

Hip Mechanics of Infants

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BOISE APPLIED BIOMECHANICS OF INFANTS

LABORATORY

Understanding Hip Angles of an Infant in Different Baby Carrier Styles

BACKGROUND

- Developmental Dysplasia of the Hip (DDH) can occur in 1-3% of newborns¹.
- DDH is responsible for 29% of hip replacements in people under the age of 60³.
- The Pavlik Harness (PH) is used to treat DDH and is the standard for the healthy hip position of 90° flexion and 80° abduction⁴ angles.
- Some commercial baby carriers subject babies to specific hip positions, but limited research exists on infant hip biomechanics and development in baby carriers.
- Quantifying hip angles within infant devices may improve understanding of healthy hip positions in commercial baby gear.

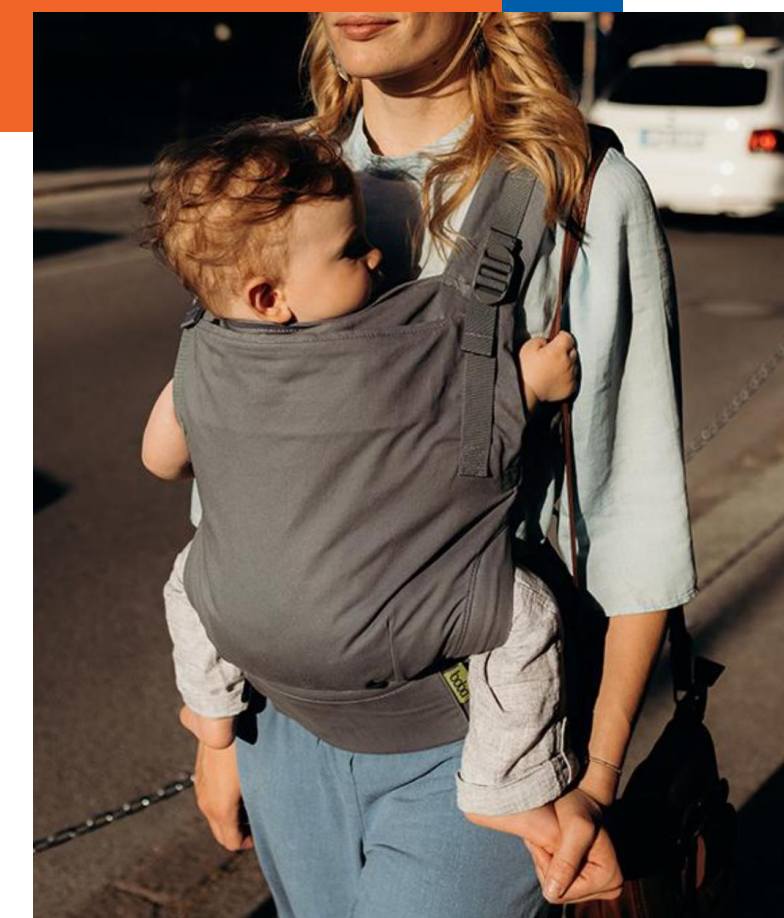


Figure 1. Baby carrier design on the market today².

PURPOSE: To develop testing methods to accurately measure infant hip angles in various baby carriers.

METHODS

3 baby carriers and 4 positions
1 infant manikin (Figure 2): 2.83kg.
1 adult manikin

Measurement Methods

Goniometer

- Device that measures flexion and abduction angles of the infant's hips.

MATLAB

- Photo analysis functions calculate the flexion angles.

Novel Pressure Sensors

- Placed pressure sensors around one thigh and back/gluteus maximus of the infant manikin.
- Measured maximum force, peak pressure, and mean pressure that



Figure 2. Free joint newborn manikin.

