Myoelectric or Body-powered Prosthesis

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Clinical Question: Does a body-powered prosthesis or a myoelectric prosthesis provide a significant general advantage?

Background: Nearly one third of amputees reported being dissatisfied with the comfort of their device while 18.4% of respondents reported being fit with a new prosthesis at least once a year[1]. Some reports suggest as many as 50% of upper limb amputees choose not to wear a prosthesis[2,3], often citing that the functional advantage or cosmesis did not outweigh the discomfort or inconvenience of the device. Reports of rejection rates of upper limb prostheses vary in the literature from 0 to 50%[4,5]. The role of the amputee in selecting the device and the timeliness of delivery are significant factors in prosthesis acceptance[5]. Limited function of prostheses may cause awkward aberrant movements not normally experienced by non-amputees, called compensatory motion[6,7].

Prosthetic prescription currently depends to varying degrees on patient input, the prosthetist's experience with available components, literature on component function, manufacturer's claims and reimbursement methods. Availability and prescription of prosthetic components can be dependent on medical insurance coverage and payer restrictions. Externally powered upper limb prostheses cost substantially more than body-powered prostheses[8]. Myoelectric prostheses users also incur a higher cost for fitting, training and maintenance[8]. Major private insurers as well as government health plans limit prosthetic and rehabilitation coverage and require justification to show the necessity of the prosthetic device to restore "normal" function in activities of daily living (ADL)[9]. Because body-powered and myoelectric prostheses are the predominant prosthetic options for upper limb amputees, the purpose of this literature review was to identify evidence regarding differences between them in the following areas: functionality, control and feedback, cosmesis, and rejection that could be used to support the clinical management of persons with upper limb amputations.

Search Strategy:

Databases Searched: PUBMED, CINAHL, RECAL Legacy, PMC-NIH Research Publication Database and Web of Science **Search Terms:** myoelectric, body-powered, hybrid, externally powered, transradial, transhumeral, upper extremity, prosthesis, artificial limbs, voluntary opening, and voluntary closing, as well as variable spellings such as trans-radial.

Inclusion/Exclusion Criteria: Included: Published 1993-2013 **Excluded:** Conference proceedings, dissertations, non, partial hand/finger articles, surgical articles, modeling articles, pediatric only articles and electromyography (EMG) only articles

Synthesis of Results: Research comparing upper limb prostheses is limited. Body-powered have demonstrated advantages in durability, training time, user feedback and frequency of adjustment and maintenance[2,4]. Myoelectric prostheses have been shown to provide a cosmetic advantage [10], are more accepted for light intensity work[4], and may affect phantom pain[11] when used actively. Body-powered prosthetic control can be improved by optimizing harness and cabling systems[2]. Improvement of intuitive prosthetic control (myoelectric, body-powered or hybrid) may require use of multiple control strategies that require less visual attention.[12]

Clinical Message: Outside of surveys, there is little evidence addressing the functional capabilities of prostheses users, and fewer studies making a direct comparison of prostheses in a controlled setting. Currently evidence is insufficient to conclude that either the current generation of a MYO or a BP prosthesis provides a significant general advantage. Selection of a prosthesis should be made based on a patient's individual needs with regard to domains where differences have been identified. A patient's personal preferences, prosthetic experience and functional needs are all important factors to consider.

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	Cupo and Sheredos 1998[2]	Meredith, 1998[10]	Bouwsema et. al., 2012[12]	Bouffard et. al., 2012[11]	Huang et. al., 2001[4]
Population	16 body-powered prosthesis users; mean age 55	3 full-time prosthetic users fitted with both a body-powered spilt hook and myoelectric hand after amputations; 2 years minimum post amputation	6 experienced transradial myoelectric prosthesis users	New prosthesis users received first BP or MYO in last 3 months (n=3); Expert Prosthesis users (n=9); Health professionals	
Study Design	Experimental: Before/After	Observational: Case Series	Observational: cross-sectional	Qualitative: surveys	Expert opinions
Intervention	Fitting with AdVAntage BP prosthesis	Training with 4 prehensors			
Comparison	Assess the AdVAntage arm's advantages and reliability compared to existing above elbow body-powered arms	Effectiveness of 4 prehensors: Greifer (Otto Bock); Synergetic (Hosmer); the Electric Hand (Otto Bock) and body-powered split hook (Voluntary opening)	Skill levels of prosthesis users using various outcome measures	Surveyed differences between new and expert users in Phantom limb sensation and pain and user satisfaction	
Methodology	Before/after fitting, training and use of Arm	Trained with 4 prehensors; Repeat testing with each: Nine hole peg test, Box and Blocks Test and Jebsen-Taylor Test	Instructed how to execute tasks of SHAP time scores transformed to z-scores; Joint angles calculated; gaze behavior classified	Prosthesis users: 75 minute meeting with two surveys and a semi-structured one-on-one interview; Health professionals: 60 minute interviews	Self-directed learning module to gather expert opinions on recent advances in terminal devices
Outcomes	Subject Response Survey administered Pre fitting, Post 30 day, Post 90 day	Nine hole peg (timed coordination), Jebsen-Taylor (Unilateral ADL hand function; Box & Blocks (timed manipulation and precision	Southampton Hand Assessment Procedure (SHAP); Kinematics (Vicon); Eye gaze (iScan)	Quebec User Evaluation of Satisfaction with Assistive Technology Questionnaire (QUEST29) and Groningen Questionnaire Problems after Arm Amputation	
Key Findings	Adjustability and reduced friction and energy required lifting forearm and opening TD are advantages of the body-powered AdVAntage arm	Upper limb myoelectric prosthesis are preferred for cosmetic reasons; Control scheme familiarity may provide a functional advantage	Participants who scored higher on SHAP needed less visual attention. Therapists should focus on visual control and time to develop higher level of skill for prosthetic user.	MYO users reported phantom limb sensation interacts (positive or negative dependent on subject) with prosthesis use while BP users reported that PLS did not influence the use of	BP prosthesis: durable heavy work; MYO: light work, difficult to keep clean

				prosthesis	
Study Limitations	Custom survey; low internal validity	Low internal validity; Only 3 subjects		Qualitative; n=12	Opinion