Fabric Hip Brace for Hip Replacement Postoperative Use

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Abstract
A well-recognized complication associated with hip replacement surgery is the dislocation of the hip joint following surgery. The risk of dislocation is highest in the first few months following surgery. To reduce risk of dislocation, the patient is required to wear a metal hip abduction brace. The function of the brace is to regulate flexion, extension, and abduction (forward, backward, and sideways) movements in the hip.

The aim of this project is to develop an alternative design to current post-operative hip braces, presented in the form of a mockup. The main specifications were to remove the metal pieces and replace them with a fabric design, while maintaining functionality. We hypothesize the outcome of these changes would improve the ease of wear of the brace and the overall comfort of the hip-surgery patient.

Introduction
This project originates from Dr. Brian Lewis, an orthopedic surgeon who specializes in adolescent hip replacement surgery, and the USU Spider Silk Lab. In his career, Dr. Lewis has experienced patient noncompliance regarding post-operative hip braces, due to the brace being uncomfortable to wear for extended periods of time. Dislocation is the second most common complication following total hip replacement [1]. Not wearing the hip brace would leave the patient vulnerable to hip dislocation, which could result in additional surgeries to fix the dislocation depending on the severity.

The overall goal of this project is to create a more comfortable hip brace to improve the wearability by adolescent patients. The project proposed will achieve this goal by focusing on the exclusion of metal components through the creation of a post-operative hip brace that is primarily made of fabric. This design will be constructed using current sports hip braces as a baseline, because sports hip braces present an all-fabric hip brace design.

Approach

- Total hip arthroplasty
- Outdoor Product Design Department
- Patent Review
- Fabric Properties
- Tensile tests on athletic mesh bonded with fabric adhesive
- Elasticity and Young Modulus
- Strength testing of leg
- Kinesiology and Health Science Department
- Biodex
- AutoCad Sketches
- 3D Rendering
- Mockup Design

Literature Review
Post-operative hip braces restrict the hip motions of abduction, flexion, and extension. Braces limit abduction to 10°, allow no extension, and allow flexion up to 60° [1]. A hip brace may be worn for two to four weeks following surgery to prevent dislocation. An uninjured human hip can generate up to 0.8 N·m of torque in flexion/extension and 0.5 N·m in abduction.

Thermoplastic
- Moldable when heated
- Strength and rigidity
- Cost-effective for each patient

Athletic Mesh
- Breathable
- Moisture-wicking
- Bilateral strength

Neoprene
- Compressive capabilities
- Compatible with Velcro
- Long-wearing

Silicone
- Helps diminish scar
- Moldable
- Biocompatible

References

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Discussion
To be effective, our design must resist torques of 0.8 N·m in flexion and extension and 0.5 N·m in abduction. By designing to the forces generated by a healthy individual, we hope to create a margin of safety for the patient.

Our mockup will be built and tested to a single individual. Our mockup will use thermoplastics as an alternative to a metal stop and will also use Velcro straps create additional resistance. We will create and test the mock-up – up to a single individual as a proof of concept.

Future Work
The work done by our team is very preliminary. Our team will be finishing the mockup and conducting performance testing. If testing of the mockup demonstrates adequate ability to limit movement while still being more comfortable than a traditional brace, then future teams will work to prototype and finalize the design for manufacture. Clinical testing will be necessary. A finalized design would be subject to FDA regulation. The most likely path to market would be 510(k) clearance.

Team Members

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OUR DESIGN