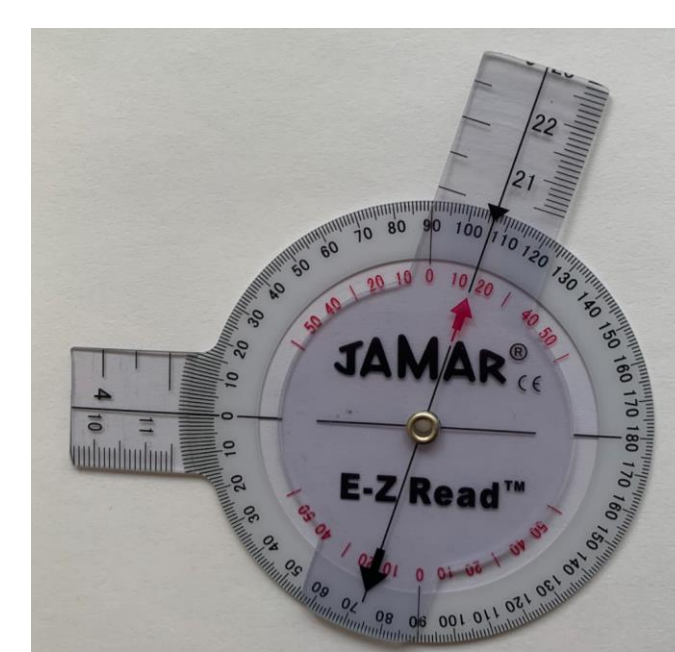


Figure 3. Goniometer measuring device.

RESULTS

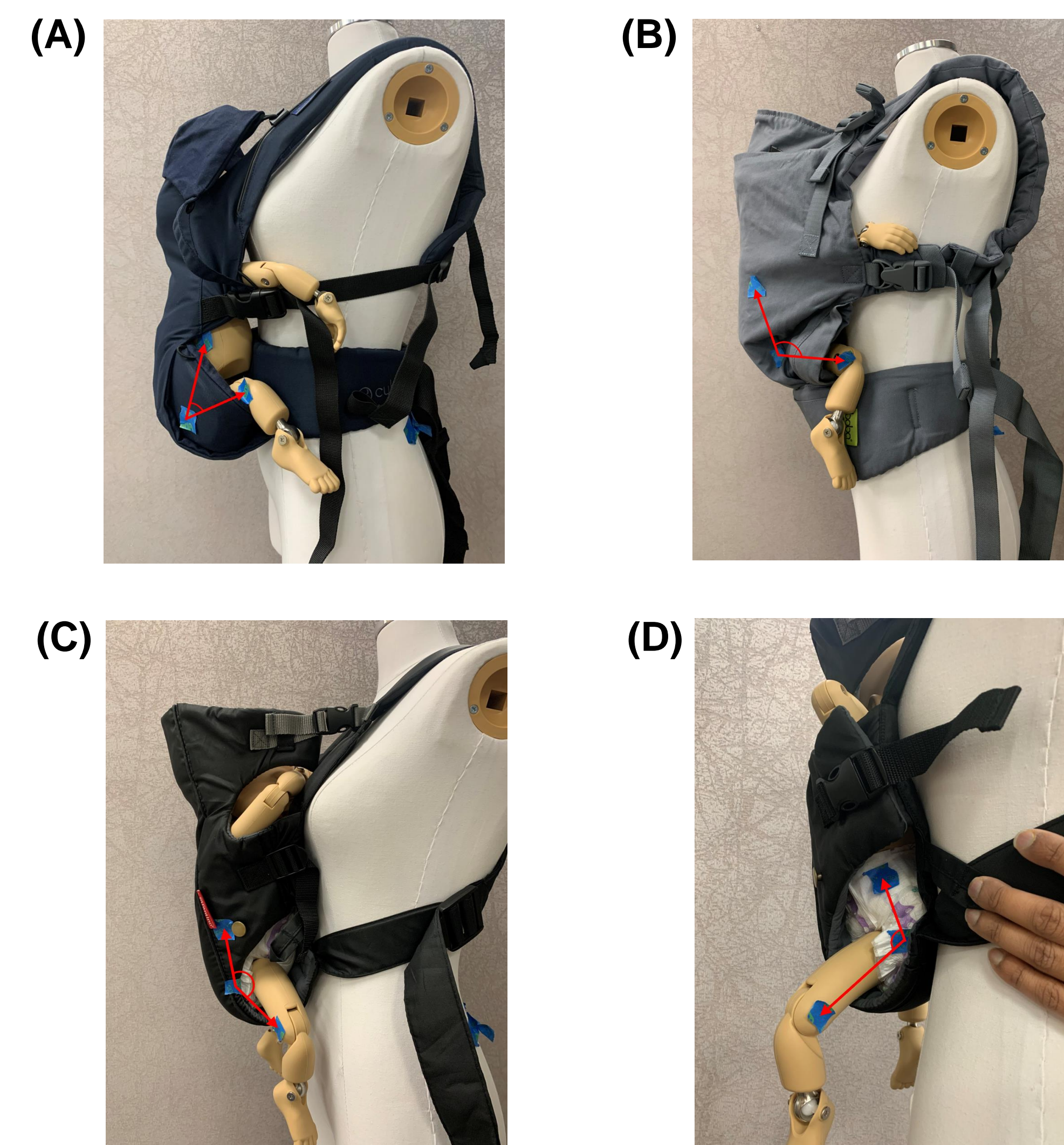


Figure 4. Manikin placed in baby carriers with markers for photo analysis and the angles measured labeled, (A) Carrier A facing inward, (B) Carrier B facing inward, (C) Carrier C facing inward, (D) Carrier C facing outward.

