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Algorithmic two-site selection for upper-limb myoelectric prosthetic control

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Introduction: Reliably controlling upper limb prostheses continues to be a limiting factor in clinical deployment. This unreliability can lead to fatigue causing considerable reductions in function, which is found to be a main cause of prosthesis abandonment[1]. Ultimately, preventing the issue of unreliable prosthesis control can lead to a substantial increase in the quality of life of people living with limb absence.

The OptiMyo system was designed to address this problem by finding the optimal 2-site electrode locations and control strategy algorithmically.

Methods: The OptiMyo system consists of 128 monopolar electromyographic (EMG) channels that were filtered and converted to differential channels representing conventional electrode spacing. An algorithm was developed to identify the optimal site locations and incorporates accidental co-contraction, natural movement, the weight of a socket, and arm position during both intended and unintended actuation of the prosthesis (Figure 1).

Each subject was consented to an IRB-approved protocol and had sites located by the OptiMyo system and by traditional methods using the technique taught to student prosthetists at the University of Salford. The sites were evaluated by measuring the "EMG Skill" through the use of static and dynamic tracking exercises similar to those proposed by Chadwell[2].

Subjects: 4 people: 2 male, 2 female. Age: 33 ± 9 yrs

Apparatus: OT Bioelettronica EMG-USB

Results: EMG Skill testing showed better results for the OptiMyo System in 12 out of 20 static testing conditions (Figure 2). Additionally, 3 out of 4 subjects scored better with the OptiMyo system during dynamic testing.

Discussion: The EMG Skill results were similar between subjects using sites selected from the first iteration of the OptiMyo system and sites selected following traditional site finding methods.

Conclusion: The first iteration of the OptiMyo system demonstrated equivalence to the current standard of care for myoelectric site finding. There are clear and obvious improvements to be made to the algorithm, and these changes will be implanted with additional testing on limb absent subjects to be completed in the summer of 2022.

Clinical applications: With further improvements the OptiMyo system has the ability to improve the myoelectric site finding process and control strategy selection for upper-limb prosthetics. The OptiMyo system can simplify and streamline the fitting process for clinicians while also providing data on the entire arm during simulated real life-scenarios (different arm movements, weight of socket, etc.). Future iterations of the OptiMyo system will aim to select the best control strategy, gain, and dead band level for each patient.

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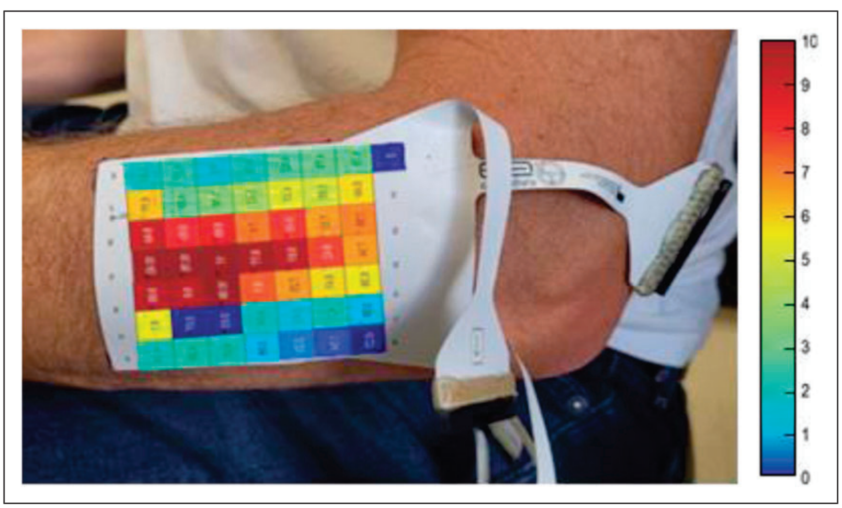

Figure 1. A visualization of the output from the OptiMyo system on a subject's extensor muscles. Darker red sections reflect a higher (better) score.

