

THE WILMER APPEALING PREHENSOR

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Abstract

A new type prosthetic prehensor for children aged 4 – 9 has been designed, constructed and build in an attempt to improve the appearance of the split-hook prosthesis. The new prehensor is a mechanically operated voluntary opening device. All mechanical parts are within the frame, and covered by a polyurethane cosmetic cover, which can be made in almost any color desired.

Clinical testing of the prehensor by 4 children with a total time of use of over 170 months, revealed the mechanism to be very robust and reliable. The colorful hook cover is highly appreciated by the children.

Encouraged by this success, a second larger size has been made intended for children aged 7 - 14. This medium size prehensor is now in clinical use by 1 child for over 12 months. Again, the appearance of the hook is highly appreciated, and again, the mechanism proves to be very reliable.

Introduction

The standard split hook prosthesis is, despite its functionality, most often rejected by parents of a child with an upper limb defect because of the very poor and deterring outward appearance. These parents prefer the more cosmetic, but less functional, hand prosthesis. The WILMER group started a project to develop a new prosthetic prehensor for these children. The objective was to preserve the functionality of the standard split hook prosthesis, while improving on the outward appearance.

Method

A shape study was performed to determine the outline of the new prehensor [1]. The resulting shape, preferred by almost all, is a hook-like prehensor, Figure 1. Its volume and outline are derived from the contour of a hand of a 4-6 year old child. The length of the fingertips and the position of the rotating finger are approximately similar to a healthy hand. The connection to the forearm is harmonic and smooth. All mechanical parts, including the operating cable, can be placed out of sight in the interior of the prehensor.

The mechanism design has gone through several iteration steps [1 – 3]. After each step a successful laboratory test was succeeded with a clinical trial with 4 – 5 children. As the initial mechanisms caused many repairs, a third redesign was made, Figure 2 [4]. A four bar linkage mechanism is used to reduce the input forces. A slightly inclining input characteristic ensures the controllability, for both shoulder harness and elbow-control. The resulting grip force is approximately constant over the full range of opening.



Figure 1. The WILMER appealing prehensor.

