COMPACT HAND ORTHOSIS ACTUATING SYSTEM

K. Öberg, G.M. Hägg
Een-Holmgren Orthopaedic Co.
Bergsbrunnagatan 1
S-753 23 Uppsala, Sweden

Abstract

For persons with totally paralyzed hands it is not possible to use wristdriven hand orthoses. If a handorthosis shall be useful to this category the grasping movement must be powered.

To be able to obtain this, a supercompact electric actuation unit is developed for direct application on a Jaeco or Engen type orthosis. The control unit, which is connected to the orthosis via a cable, also contains the rechargeable 6 V battery cartridge. The orthosis is controlled by some gross movement primarily of the contralateral arm. A selfcontained version of the orthosis is also developed. Generally much attention is payed to practical problems like for instance making it possible for the patient to take the orthosis on and off without assistance. The actuating unit gives a closingtime of the full gripping range of 0,6 s. Maximum force is 24N and the weight of the unit is 100 g.

Practical experience from some 10 applications on patients are presented.

Background

Persons with a total paralysis in their hands can not use so called wristdriven handorthoses, as these types imply active motion in the wristjoint. If a handorthosis shall be useful for such a person, the finger movement must be motorized.

An inventory of the commercially available motorized hand-orthotic systems in the market has been made by the Unit of Applied Orthotics, EFTO, at the rehabilitation clinic in Jönköping. This inventory has shown, that all motorized hand-orthoses are driven by a rather large motor mounted on a wheel-chair. The force transmission is done by a bowdencable from the motor. The energy source is mostly rechargable electrical batteries, which also are mounted on the wheelchair. Also pneumatic systems have been used. The compressed gas is stored in metal bottles on the wheelchair and the transmission of the gas to the pneumatic actuator on the orthosis is done through tubes and control valves. These available motorized handortho-tic systems have thus in common the dependence of a rather bulky and heavy driving unit that is difficult to carry for the user.

The late medical doctor and engineer Fredric Möhl worked out new principles for motorized handorthotic systems during his research efforts in Uppsala and Jönköping. He developed small electrical screwjacks that could be placed directly on the handorthoses. The actuation of the three jaw-chuck grip could thus be made directly from the actuator to the fingerjoint. He also developed some simple "on-off" control devices for the actuators. His constructions became, however, not completed for practical use for the patients. The force and speed of the screw jack were inadequate and the lifetime was too short. Also the placing of the screwjack on the hand caused a cosmetic and practical disorder. The actuator should rather be placed on the forearm with a transmission to the fingermechanism. Minimum demands were set as follows:

Closing velosity: Full griprange in 1 s.

Grip force: 10N (1kp)

The actuating unit

The above mentioned demands were met and more by the actuating unit shown in fig. 1. The unit consist of five parts, the motor, the gearbox, the lock, the universal joint and the screw.

The motor is a microminiature. Swiss made 6 V DCPM motor. The gearbox is a commersially available planetary type gearbox. However some of the wheels have to be casehardened to give an acceptable life.

