Mechanical Characterization of Anchoring Devices for Preventing Trauma and Driveline Infection in Patients with Left Ventricular Assist Device

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Objective

Driveline infection (DLI) is one of the most common adverse events associated with left ventricular assist device (LVAD) therapy [1], leading to increased patient mortality and morbidity [2]. To avoid trauma to the driveline exit-site (DLES) as major risk factor for DLI [3], the use of adhesive anchoring devices for driveline (DL) immobilization is recommended [4, 5]. However, as there is no evidence of superiority for a specific device, this study aims to mechanically characterize the effectiveness of different adhesive anchoring devices used in clinical practice.

Methods

Commonly used anchoring devices were identified through a literature review and by contacting nine international VAD implanting centers. For mechanical characterization of the anchoring devices, an in-vitro model of abdomen and DLES of the patient was constructed (Fig. 1), in which a tensile force (10N) could be applied from an adjustable angle (0–90°) to a HeartMate 3 LVAD DL and the resulting force (F_{Total}) on the artificial DLES recorded using a three-axis load cell. F_{Total} was classified into four trauma protection categories (high: 0-25%, medium: 25-50%, low: 50-75%, no protection: 75-100%) of the applied tensile force.

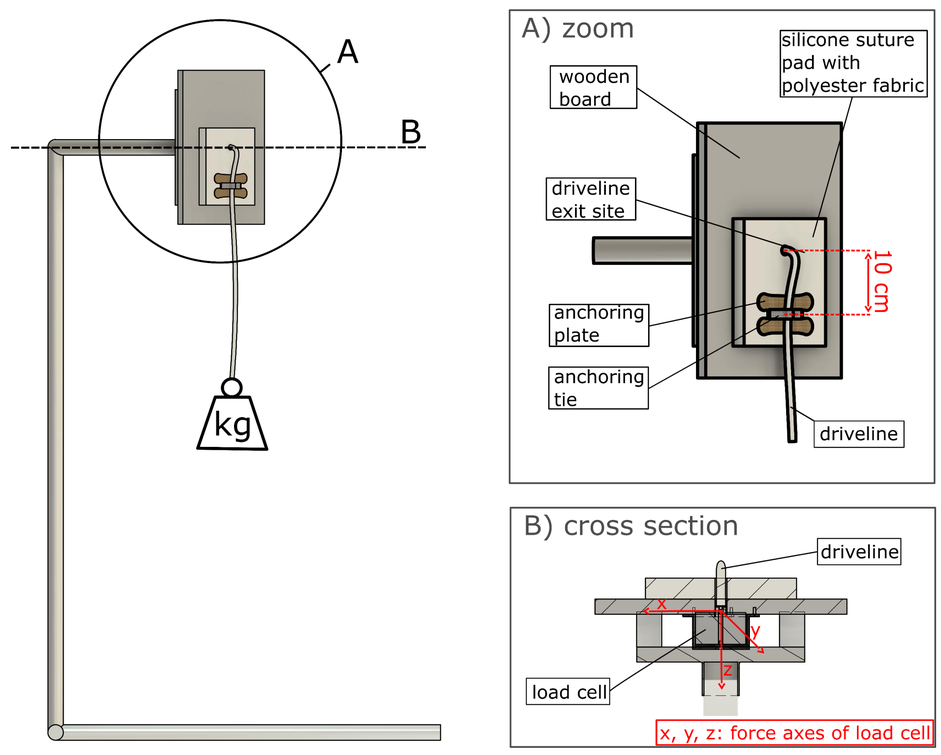


Figure 1: Measurement Setup: A) zoom of abdomen model, B) cross section of abdomen model with load cell axis

Results

In total, eigth different anchoring devices (Fig. 3-10). were identified and tested (Fig. 2), with Hollister and Foley Anchor being the most commonly used clinically. The CathGrip anchoring device provided 100% ‘high protection’ (F_{Total}=2.1±0.4N), Secutape (F_{Total}=2.6±0.3N) and Tubimed (F_{Total}=2.9±0.2N) 60-70% ‘high protection’, and Hollister (F_{Total}=2.7±0.5N) 80% ‘medium protection’. All four devices were significantly ($p<0.05$) better at preventing tensile forces at the DLES compared to the other four devices (Main-Lock: F_{Total}=3.7(0.7)N, Secutape sensitive: F_{Total}=3.9±0.4N, Foley Anchor: F_{Total}=4.3±0.5N, Grip-Lok: F_{Total}=5.4±0.8N–worst with 55% ‘low protection’). Not using an anchoring device resulted in F_{Total}=8.2±0.3N (100% ‘no protection’).

