A MECHANICAL MODEL FOR HIP REDUCTION VIA PAVLIK HARNESS IN NEWBORNS

INTRODUCTION
➢ Developmental dysplasia of the hip (DDH) is an abnormal condition in infants and commonly treated by the use of the Pavlik harness.
➢ 1 out of every 20 babies has some hip instability.
➢ The effectiveness of the Harness depends on physician expertise, experience and trial-and-error procedures.
➢ For a better understanding which procedure with the Pavlik harness is most effective a multi-physics computational approach has been done.
➢ To prove the results of the computational approach a mechanical model is needed which will provide physicians a better understanding of the mechanics of DDH when using the Pavlik Harness.

METHOD
➢ Trial and error experiments will calibrate the pneumatic to adjust for the right pressure that will replicate the individual curve
➢ The data of the path of reduction of the femoral head will be acquired by IMUs, and will be processed using MATLAB.

RESULTS
➢ A scale of 4x for the model was calculated to be practical for teaching purposes

ABSTRACT
Developmental Dysplasia of the Hip (DDH) refers to an abnormal hip condition in neonates characterized by anomalous development of the hip joint, in which hip joint dislocation, misalignment, and musculoskeletal instability are present in newborn infants. Clinical reports and previous research indicate very low success rates for the Pavlik Harness for severe grades of hip dislocation; statistically, it has been shown that for reduction rate for the International Hip Dysplasia Institute (IHD) Grades I-III is 92% while only 2% for grade IV.

In order to experimentally verify the computational model of the hip reduction and abduction via the use of the Pavlik Harness in severe cases of DDH, a mechanical bench-top model is to be designed, built and tested for the four grades of dislocation.

This approach will be repeated for three patient-specific neonate musculoskeletal models, as to corroborate the use of this experimental bench-top design in the validation of the patient-specific computational model.

The primary impact of this project on society will be to assist in the improvement to the success rate on non-surgical interventions for patients with DDH, as well as its consequences in adulthood; DDH is found responsible for 25% of primary hip replacements in people up to 60 years of age.

REFERENCES

ACKNOWLEDGMENTS
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OBJECTIVES
➢ Hernes
➢ Commonly
➢ Improvements
➢ The
➢ people
➢ patient
➢ simulate
➢ Harness

Figure 1. Infant wearing a Pavlik Harness
➢ Replicate an infant's hip with DDH and the 7 muscles important during the hip reduction.

Figure 2. This computational model with grade IV dislocation and its path of reduction has to be proven with a mechanical model
➢ The mechanical model will be scaled proportionally to the size of an infant and simulate the passive muscle forces.

Figure 3. Each muscle has an individual force vs. stretch curve representing the passive muscle force; these curves have to be replicated

Figure 4. Set up of the 7 pneumatic muscles attached to an air compressor
➢ Air Compressor
➢ Air Hose
➢ Air Regulator
➢ Air Muscle
➢ Air Way Splitter

Figure 5. From Left to Right IHD Grades I-IV
➢ Normal
➢ Subluxation
➢ Low Dislocation
➢ High Dislocation

Figure 6. The 3D printer MakerBot 5th Generation has been the most expensive purchase
➢ 3D printer
➢ Foot and tibia have been printed with a scaling factor of 4

Figure 8. The lower extremities were created using a CAD software, ready to be 3D printed
➢ figure

Figure 9. McKibben air muscles have been chosen to replicate the individual force vs. stretch curves; by varying the pressure the passive muscle force can be adjusted

Figure 10. Foot and tibia have been printed with 3D printed

Figure 11. Right half of the lower extremity with muscle location
➢ Adductor muscles origins and insertion points

BUDGET
➢ Expensive purchase
➢ Total Budget is $3640.20

Figure 7. Visual representation of budget divided between 3D prototyping and Air muscle pneumatics; Total

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