Improved Prosthetic Functionality Through Advanced Hydraulic Design

Christian Fredrik Stray[1]; Jos Poirters[1]; Ole Lerstøl-Olsen[1]

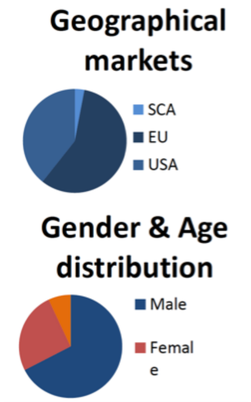
Introduction/Background

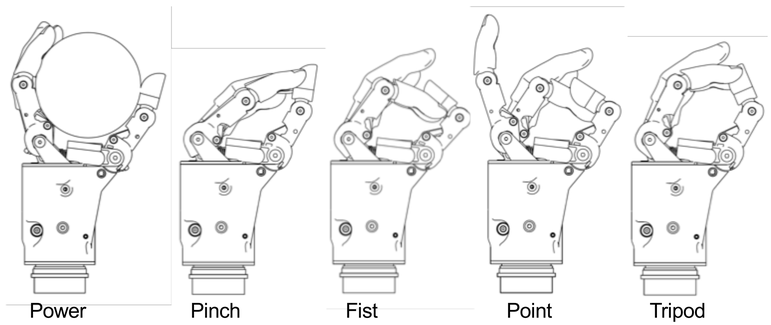
Advancements in technology can often result in overdesign and underutilization. Current prosthetic technology provides limited options for veteran and civilian amputees: patients are provided with either standard myoelectric grippers with limited functionality, or advanced bionic-like hand prosthesis. Each of these choices results in underutilization or inadequate functionality, or both. Hy5 has integrated a simple design with lightweight materials and advanced motion control and flexibility, resulting in a prosthetic hand that improves utilization and functionality for daily life. The Hy5 design addresses this critical gap and does so at a competitive price through the use of 3D printing.

Methods and Materials

Hy5 employed a mechanical-based design which improves upon cumbersome myoelectrical pulse sequences sent from the user. The opening and closing (i.e. gripping) of the prosthesis is myo-electrically controlled. External control of the prosthesis gesture is done by the opposite hand or other fixed object to make a fist or point the index finger. The prosthesis uses a single motor to control three hydraulic cylinders. Each hydraulic cylinder controls 2 digits of the thumb-, index- and middle finger by means of a mechanical solution in their respective MCP joints. This enables an adaptive and independent pressure build-up on the thumb, index and middle fingers (ring and pinkie move together with the middle) as they grasp an object, thus mimicking realistic hand gripping without requiring one motor per finger as in bionic-like prosthesis. The Hy5 device design specifications demonstrate its significant functionality: a maximum power grip of 120N, maximum tripod grip of 60N, maximum static load of 40kg, the maximum time to close is 1.2 seconds and weight is 580g.

Performance specification	
Maximum power grip	120 N
Maximum tripod grip	60 N
Minimum time to open/close: power grip	1,5 Sec
Minimum time to open/close: tripod grip	1,5 Sec
Maximum static load: hook grip	40 Kg
Maximum load individual finger – hook grip	20 Kg
Fingertip extension load	8 Kg
Weight	580 g
Size	7 ¾





Results

- 21 users tested the Hy5 device on the "Southampton Hand Assessment Protocol (SHAP):" a series of manipulations of both lightweight and heavyweight abstract objects intended to directly reflect specific grip patterns, while also assessing the strength and compliance of the grip, followed by 14 Average Daily Life (ADL) tasks.
- The SHAP test concluded that the device manages all grips (pinch, power, fist, tripod and point) as intended and works as a substitute for a missing hand.
- The possible gripping patterns of the prosthesis allow recovery of up to 30% of total gripping functionality required for activities of daily life (ADL's) compared to standard grippers.

Conclusions

Hy5 has designed a prosthesis to fill the gap between standard myoelectric grippers, and premium, bionic-like hand prosthesis. This technology offers cost-effective advanced motion control and flexibility with critical functionality. Hy5 will break critical barriers for user comfort, directly addressing the existing needs for lighter and faster hand prosthesis. Providing veterans and service members with a wider variety of options allows individuals to select prosthetic devices best fit to their lifestyle, and improves quality of life.

Outlook

Hy5 is regulatory approved in Europe and Australia, with marked introduction in Canada and the US.

Contact: www.hy5.no

MHSRS, Military Health System Research Symposium exhibition, Florida 20-22nd August 2018