Operating Table Clamp for Securing Patient Transfer Devices

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Project Introduction

Background

Lateral patient transfer devices are used to transfer patients between beds or onto an operating table.

- Device is inserted and inflated underneath the patient
- Underside material is made from a **low friction** material which reduces the force necessary for staff to move/transport the patient

The low friction bottom increases the risk of patients slipping off of the OR table during surgeries involving the Trendelenburg position (shown in **Figure 1**).

- Patients in this position lie supine, tilted with their feet raised above their head. The Trendelenburg angle ranges from 0° to 40°
- 30° – 40° is the steepest Trendelenburg angle, associated with the **highest risk of slipping** off of the OR table

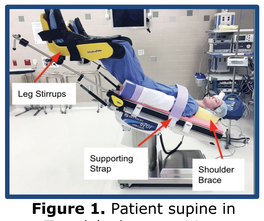

Figure 1. Patient supine in Trendelenburg position.

Need

The transfer device is used to move patients to the OR table, deflated, and kept under them during the operation.

- The device being kept under the patient increases the likelihood the mat will slip and the chance of surgical complications or injuries to the patient/staff
- Removal of the device is often unavoidable for larger patients, due to this task requiring strenuous effort

This indicates that there is a need to reduce the frequency of perioperative slipping while using this category of devices in order to reduce the risk of surgical complications.

Design Requirements

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- Anti-slip device must be able to counteract the force of gravity at Trendelenburg angle of up to 40 degrees
- Device must be able to withstand the weight of the patient
- Device must be able to fit around the OR table
- Device needs to maintain a low profile to not get in the way of surgical staff
- Parts of the device in contact with transfer technology must not cause damage to transfer tech.
- Device will withstand repeated sterilization without corrosion
- Device material is durable (strong) and will not bend or fracture with repeated use
- Material is not combustible
- Device storage must comply with medical fire safety standards
- Device must not inconvenience caregivers or risk patients' health
- Cost of the device stays near current market cost

Design Specifications

- The device must provide a reaction force of **1307.2 N**
- Device can withstand a patient weighing **1000 lbs .**
- Device must have unattached dimensions of **1.125 in x .5 in**
- Device must not add more than **2.4 inches** to the overall width of OR table
- Material chosen for part in contact with transfer technology must **not have a sharp edge or be too rough**
- Material chosen for clamp base can **withstand sterilization 3900 times**
- Material base has **UTS of 420 MPA, E of 200 GPA, and a shear modulus of 80 GPA**
- Materials comply with standards ASTM E136 and ASTM E2652
- Device must be able to be stored at a maximum depth and height of **0.9x0.76 in**
- Time from opening device to patient transfer must be **below 2 minutes**
- Device production cost l**ess that $80**

Detailed Design

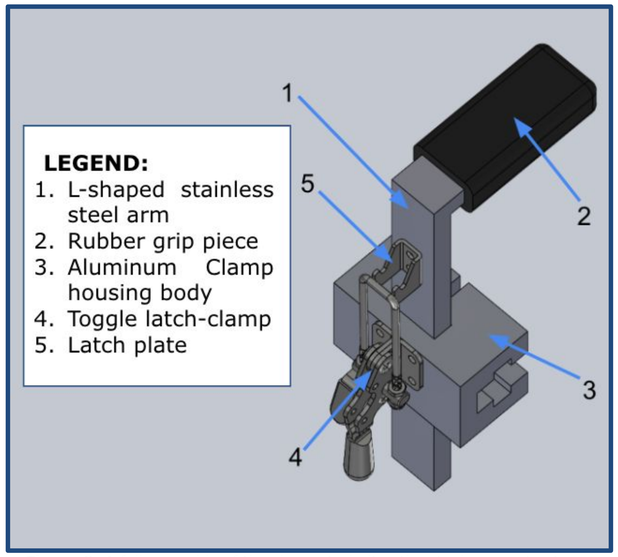

Figure 2. A full assembly of the clamp, including the steel arm, grip piece, housing body, latch clamp and latch plate.

Design Overview

Our clamp is a fairly simple design with an L-shaped stainless steel arm that extends up from the rails of the operating table and can then sit over the top surface of the table. The clamp housing is designed to fit onto the standard 1" x 3/8" rails of most operating tables and successfully prevents the HoverMatt/transfer device from causing the patient to slip even at max Trendelenburg angles (40°).

Design Features

- Simple and quick setup does not interfere with surgical prep
- Relatively inexpensive so number of clamps can be customized to meet the specific needs of the patient and surgical staff
- Adjustable length of the toggle latch U-bolt can be used to set the depth of compression to the OR table when fully engaged.