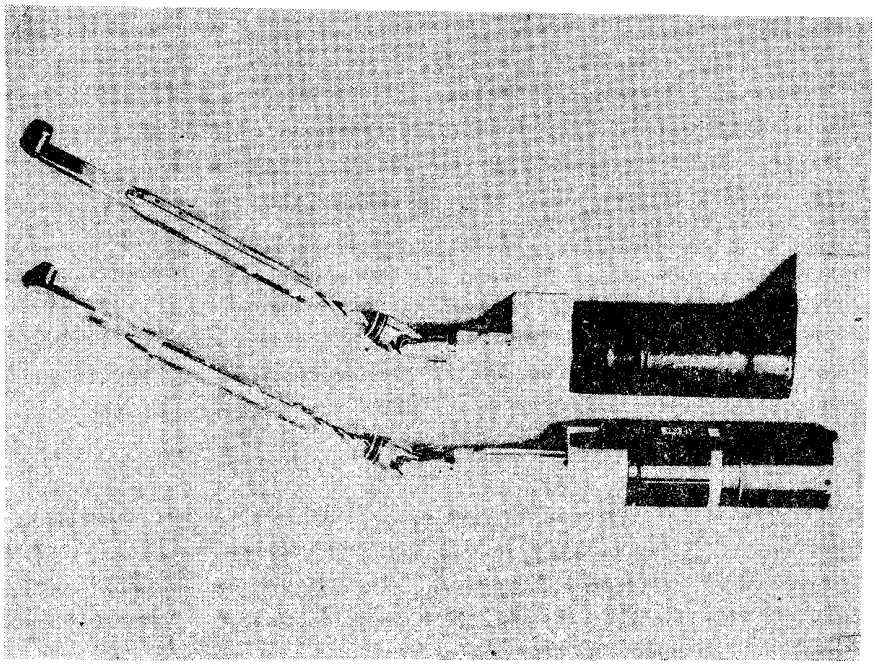

Fig. 1
Orthosis actuating unit. The upper one is for integration into the compact version, while the lower one is ment fot application directly on a standard orthosis.

The gearhead is followed by an unique patented locking device to prevent a passive opening of the grip by externally applied opening forces. The locking is based on the fact that an externally applied opening force besides a rotary torque via the screw, also gives an axial force which engages a small disc brake on the output axis. The output torque of the gearhead is transfered to the braking disc and the output axis via small rollers, rolling on oblique surfaces on the disc giving also an axial force to override the external axial force and thus release the discbrake.

The lock is followed by an universal joint, which is positioned at the human wristjoint to admit operation at different wrist-angles.

Finally the rotary movement is converted into a linear movement by a screw with a nut. The screwtransmission has an unique design, which combines high efficiency (83%) with low production costs. The screw is made from two twisted music wires and the nut is made of teflon.

Standard application

The actuating unit is suitable for different commercially available handorthoses such as the Jaeco, Snelson and Engen finger driven orthoses after minor modifications of the orthoses. See fig. 2.

In these cases the battery is contained within the external control unit (see below). In this application maximal gripforce is 24N (2,4 kp) and the closing time is 0,6 s. The unit has been tested in this application by the Unit of Applied Orthotics (EFTO) in Jönköping. See (1).

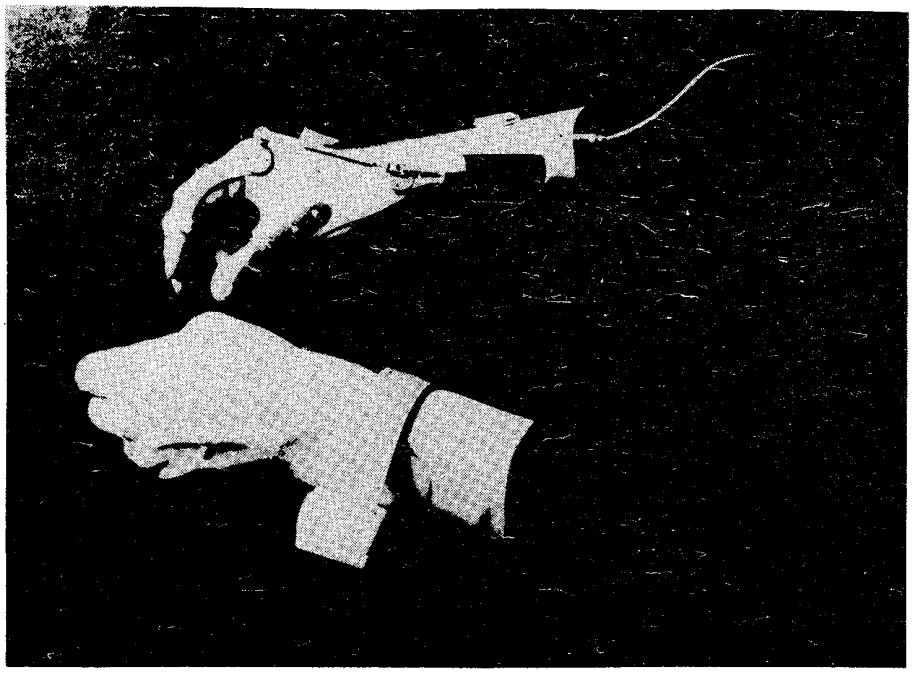

Fig. 2
Actuating unit applied on a handorthosis. The battery can be seen together with the control unit on the left arm.

