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MRI Hip Joint Traction Device

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Introduction

Imaging contrast agents are often used to improve resolution and acuity when employing MRI (magnetic resonance imaging). For the hip, introducing MRI agents into the articulation is very challenging because the femoroacetabular articulation is highly congruous. This anatomy also prevents the contrast agents from remaining in the joint during imaging sequences. Therefore, getting the ideal image resolution and making diagnoses of the hip are difficult in MR arthrography.

Project Objective

The objective of our senior design project is to design a device that will successfully distract one hip joint while also stabilizing the patient's pelvis to improve visualization in MRI so that clinicians are able to better diagnose the status of an abnormal hip.

Design Requirements

- Consistent/Constant hip traction
- Pelvis stabilization
- Load measure
- Release Mechanism
- Non-ferromagnetic

Due Diligence

Two main approaches have been employed in the past to provide hip distraction for MRI arthrography. One approach uses bags full of saline suspended over the edge of the MRI table and attached to the foot (Suter et. al). Another traction device consists of weights suspended from a pulley system attached to an ankle brace (Schmarazner et. al). A splint is positioned so that the affected extremity is stabilized and the contralateral leg balances on a supporting plate to stabilize the hip. These methods are effective in distracting the hip, but they do not have effective stabilizing features, a way to measure applied load, nor do they address increased patient anxiety that may result from the combination of claustrophobia in the confines of the MRI and having a large device attached to their bodies.

Design Concepts

1. The first design consisted of a box containing a motor and a weight that would stabilize the box, as well as a clamp attached to the box that would serve to hold the leg or foot in place. The device was moveable to a fixed distance by a remote in order to apply the traction.
1. The second design consisted of a platform for the patient to lie on and a device to apply the traction. The platform would be large enough to fit the patient's lower extremities and would have several velcro straps to secure the patient's waist and stabilize the opposite hip. The traction portion of the device would be attached to the platform and secured around the patient's knee. The traction would be run by a set of spur gears with a handle that could be turned so that the traction is applied parallel to the patient's leg.
1. The third design also had a platform incorporated into the traction device. There would be two components to this device, one responsible for hip distraction and one to provide stabilization. Each leg would be surrounded by two adjustable vertical plates on the interior and exterior-- this would secure the leg to the device. One side would distract the leg with a lever connected to the walls of one leg, while the other would keep the opposite leg in place. The lever would be attached to the traction portion of the platform with gears. As the lever is turned, the amount of force applied to distract the hip would increase incrementally to the desired tension.

Future plan

1. Possible patenting and continued testing.
2. Designing and improved gear to have the optimum dimensions to last for more cycles of use.
3. Finding a more effective way to measure the load applied via the spring.

Final Design

A platform was designed to contain each component of the device. The traction component includes a ratchet gear winch system secured to the platform and attached to an ankle brace that will provide various loads of traction with the turn of the handle. Stabilizing components include posts strategically placed under the arms and in the groin area. To alleviate some of the psychological concerns a patient may have, a release mechanism was incorporated into the design that allows the patient to open the velcro straps for the ankle brace and thus release the ankle brace. The spring for the spring scale is made from beryllium copper because it is non-ferromagnetic and is ideal for use as an extension spring. The platform, posts, gear system, and spring box for this prototype is made from wood because it is inexpensive, and moderately strong and hard. Lastly, a basic ankle brace was incorporated into the design to connect the patient with the device.

