Clinical Evaluation of NASA Sight-Switch for Activation of Flexor-Hinge Splint

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The well publicized sight-switch wheelchair control developed under the National Aeronautics and Space Administration program has been clinically evaluated at certain medical schools and rehabilitation hospitals. The conclusions drawn from these evaluations have been documented in both lay magazines and medical journals (1, 2, 3).

At the Hot Springs Rehabilitation Center (Arkansas), we adapted the sight-switch to the activation of battery-powered flexor-hinge splints (Fig. 1) to permit use of the splint for manipulation of the standard controls of a mechanized wheelchair and also to allow functional use of

Fig. 1
Sight switch attached to powered wheelchair.

[1] Hot Springs Rehabilitation Center, Hot Springs, Arkansas.

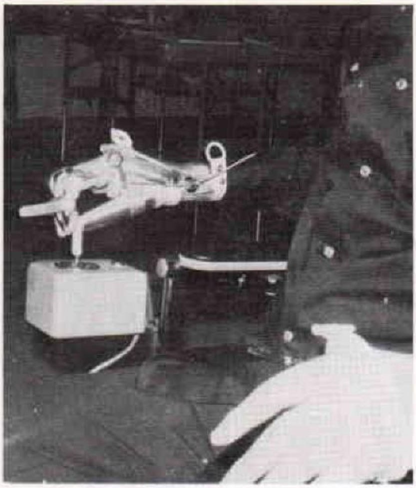

Fig. 2
Sight switch attached to Hot Springs flelexor-hinge splint.

Fig. 3
Extension stick on standard control of mechanized wheelchair.

the prehension device for hand activities once the target area was reached (Fig. 2).

The evaluation was carried out on five "high-quadriplegic" students over a period of four months and fractionated trials were made on normal individuals. The advantages and disadvantages were categorized empirically as major and minor advantages and disadvantages, and are listed below as such.

MAJOR ADVANTAGES

1. A simple extension stick on the standard control allows wheelchair operation by use of the motorized flexor-hinge splint (Fig. 3). Of course, the quadriplegic operator must have ball-bearing trough feeder or suspension-sling support of the arm (Fig. 4).

2. The externally powered flexor hinge splint can be used without the linear or curvilinear limitations imposed by the shoulder switch or the mouth switch which require the person to be sitting upright in his wheelchair. The sight switch permits trunk movement forward or laterally within the limitations of the feeder (Fig. 5).

MINOR ADVANTAGES

1. Only a relatively few hours of practice are required to attain proficiency.

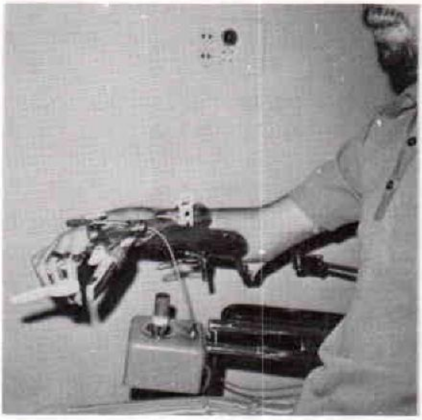

Fig. 4
Operator's arm in ball-bearing trough feeder.

Fig. 5
Operator using sight-switch to activate hand splint.

2. Acceleration and deceleration of the wheelchair do not affect the sight switch as they do the shoulder and mouth switches.

3. Rough terrain, doorjambs, and other floor obstacles which cause intermittent contact in the other switches do not affect continuation of current by the sight switch.

MAJOR DISADVANTAGES

1. The sight-switch required that the vision be turned away from the hand and object at the very instant it was most needed for effective prehension and monitored activity.

2. The equipment, particularly the control box, was a cumbersome accessory to attach to the frame of a mechanized wheelchair. Furthermore, this form of attachment made adjustment awkward.

3. The equipment needed fine and frequent adjustment in relation to posture, ambient light changes, and power fluctuations. The gain control almost required a rheostatic regulator.