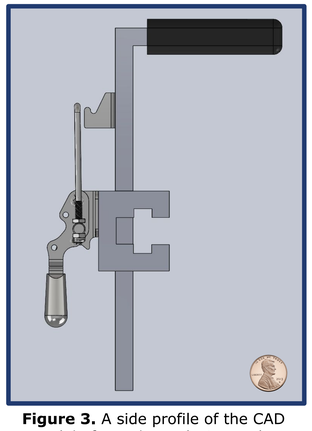

Figure 3. A side profile of the CAD model of our clamp design and a penny for reference of size.

Figure 4. The latest prototype of our clamp design.

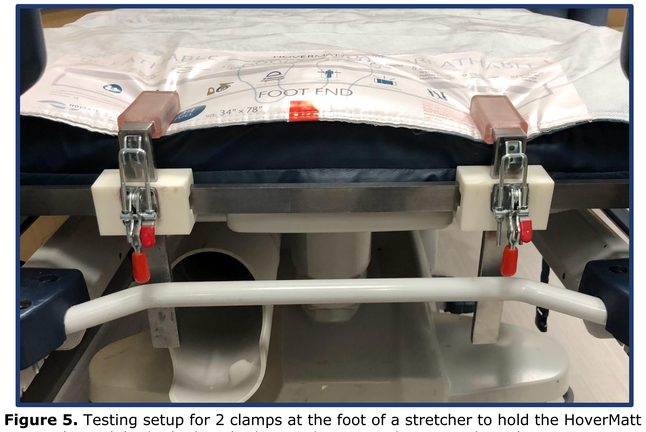

Figure 5. Testing setup for 2 clamps at the foot of a stretcher to hold the HoverMatt in place while the bed is tilted to 40 degrees with a test subject lying on top.

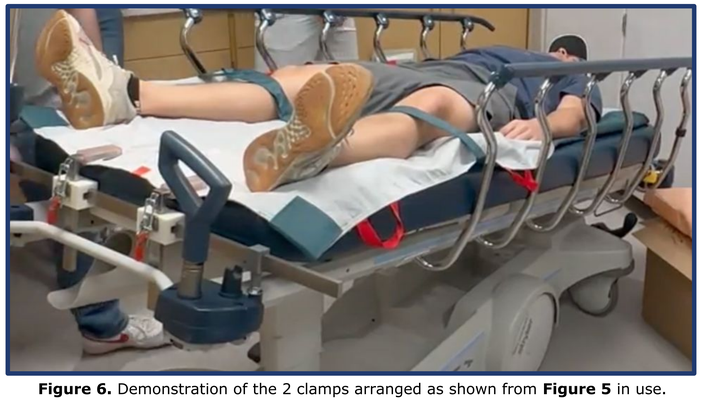

Figure 6. Demonstration of the 2 clamps arranged as shown from **Figure 5** in use.

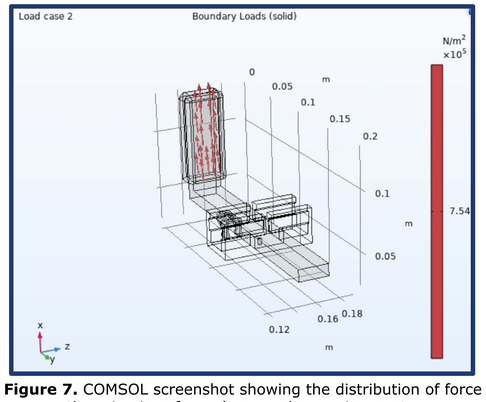

Figure 7. COMSOL screenshot showing the distribution of force on the grip piece for a clamp under maximum stress.

Validation and Results

Reduction in Patient Slipping

- 'Slip test' done both with and without the clamps
  - Without the clamp, patient slips 100% of the time, needing someone to stop them
  - With the clamp, the patient slipped a maximum of 1 inch before stopping

Supporting the Patient

- Device must be able to withstand 1000 lbs
  - An FEA test was conducted and received a fatigue usage factor of 0.772

Non-damaging

- Five trials of the entire process is conducted to test for any damage done to transfer device
  - Zero signs of damage is shown after the tests were concluded

Reusable

- Base of device must be able to withstand 3900 uses
  - FEA test conducted using steel alloy properties and can undergo 1×10^6 uses
- End grip must be able to withstand 780 uses
  - FEA test conducted using thermoplastic polyurethane properties yielded maximum stress under ultimate tensile stress

Conclusions and Next Steps

In conclusion, the current state of the device is showing promising results. The device is considered easy to use, remains out of the way of healthcare providers, and reduces the chance of perioperative slipping in the steep trendelenburg position. With this, our analyses suggests further prototyping of the current design.

Moving forward, design changes as a result of EDR feedback and validation & verification testing results will be implemented. From this a second prototype will be machined from final design materials as compared to 3D printed parts currently in use. This prototype will be tested to meet design requirements in physical settings with clinical experts as compared to COMSOL simulations.

Acknowledgements

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