Compact version

The same actuating unit is used in a selfcontained version. See fig. 3. Both actuating unit, battery-cartridge and control switchlevers are contained within a prefabricated armshell, which is available in two sizes. A corresponding handpart is available in four sizes. This type can also be controlled by an external control unit (see below). Technical data are the same as for the conventional application.

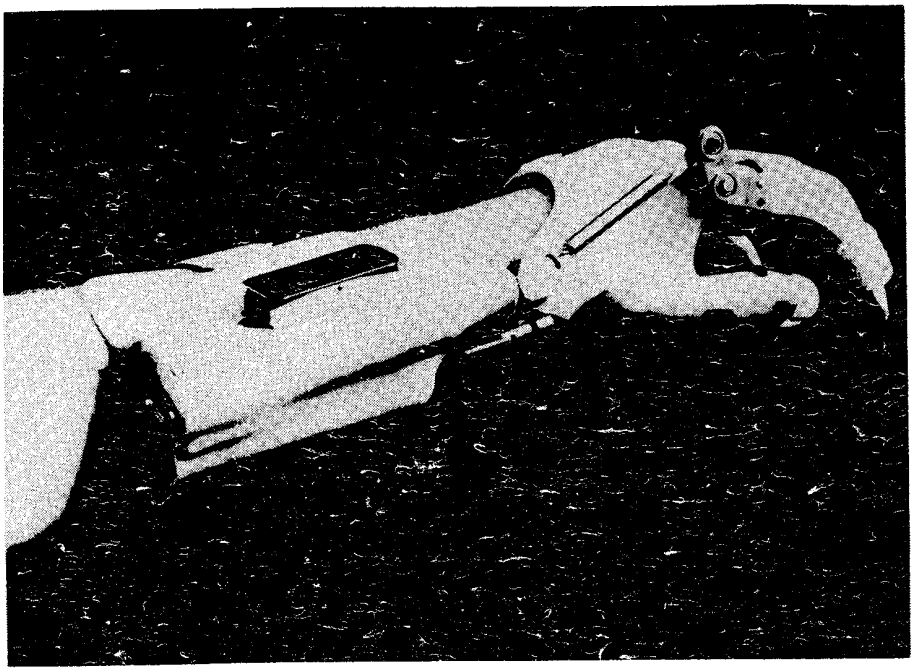

Fig. 3
Compact selfcontained handorthoses.

Control

A number of control options are available for both types of orthoses. For the standard type there are two external control units seen in fig. 4 and 5.

The first one is intended to be placed on for instance a wheelchair table. The opening and closing of the orthosis is controlled by a slight push on either side of the top plate.

The other one is design to be worn with a strap around the contralateral wrist. A slight pronation or supination with a firm support will open or close the orthosis. See also fig. 2.

The compact orthosis can be controled by either of the above mentioned units though it is primarily intended to be controled by the controlswitchlevers on the armpart. This is done by some gross movement of the contralateral arm.

The battery cartridges are charged in an external charger.