- Pressure and force data collection was inconclusive to the understanding of infant hip mechanics.
- Baby carrier C in both inward and outward facing conditions did not support the infant's hips for a healthy position.

Hip Angles

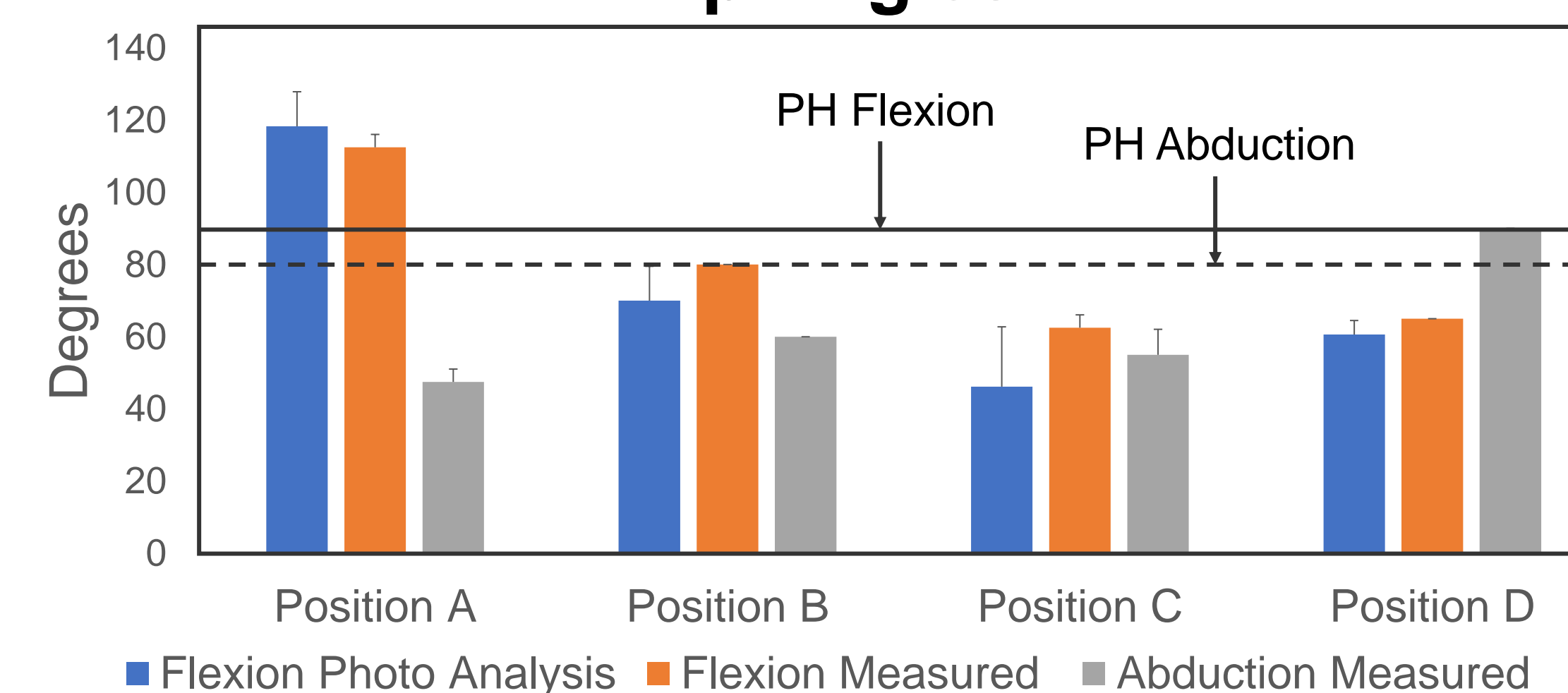


Figure 5. Measured flexion angles in comparison to calculated angles and measured abduction angles for each condition.