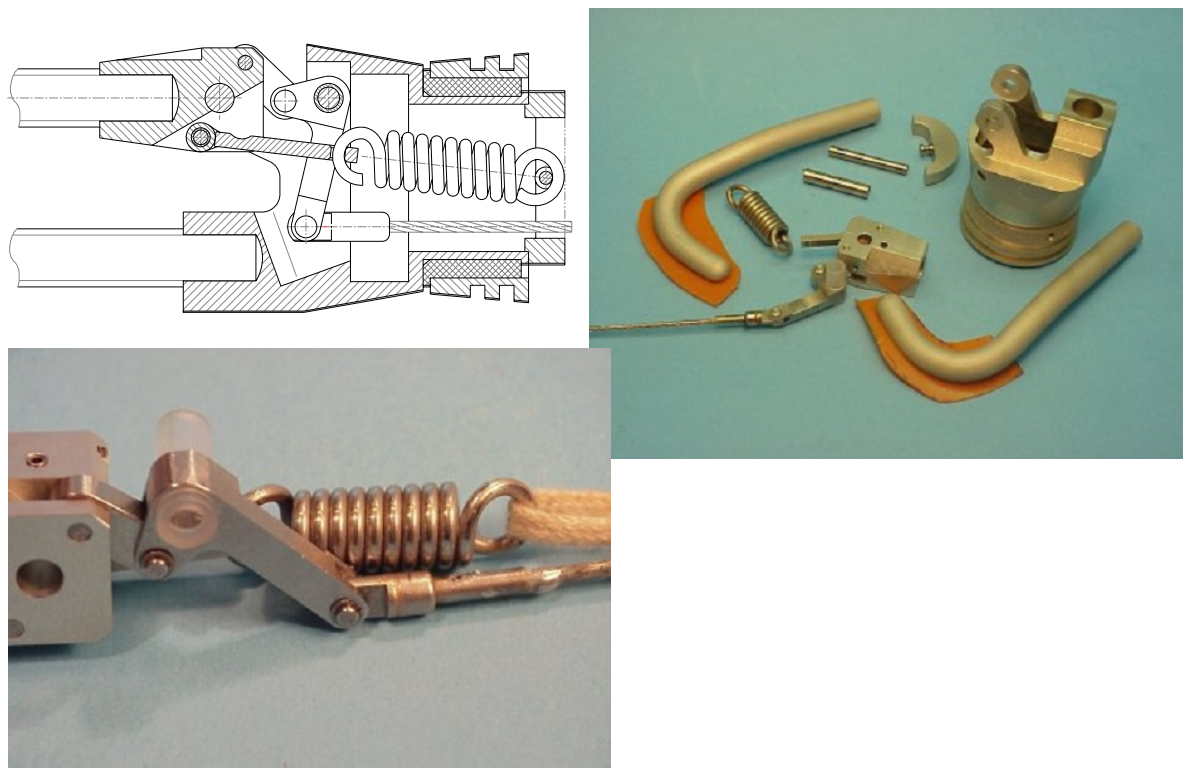


Figure 2. The WILMER appealing prehensor. Top left: cross sectional drawing of the mechanism; top right: several parts, partly assembled; bottom: assembled four bar mechanism.

Integrated into the frame of the prehensor is a lightweight friction wrist prosthesis. The frame is enclosed by a cosmetic cover made out of flexible polyurethane resin. This way several unique features were obtained: the outside of the prehensor is rugged and easy to maintain; the cover can be easily removed to access the mechanism; and the cover can be coloured. Giving the cover a bright primary colour emphasises the toy-like nature of the prehensor, thus advancing the acceptance and use of the prehensor by the child. It is even possible to supply several covers in different colours, which can be exchanged by the child according to its daily moods.

Results

After successful laboratory testing, the latest version of the WILMER appealing prehensor has been issued for clinical trials. It has been in daily use by four children for over 170 months of total testing time, Table 1.

Table 1. Users of clinical prototype WILMER appealing prehensor

| Name | Gender | Born | Affected side | Period of use | No of fittings | Colour |
|------|--------|--------|---------------|------------------|----------------|--|
| AS | V | 199208 | L | 199912 – to date | 1 | Yellow Red [200102] Blue [200305] |
| NB | V | 199411 | L | 199904 – to date | 2 | Yellow & Red [1 st fitting] Red & Yellow [2 nd fitting] |
| JG | V | 199508 | R | 199907 - 200002 | 1 | Yellow |
| YK | M | 199612 | L | 200111 – to date | 2 | Blue [1 st & 2 nd fitting] |

User JG unfortunately suffered from several medical problems, not related to the arm defect, a few months after the start of the clinical trial. Her parents therefore decided to stop the use of any arm prosthesis. The other three users still use the WILMER appealing prehensor. User AS changed the colour of the hook on two occasions, but still uses the original mechanism. Users NB and YK on the other hand, each received a second prototype due to excessive wear of the fingers of the hook after respectively 27 and 40 months of use.

All children highly appreciated their device. It has not caused any negative reactions or strange associations, with, for instance, science fiction. Because of the smooth outline of the prehensor and the integration of the control cable, wear of clothing is reduced considerably. The children are delighted by the bright coloured appearance of the prehensor. All children chose a colour out of our standard palette, one [NB] of them mixed colours between the housing and the thumb.

Over the overall testing period only a few repairs were necessary. On two occasions an axle of the four bar mechanism was lost due to corrosion of the stainless steel [!!] retaining rings. After replacement of the axle and the retaining rings from a second delivery batch the problem did not occur again. On three occasions the operation cable broke at its connection to the mechanism. This could be repaired by renewal of the

soldered connection. Finally, on two occasions the rubber grip surface on the fingers of the hook partly detached from the fingers.

Discussion and conclusion

The overall results of the clinical testing have been very satisfying. The children and their parents highly appreciate the prehensor, because of its looks and because of its functionality and reliability. The reliability was also highly appreciated by the designers and by the prosthetists.

Encouraged by this success, a second larger size has been made intended for children aged 7 - 14. This medium size prehensor is now in clinical use by user NB since April 2004. She chose the hook cover purple and blue. Again, the appearance of the hook is highly appreciated, and again, the mechanism proves to be very reliable; no repairs have been necessary despite continuous daily use.

Furthermore, the appealing prehensor has drawn the attention of philosophers who deal with body image and personal identity in relation to bodily differences [5, 6]. They see the bodily difference as something that positively adds to the person's identity. In this respect wearing a brightly coloured artificial prehensor can be noted as a clear statement of personal uniqueness.

With the development of this new appealing prehensor we hope to have provided a way out of the classic prehensor dilemma: either cosmetics or function. This prehensor we believe combines both cosmetics and function.

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