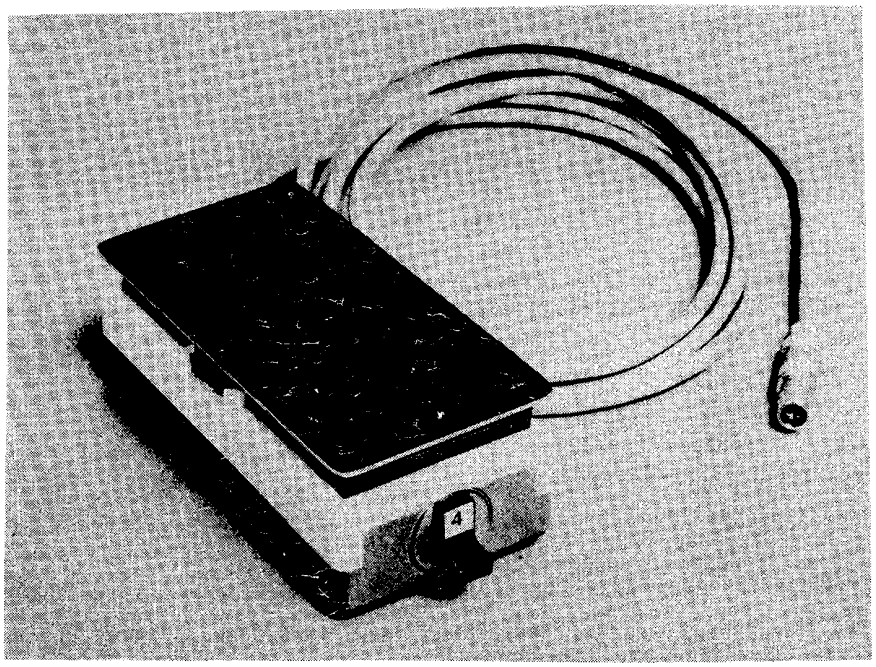

Fig. 4
Table control unit.

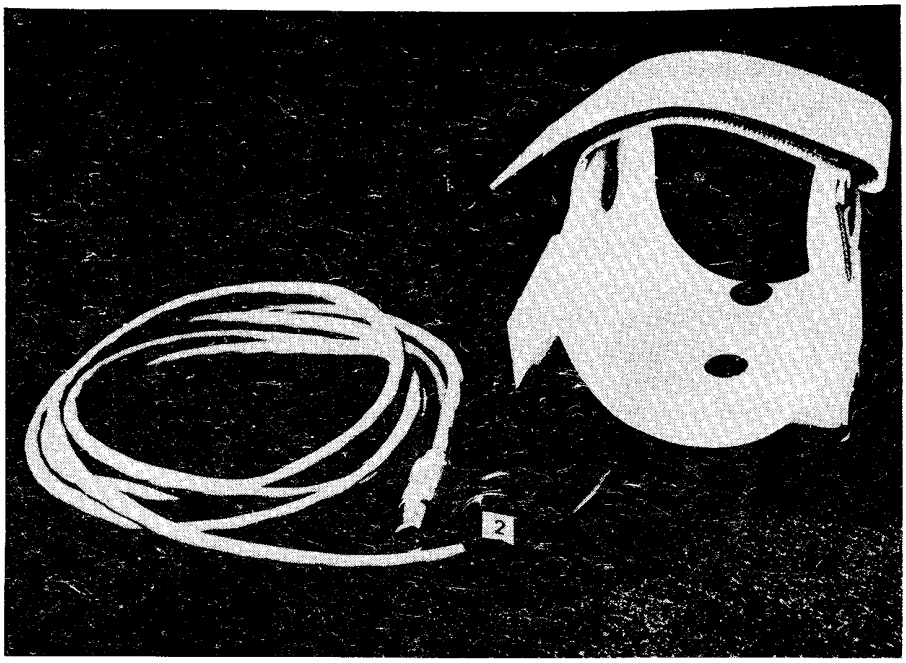

Fig. 5
Pro- and supination control unit.

Application results

So far 16 clinical applications has been made, 8 of each kind. So far 9 of these 16 are still regular users. See (1). With the orthosis they can for instance eat, write or dress, which they could not do without the orthosis.

The functional gain measured in terms of decrease in costs for the daily care of these often severly handicapped is minor. However, seen from the patients view, a gained ability to handle a pencil or to eat without help is invaluable.

References:

(1) S. Dillner, G. Georgiev, Clinical and Technical Testing of Hand Orthoses, The Dubrovnik conference 1978.