A PEDIATRIC SHOULDER DISARTICULATION/PARTIAL HAND: CASE STUDY AND SIX YEAR FOLLOW-UP

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ABSTRACT

Management of high level pediatric limb deficiency is challenging. Issues of prosthesis weight, complexity of control and functional utility are often cited as reasons for prosthesis rejection. Design goals include lightweight construction, simple control, and functional grasp [1]. This case study will review the prosthetic treatment over a six year period of an individual who presents with multiple congenital physical anomalies. Our subject, MK, presents with absence of his right arm at the shoulder disarticulation level, left partial hand with complete absence of his thumb, fused left elbow at sixty degrees of flexion, no forearm rotation, and scoliosis. This case presentation demonstrates that in cases where the prosthesis can provide functional gain, is light-weight and simple to control, the high level congenital limb deficient individual can achieve long-term success with appropriately designed prostheses.

INTRODUCTION

MK received his first prosthesis at age four. This prosthesis had passively positioned elbow and shoulder with a split hook. This prosthesis did not provide active grasp but did allow for passive function such as holding down objects while manipulating with the left hand or carrying objects draped over the forearm with the elbow flexed. Progression to an active terminal device was later attempted by attaching the control cable to a thigh cuff. Terminal device activation was possible by leaning or rotating the trunk however MK did not find that this control produced meaningful terminal device function. Despite the lack of dynamic grasping function, MK still wore the prosthesis daily at school.

At age seven MK was referred to Hanger Clinic seeking a more functional prosthesis. At this time it was decided to fit a myoelectrically controlled hand that MK could control with a single site control scheme using his pectoralis muscle. Reduction of prosthesis weight and the ability to position the myoelectric hand in a wide variety of locations were considered to be primary goals in order to maximize the utility of the prosthesis. Additionally, the absence of a thumb on the left hand was addressed by provision of a multiposition thumb (figure 1).

Figure 1: Shown at first test fitting of hybrid prosthesis.

The right shoulder disarticulation prosthesis employed the Otto Bock System 2000 hand with voluntary open/automatic close single site control strategy. The LTI Omni wrist provided multi-direction angulation of the terminal device passively positioned under static friction. The LTI/Steeper friction elbow allowed elbow flexion and rotation with conduit through the elbow for the control signal. The Otto Bock ball joint shoulder provided multi-direction positioning of the shoulder. The forearm, humeral section, and socket frame were made of prepreg carbon to minimize overall weight. The socket interface was made of HCR silicone. The finished weight of the completed prosthesis was 680 grams (figure 2).

The left prosthesis used a HCR custom silicone construction with carbon prepreg stabilizer for the Vincent Systems locking finger. The finger provides multiple positively locking positions and is repositioned by distracting the joint, then moving it to the desired position and releasing the finger (figure 3).

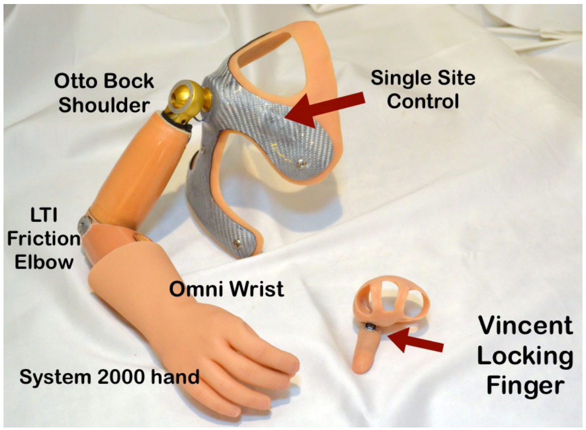

Figure 2: Components of MK's prostheses.

After receiving his new set of prostheses MK commented that the prosthesis was much lighter than his previous right prosthesis and he liked the more life-like hand compared to the hook and how small the socket was compared to his old prosthesis. He was immediately capable of controlling the myoelectric hand and was able to reposition the left thumb using the right hand to actively grasp the thumb. The multiposition thumb provided the ability to grasp objects of large or small diameter depending on the position of the thumb. At a recheck appointment two months after delivery, MK reported that his wear time had increased to a maximum of 8 hours and he continued to wear the prostheses daily at school.

One year after delivery, both prosthetic interfaces were remade due to growth reusing all of the existing components. At a recheck appointment two and a half years after the myoelectric prosthesis was delivered, MK is now ten years old and reports continued daily use of the shoulder disarticulation prosthesis. He has discontinued use of the thumb prostheses for the present time. MK feels that he can do a lot without the thumb prosthesis and sometimes it gets in the way. Since he is not able to independently donn the thumb prosthesis he feels it is easier not to wear it. He does seem interested in using the thumb prosthesis for specific activities.

Figure 3: Repositioning thumb using myoelectric hand.

Due to his fused elbow, MK is unable to reach the superior harness strap of his right prosthesis and therefore cannot independently don it. Our future plan is to explore different buckle systems such as those from Fidlock that have a magnet to allow easy one-handed attachment. MK has been able to doff the shoulder disarticulation by having a string attached to the superior strap that hangs low enough for him to reach it with his left hand. He is independent in doffing the left prosthesis by wedging it between his knees and pulling it off.

CONCLUSTION

This case presentation demonstrates that in cases where the prosthesis can provide functional gain, is light-weight and simple to control, the high level congenital limb deficient individual can achieve long-term success with appropriately designed prostheses (figure 4).

Figure 4: MK demonstrating active grasp.

REFERENCES

[1] J. Uellendahl, J. Riggio-Heelan, "Prosthetic Management of Children With Upper Limb Deficiencies", Physical Medicine and Rehabilitation: State of the Art Reviews, Vol 14:2, pp.221-235, 2000.