## 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.

## OBJECTIVES

- Replicate an infant’s hip with DDH and the 7 muscles important during the hip reduction.
- The mechanical model will be scaled proportionally to the size of an infant and simulate the passive muscle forces.

## 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.
- The team successfully created a 3-D printed model of the right half of the lower extremities that will be used to visualize the desired points of origin and insertion.
- The 3D model will also help to visually understand what is happening during the hip reduction process in order to implement this procedure on a patient-specific case.

## REFERENCES


## ACKNOWLEDGMENTS

Dr. Eduardo Divo, Associate Professor of Mechanical Engineering at ERAU

Dr. Victor Huayamave, Assistant Professor of Mechanical Engineering at ERAU

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**Figure 1.** Infant wearing a Pavlik Harness

**Figure 2.** This computational model with grade IV dislocation and its path of reduction has to be proven with a mechanical model

**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

**Figure 5.** From Left to Right IHDI Grades I-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.

**Figure 6.** The 3D printer MakerBot

5th Generation has been the most expensive purchase

**Figure 7.** Visual representation of budget divided between 3D prototyping and Air muscle pneumatics; Total Budget is $3,140.20

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

**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 a scaling factor of 4

**Figure 11.** Right half of the lower extremity with muscle location