4. Miscellaneous technical difficulties were encountered. The verbatim report of the orthotist, one of the authors, is as follows:

"The sight switch, Model SS40B, was received in nonoperable condition. It was carefully packed in a corrugated carton, but had not been secured internally. Both relays had come out of their sockets in transit, and banging around inside the case did considerable damage to wiring and other parts.

It was returned to Huntsville for repairs and, when it was returned, only one channel would function. Mr. Weaver from Hayes International came to the Center and worked on it. He replaced a transistor circuit board, rewired the indicator lights so they were driven directly by the transistors instead of the relays, and wired around the output jacks which were grounded to the chassis and not suitable for the application. After this, it could sometimes be made to function; however, it was very temperamental and inconsistent.

Until this time, I had maintained a hands-off attitude towards the device as far as the internal mechanism was concerned, but decided that, if it was to operate, some changes would have to be made. Following are some of the alterations:

1. Installed a four-prong output and two-prong input socket.

2. Removed 110 volt and six-volt-line cords.

3. Rewired chassis so that both

sight switch and hand-splint motor would operate from the input jack.

4. Added a variable resistor to drop twelve-volt input to six-volt required for sight switch.

5. Adjusted tension on relay return springs to operate with less current.

6. Wired indicator lights back into relay circuit as they seemed to be robbing too much current from the relay coil.

7. Went over entire unit looking for faulty solder joints and found several, especially on transistor boards.

8. The wiring harness on the glasses was too short and, although we requested longer leads or an extension, none was forthcoming.

The device now worked somewhat better but was still inconsistent and difficult to keep in adjustment. When the head was moved, light from the windows and overhead lights would fall on the photocells and require a change in the gain control. A considerable amount of fiddling was required each time to set the light so it would shine on just the right part of the eye."

MINOR DISADVANTAGES

1. Frequent changes in optic focus, secondary to activating the sight switch by looking away from the target area, caused an annoying dizziness or quasi-disorientation at times.

2. The glasses frames seemed to hinder peripheral vision moderately and, when worn for a protracted period of time, became an impediment to "unconscious awareness."

3. Evidence of irritative inflammation of ocular conjunctiva was noted, although somewhat inconsistently, after lengthy periods of sight-switch use.

4. The time and tediousness required in rigging and adjusting the equipment to the patient and the chair seemed to require more than help from the uninitiated layman. Needed were careful adjustment of the lights and sensors, insertion of several plugs, and adjustment of two gain controls.

BLACK-PATCH MODIFICATION

In an attempt to correct some of these problems, we devised the so-called black-patch modification. We moved the light source and sensor back along the temporal bone so that it shone on the skin approximately one-quarter of an inch behind the outer corner of the eye. (Fig. 6). We then stuck a small circular piece of black tape to the

Fig. 6
"Black-Patch" modifications.

skin just beyond the lighted area. When the orbicularis oculi muscle was contracted tightly without closing the eyelids, the skin moved forward, positioning the tape in front of the light and thus triggering the switch. The steady contrast between the skin and black tape and the positioning of the light source close to the skin cut down on the effect of ambient light and made adjustment of the unit less critical. As a matter of fact, it required no changes over a three- or four-hour working period.

Another big advantage of this method was that the hand and object were visible at all times within this exaggerated squint. In addition, the demand for changes in optic refocusing were circumvented. Furthermore, we encountered less conjunctival reaction.

CONCLUSIONS

The sight switch is an intriguing idea. It has certain advantages over other switches in the realm of the *man* as compared to the realm of the *machine*. Thus, further development and emendations seem indicated.

It would appear, however, that in its present unmodified form it is not realistically applicable because:

1. It is too complicated for every-day use by laymen, i.e., donning, adjusting, and accommodating.
2. It is too cumbersome for portable application to wheelchair frame.
3. It is too prone to failure.
4. It has some inherent contrariety to optimum man-machine relationship.

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