ILL-FITTING PROSTHESES DUE TO GROWTH: IMPACT ON GAIT FOR CHILDREN WITH LOWER LIMB LOSS

Claudia Ghidini[1], Nikee Parekh[2], Roisin Delaney[2], Caitlin Edgar[1], Alasdair Gilbertson[2], Sherron Furtado[2], Matt Thornton[2], Anthony Bull[1], Craig Gerrand[2]
[1]The Centre for Paediatric Blast Injury Research, Department of Bioengineering, Imperial College London, London, UK
[2]Royal National Orthopaedic Hospital, London, UK
Email: claudia.ghidini20@imperial.ac.uk

Summary
This study investigates how changes in prosthetic fit due to growth impacts the gait of children with lower-limb loss. Growth-related changes in children can lead to ill-fitting prostheses (short and/or tight), affecting socket comfort and gait. 4 children were assessed using motion capture while walking with an ill-fitting and a well-fitting prosthesis. Spatiotemporal parameters (STP), gait symmetry index (GSI), vertical ground reaction forces (VGRF) and socket comfort scores (SCS) were analysed. Results showed an improvement in STP, GSI, and SCS with the well-fitting prosthesis, although changes were not statistically significant. VGRF patterns indicated worse asymmetrical loading with the ill-fitting prosthesis, with higher peak VGRF. These preliminary findings highlight the importance of proper prosthetic fit in improving gait outcomes.

Introduction
Paediatric amputation is uniquely challenging due to the impact of growth on prosthetic fit and function. Anecdotal evidence highlights the implications of growth, which negatively affects prosthetic socket fit (tight prosthesis) and contributes to length discrepancy between the prosthesis and the intact limb (shorter prosthesis) [1]. Although similar issues are associated with secondary impairments in the adult cohort [2], the specific impact on paediatric gait remains unexplored. The aim of this study is to assess changes in paediatric gait when using an ill-fitting prosthesis and a newly made, well-fitting prosthesis.

Methods
Ethical approval was granted by NHS Health Research Authority (IRAS_291087). Children were invited to participate in the study when they required a new prosthesis due to growth (as defined by their prosthetist). Gait data collection with the GRAIL Motek System on a treadmill was conducted during the prosthesis delivery appointment. Participants walked at self-selected speed with both the ill-fitting and well-fitting prosthesis. STP and GSI (calculated from prosthetic and intact step lengths) and SCS were compared between prostheses. VGRF data were compared using statistical parametric mapping (SPM).

Results and Discussion
4 children with a below-knee unilateral congenital amputation participated in the study (mean age: 9.7±2.6years). Mean length discrepancy between the two prostheses was 1.8±0.6 cm. SCS improved from 6.5±2.4 to 9.5±0.6 with the well-fitting prosthesis (p=0.057). Stride length increased by 2cm and step width decreased by 2.5cm on average when using the well-fitting prosthesis. GSI also improved (92.1% to 94.5%). Although STP showed positive trends, the differences were not statistically significant. SPM analysis of VGRF revealed asymmetrical loading between limbs when using the ill-fitting prosthesis during the terminal single support phase, whereas the new prosthesis facilitated a more symmetrical distribution (Figure 1). There was a greater peak VGRF with the ill-fitting prosthesis compared to the well-fitting one on both intact (1.13±0.07 N/BW vs 1.07±0.08) and prosthetic side (1.15±0.06 vs 1.07±0.04).

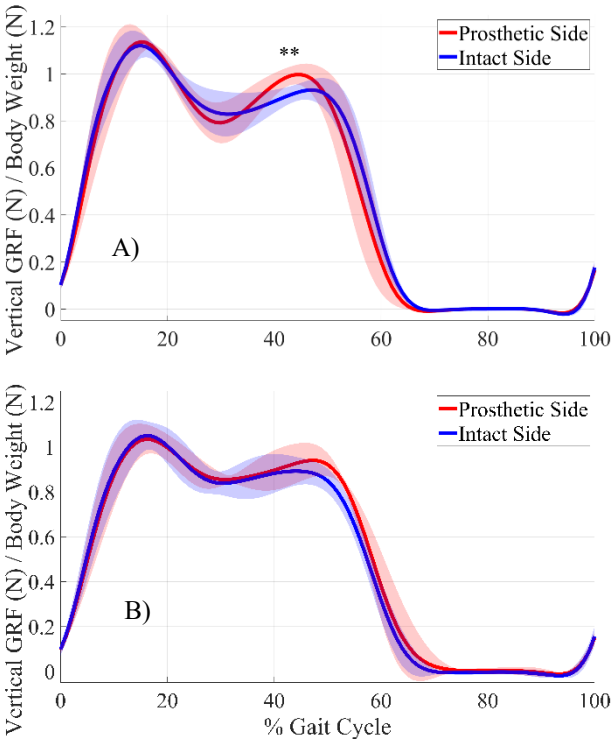

Figure 1: Loading of intact and prosthetic side with A) ill-fitting prosthesis and B) well-fitting. ** significant difference ($p<0.05$).

Conclusions
The increased peak VGRF observed with the ill-fitting prosthesis may suggest a compensation strategy to accommodate for the shorter prosthesis and subsequent shorter step length compared to intact side. The improved gait symmetry index, STP and VGRF patterns with the well-fitting prosthesis indicate that proper prosthetic fit enhances functional outcomes and suggest a tight and short prosthesis may affect step length and width. Future studies with a larger sample size are needed to confirm these preliminary findings and to further explore the specific gait deviations adopted by children using short and/or tight prostheses due to growth.

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