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Title: **Reliability of 3 different methods for assessing amputee residuum volume**

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**Aims and objectives:** Objective methods of assessing amputee residuum volume are required to inform treatment decisions with regard to timing and design of prosthetic sockets. Computer Aided Design (CAD) methods (e.g. optical 3D scanners) can capture surface geometry and colour without the need for reference targets. Data collected on residual limb models suggest these novel methods may have greater validity and reliability than methods currently used in clinical practice<sup>1</sup>. The aim of this study was to assess the reliability of a new 3D laser free scanner compared with two alternative methods previously adopted in clinical practice. We hypothesize that the CAD hand scanner will be more reliable than the other clinical measurement systems, for assessing amputee residuum limb volumes.

**Methods:** Three different operators measured the residuum volume of ten chronic lower limb amputees (5 transtibial, 5 transfemoral), on three occasions for each operator, using an Artec Eva 3D scanner, an Omega Tracer and a geometrical formula based on anthropometric measures, using a Gulick measuring tape and a crotch stick. Models were manually aligned using anatomical reference points. Intra and inter-rater reliability coefficients were calculated according with Bland-Altman statistic, for measuring indices of residual limb model volume for each method<sup>1</sup>

**Results:** Participants were chronic (>1 year) lower limb amputees with a mean: body mass 79±13 kg; height 173±11.6 cm and; time post-amputation 25.8±14.6 years). Residual limb volumes ranged from 1077 to 2406 ml. Intra-rater and inter-rater reliability coefficients were respectively 45 ml and 65 ml for the Artec Scanner (2.5 to 3.7% volume), 70 ml and 72 ml for the Omega Tracer (3.9 % volume) and 112ml and 256 ml (>10% volume) for the anthropometric measurements.

**Conclusions:** Prerequisites for a clinical method to measure amputee residuum volume are reliability, safety, and portability. Optical 3D scanners, based on laser free technology, are a promising method for assessing residuum limb volume changes in lower limb amputees. The Artec Eva scanner revealed the lowest reliability coefficients (2.5 to 3.7% volume) and could therefore be a useful method for quantifying short-term changes in the residuum volume of lower limb amputees, that might indicate recasting and refitting requirements.

**References:**

1. Seminati E, Canepa Talamas D, young M, Twiste M, Dhokia V, Bilzon J. Validity and reliability of a novel 3D scanner for assessment of the shape and volume of amputees' residual limb models. *Plos One*. 2017.