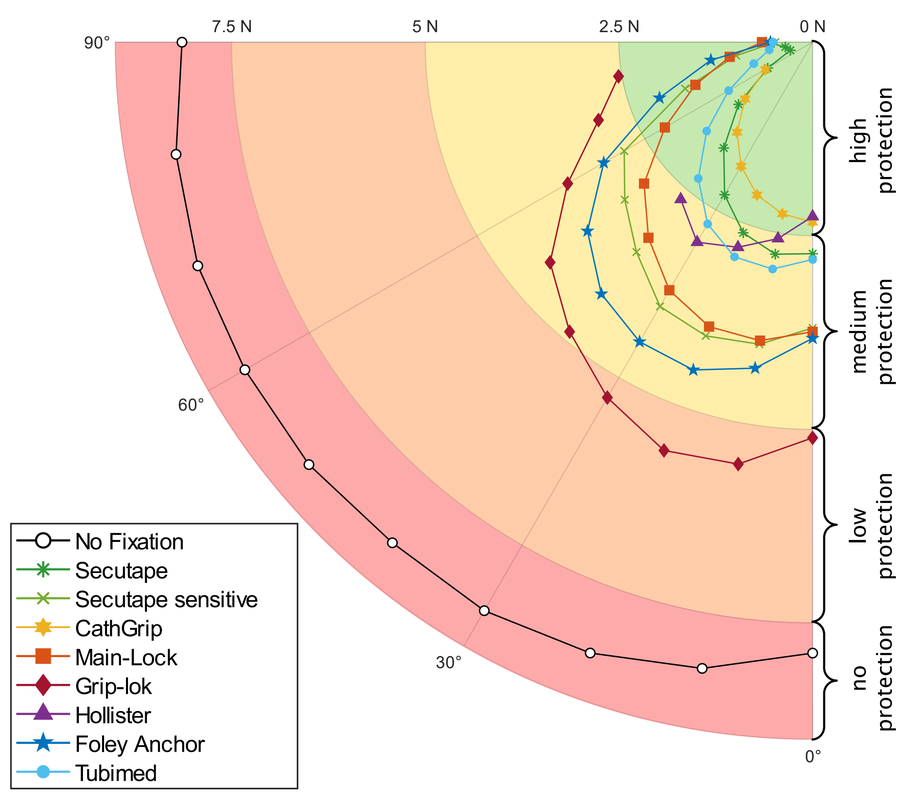
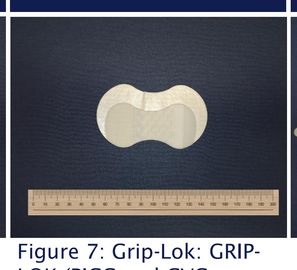
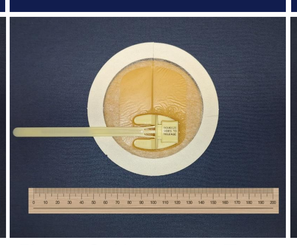
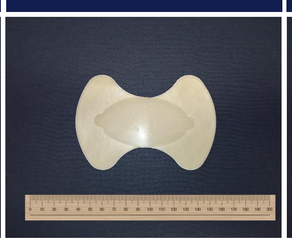


Figure 2: Mean tensile force to the DLES, 90° polar plot, stratified by seven types of anchoring device types and no fixation

Conclusion

The appropriate selection of anchoring devices plays a critical role in reducing the risk of DLI, with CathGrip, Secutape, Hollister, or Tubimed being superior in preventing trauma to the DLES and subsequent DLI.

Secutape	Secutape Sensitive	CathGrip	Main-Lock	Grip-Lok	Hollister	Foley Anchor	Tubimed
							
Figure 3: SECUTAPE Velcro binder set big nonwoven, TechniMed AG, Rorschach, Switzerland	Figure 4: Secutape sensitive: SECUTAPE® fixing set for big lumina hydrocolloid, TechniMed AG, Rorschach, Switzerland	Figure 5: Securement CathGrip® large double strap, BioDerm, Inc., Largo, FL, USA	Figure 6: Main-Lock 14, Novo Klinik-Service GmbH, Bergheim, Germany	Figure 7: Grip-Lok: GRIP-LOK (PICC and CVC Securement Device) medium, TIDI Products, LLC, Neenah, WI USA	Figure 8: Horizontal Tube Attachment Device, Hollister Incorporated, Libertyville, IL USA	Figure 9: Foley Anchor, UrineCatheter/ Drainage Line/Driveline Securement, CENTURION medical products corp., Williamstone, MI, USA	Figure 10: Drainagen Fixierung Gr. 3, Tubimed GmbH, Memmingen, Germany

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