CONCLUSION

- The Pavlik Harness is the ideal model for hip position in baby carriers.
- Baby carrier B, data resulted in the most similar hip position to the optimal 90° flexion and 80° abduction⁴.
- 75% of the photo analysis data resulted in smaller flexion angles compared to the measured angles using the goniometer.
- Labeling the anatomical landmarks for the photo analysis method was accessible and consistent.
- It was difficult to measure angles with the goniometer due to its shape and the positioning of the infant in the baby carrier.
- The pressure sensor data was inconsistent and unreliable to measure forces exerted on the infant.

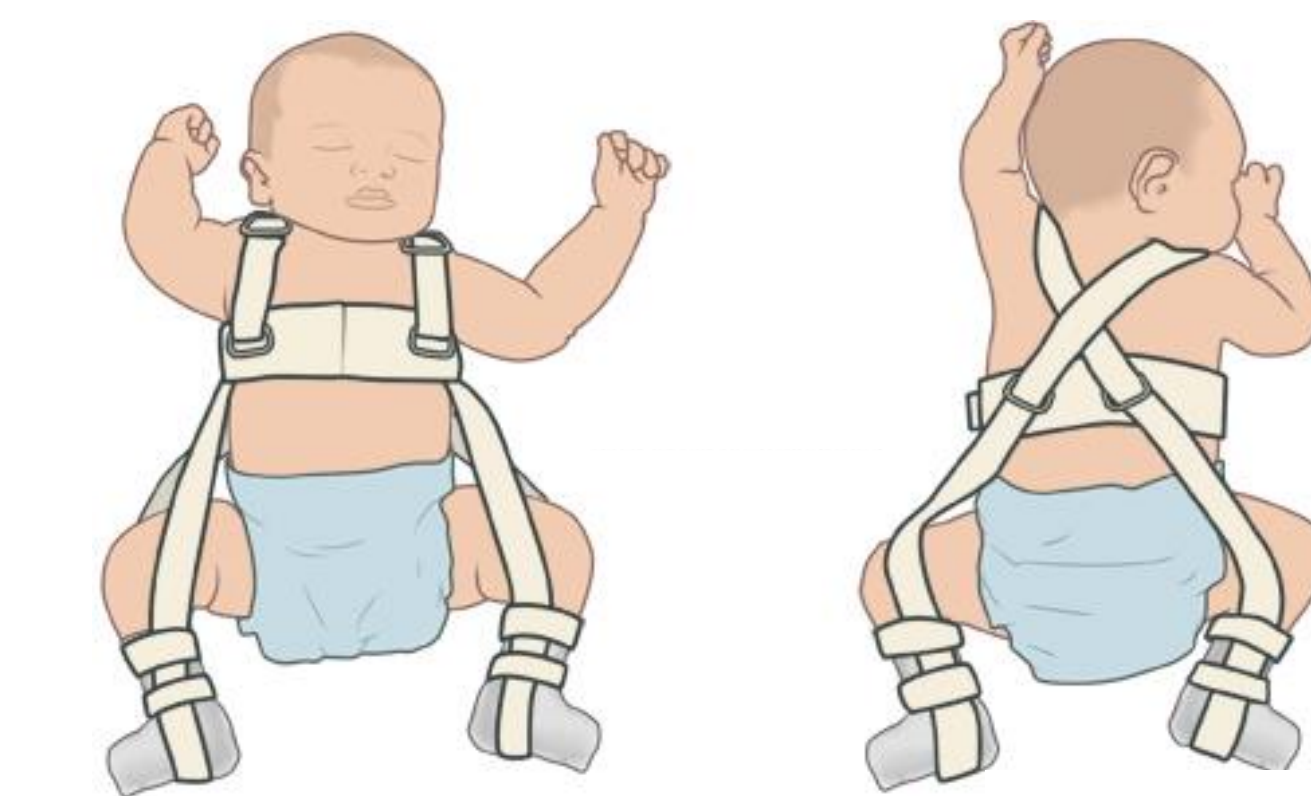


Figure 6. Pavlik Harness with optimal hip positioning⁵.

IMPACT: Determining the baby carrier style that positions the infants' hips similar to the Pavlik harness may help create a standard for baby carriers with optimal hip positioning.

FUTURE WORK

- The preliminary data collection will help us create a study with human subjects.
- Identify the style of baby carrier that is optimal for hip positioning.
- Improvements**
- The free joint newborn manikin was too small for 3 of the original 7 conditions. Use inserts for baby carriers to adjust for the size difference.
- Use a standardized infant manikin.
- Identify a more accurate method for measuring hip abduction.
- Use a digital goniometer that is imbedded in the manikin to measure the flexion and abduction angles of the hip.
- Use marker-based motion capture system, VICON, to measure hip angles.