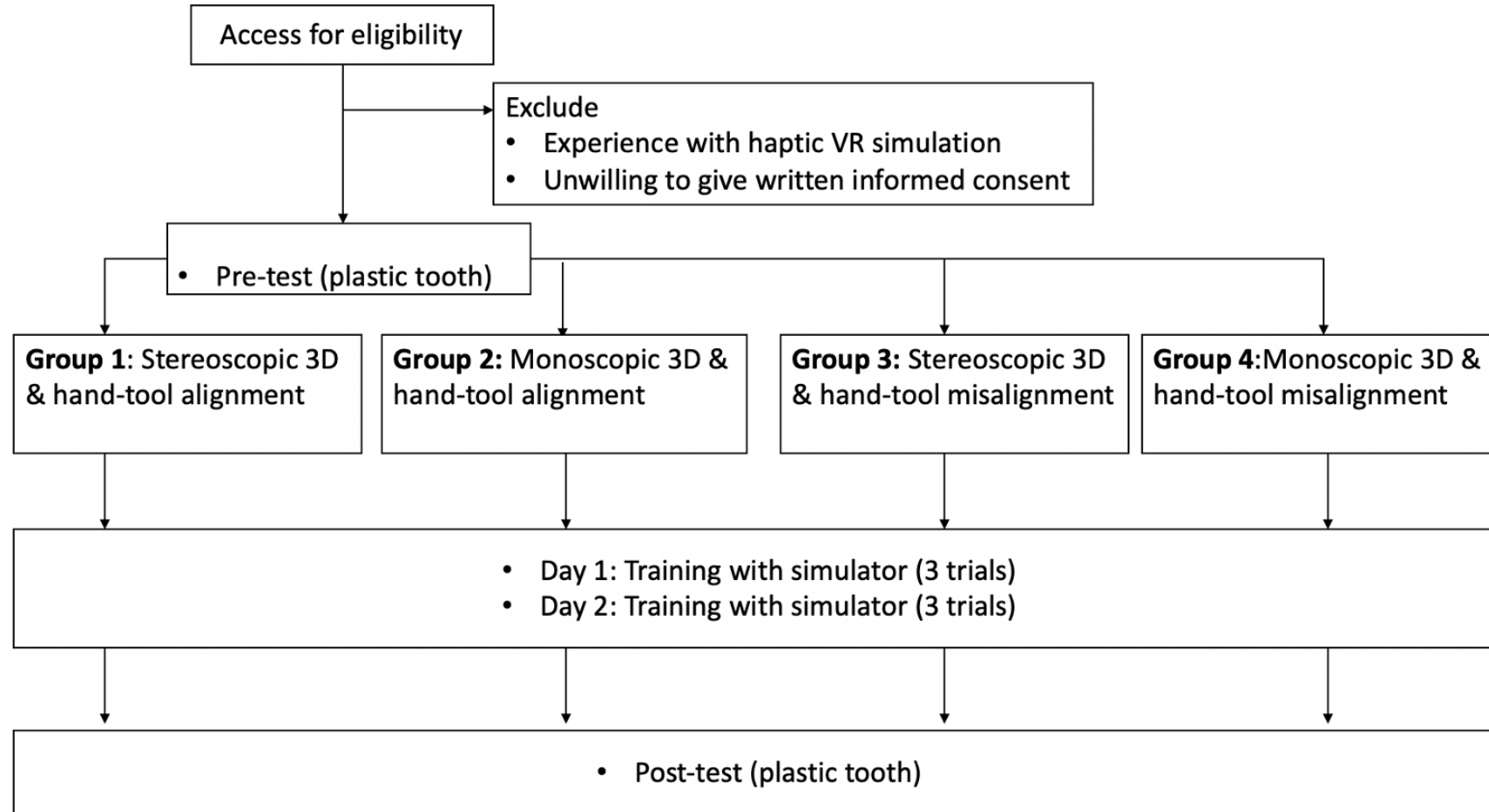 - Hand-tool alignment

VR-based Simulator

- Two haptic devices: drill, mirror

- HTC Vive HMD

- Unreal Engine

- Patient modeled with Metahuman

- Haptic feedback, drill sound