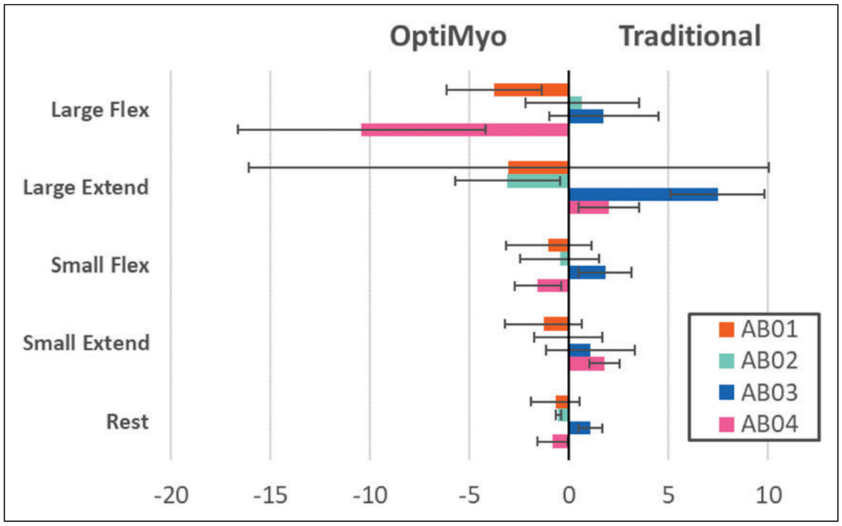

Figure 2. Difference in EMG skill between the two methods (error bars show 95% confidence interval). Negative values represent those tests where the OptiMyo sites had better scores.

References
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An examination of 3-dimensional change for infants with deformational plagiocephaly

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Introduction or purpose: Traditionally, when an infant is treated for a deformational head shape (DHS), asymmetries between the left and right cranium are quantified by taking diagonal measurements along the greater equator of the skull, and asymmetry is expressed comparison of the diagonal length asymmetries[1]. However, quantification via 2-dimensional measurements at a single level of the cranium might not always accurately portray a 3-dimensional change[2]. 3-dimen- sional changes were examined in infants treated for DHS asym- metries to compare net quadrant growth during each of these treatment methods, as well as net asymmetry change seen posttreatment (natural growth).

Methods: Two-month old infants with DHS began repositioning therapy (RT) and received physical therapy if torticollis was present. For persistent cranial deformation, caregivers were given the option to begin treatment with a cranial remolding orthosis (CRO) at 4, 5, or 6 months of age. At 6 months of age, any infant who had not switched to CRO treatment was permanently assigned to RT. In- fants received 3dMD scans at 2 months of age, at clinical resolution of their head shape, and at 12 months of age. If their head shape was not resolved by 12 months of age, they received only two 3dMD scans (at 2 and 12 months of age). Clinical resolution was based on measured cranial valult asymmetry index1 and a visual assessment by the treating orthotist.

Consecutive scans were aligned based on 25 landmarks, aniso- tropically scaled, and analyzed using a MATLAB algorithm. A morphometric analysis quantified net 3-dimensional change of the head shape between two consecutive 3dMD scans. The cra- nium was then divided into quadrants. The percentage of net growth of flattened quadrants was found by dividing the differ- ence between mean net growth of the flattened quadrant and the bossed quadrants, divided by the mean net growth of the bossed quadrants. A negative percentage indicated a worsening of the head shape (bossed quadrants growing more than flattened quad- rants) and a positive percentage indicated improvement. Excel was used to plot mean changes in cranial shape and the Kruskal- Wallis test was used to compare mean net percentage change short quadrants between groups.

Results: Twenty-six infants were enrolled and followed. Figure 1 shows morphometric changes for an infant who underwent RT, transitioned to a CRO until the head shape was resolved, and was followed through natural growth to 12 months of age.

When comparing the net 3-dimensional changes (Figure 2), the percentage of mean net flattened quadrants' growth