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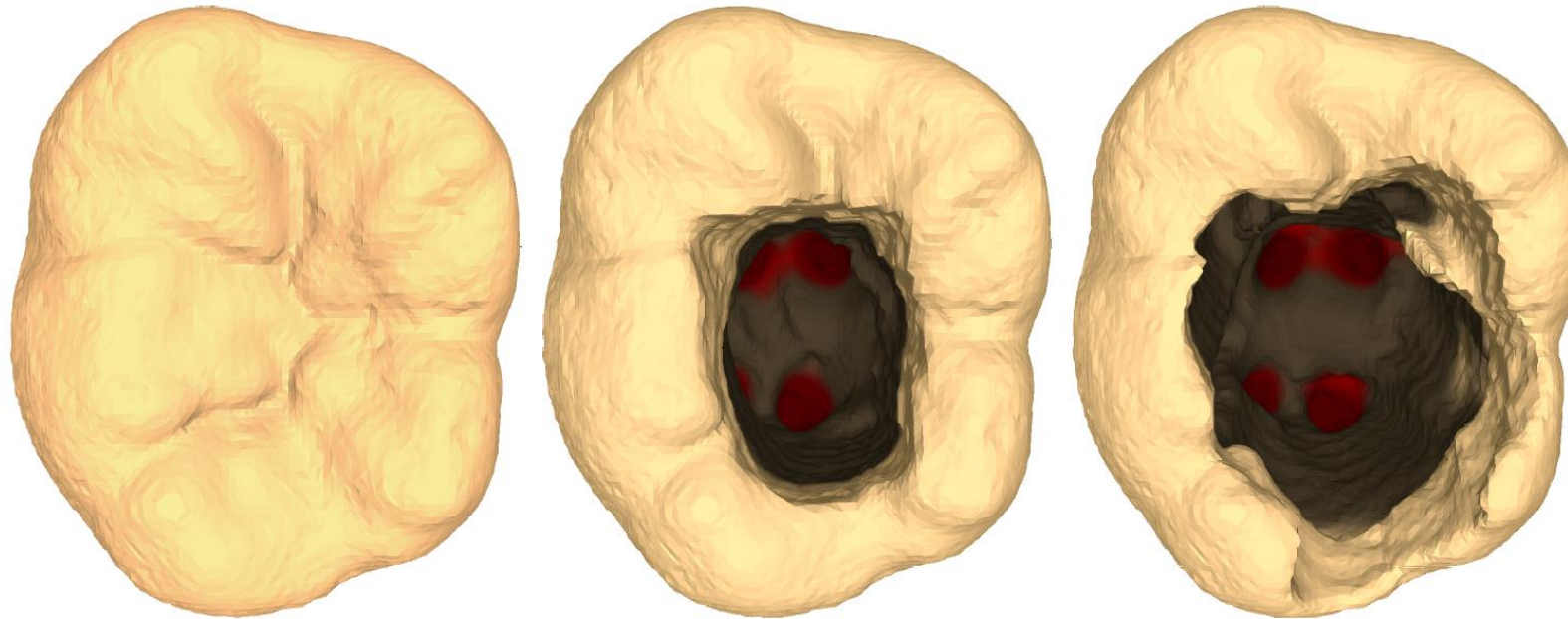- Tooth model - internal anatomy, 3 layers
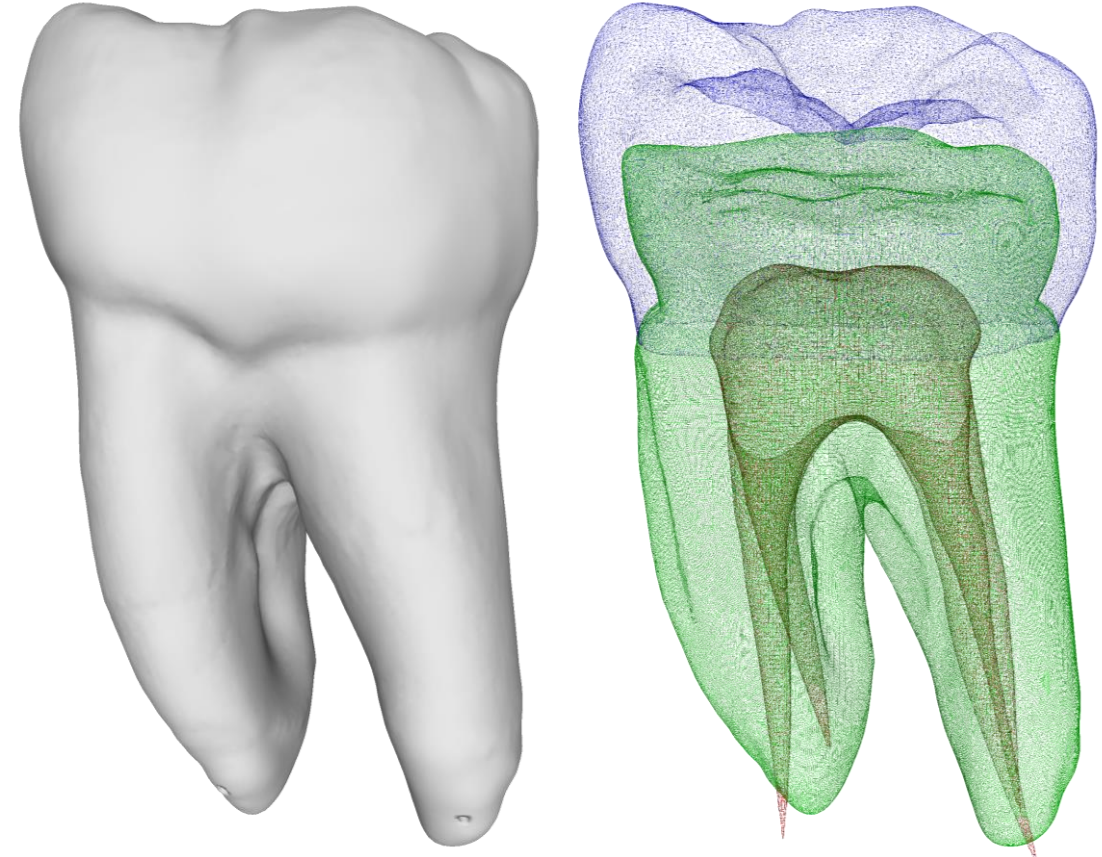
# User Study: 40 fifth year dental students

Scoring

- Two experts (kappa 0.87)
- Standard scoring scheme

Results

- ## Hand-tool alignment
  - Students with misaligned tools did not improve
  - Students with aligned tools showed significant improvement (2.71 to 2.21; **-0.5**)

- ## Stereo rendering
  - Contrary to our hypothesis
  - Students with monoscopic rendering learned better (2.56 to 2.08; **-0.47**)
  - Compared to students with stereoscopic rendering (2.97 to 2.95; **-0.03**)
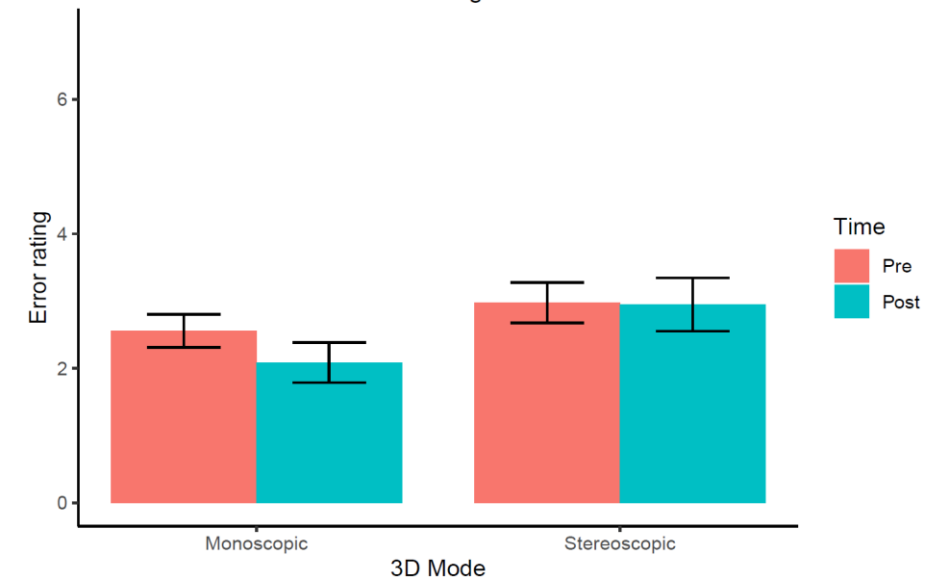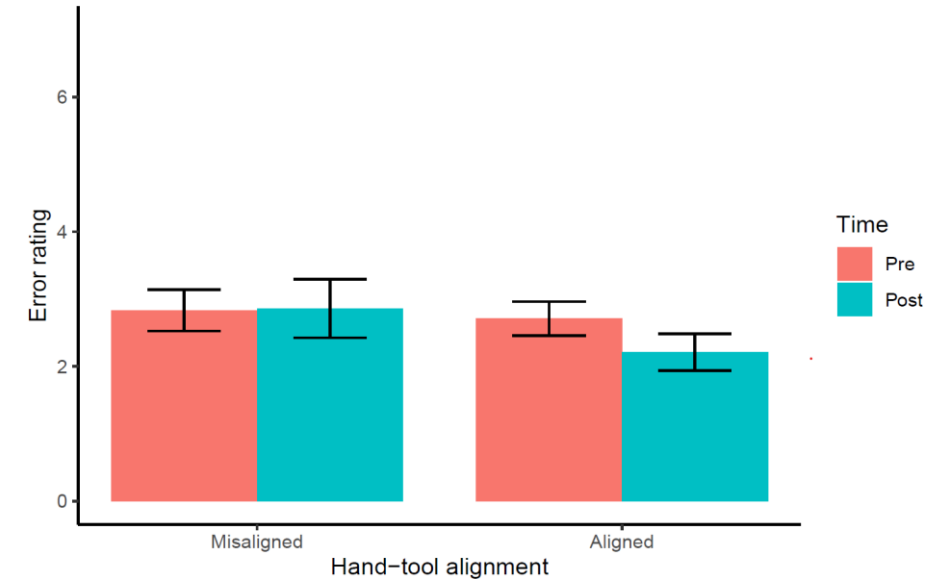
Conclusion & Future Work

- Hand-tool alignment important for training effectiveness

- Stereoscopic rendering can have negative effect
  - Monoscopic group on average looked more closely at the tooth
  - Stereoscopic group unable to look closely due to high inter-ocular disparity

- Further investigate stereoscopic effect
  - Higher HMD resolution could alleviate the problem
  - VR zoom feature similar to real surgical loupes