Grip Strengthening With Adapted Computer Switches

Joan Pashley

Key Words: equipment design • hand strength testing • purposeful activities

To meet the need for end-stage grip strengthening (80–100 lb) for patients in the Victoria Hospital Hand Program who would be returning to heavy industry, a computer adaptation was developed. This paper describes the rationale for this adaptation as well as the materials and construction used to create the adaptation, the software programs used with the adaptation, and our experiences to date.

Rationale

Traditional crafts and games do not provide enough resistance to create the functional overload needed for strength increases. Heavy workshop activities, which do involve resistance and overload, usually require more instruction and supervision than is practical or safe in the normal 4:1 patient/therapist ratio of the hand class. Thus, the tendency has been to use exercisers such as spring-loaded grippers, which provide no cognitive feedback. Unfortunately, in this approach, the benefits of the intrinsic motivation provided by purposeful activity are lost (Department of National Health and Welfare, 1986). Steinbeck (1986) demonstrated that patients will complete a significantly greater number of repetitions of a purposeful activity than of a nonpurposeful activity requiring the same muscle function. The greater number of repetitions was desired because the muscles must be exercised to the point of fatigue in order for adaptive increases in strength to occur (Fox & Matthews, 1981). Thus, a highly resistive activity that was purposeful and easy to set up and supervise was sought. The solution was to capitalize on the popularity of computer games by adapting heavy-duty grippers to the operating switches of the Apple IIe computer.

Materials and Construction

The following materials are needed for this equipment:

- Two booster cable clamps (different colors)
- Two cut-to-fit pieces of aluminum key stock
- Four 1/4 in. × 1 in. (6 mm × 25 mm) bolts with locking nuts (steel)
- Four eye connectors
- Four 1/8 in. × 1 in. (3 mm × 25 mm) bolts and nuts
- Two pairs of one-pin speaker jacks, two male and two female (same colors as clamps)
- One nine-pin D-type miniature connector (male jack) as required for the Apple IIe

It is recommended that this equipment be assembled by the hospital’s Biomedical Engineering Department or by a competent electrician. The teeth from the cable grips are removed for safety and re-
placed with a bolt to maintain handle alignment. A steel bolt and an aluminum plate are fitted to each gripper in such a way that the circuit is closed when the gripper handles are fully squeezed together. Alternatively, a microswitch could be used. The wires are run from each gripper to the plug leads and from there to the connector for hand controls (see Figure 1). The plug leads make it easier to disconnect the grippers when not in use, eliminating the need to access the back panel of the computer.

Software Programs

Any program that uses "open apple" or "closed apple" as the switches can be played with this adaptation. The normal use of the keyboard for booting and setup is not compromised. The two programs currently in use at Victoria Hospital are

1. Night Mission Pinball (Artwick, 1983), a pinball game requiring speed and timing (see Figure 2).
2. Left/Right (Smith, 1981), a perceptual game requiring accuracy but allowing a longer response time than the pinball game. (Left/Right also requires a color monitor.)

Experience to Date

The initial use of the gripper switches has yielded positive results, particularly with young patients. Patients who rarely spent longer than 3 to 5 minutes using the spring-loaded grippers had to be told to stop after 10 minutes of computer use. Therapists had to quickly adjust from ensuring that patients did sufficient repetitions that would be beneficial to preventing patients from overextending themselves.

In the 9 months since the gripper switches have been operational, an average of three to six patients have used the switches per day. The diagnosed condition most commonly seen in these patients has been partial amputation of one or more digits. Other diagnoses included fractures, electrical burns involving the hand, removal of a wrist ganglion, and injection injury to a digit. Patients' occupations included factory worker, automobile assembly line worker, construction laborer, carpenter, and engineer. The use of the gripper switches expanded from patients in the Hand Program to include orthopedic patients from the Rehabilitation Unit who require upper extremity strengthening or maintenance.

An added benefit of the gripper switches is the bilateral nature of the activity. At the time of assessment, patients frequently have below-normal grip strength in their uninjured extremity due to their generally decreased activity level. For example, the grip strength of a 24-year-old maintenance worker with an
injection injury to his right middle finger flexor ten­
don sheath was assessed 8 weeks after the injury as 32.5 kg (72.5 lb) on the right and 48 kg (106 lb) on the left on the Jamar hand dynamometer. At 10 weeks, grip strength testing showed 48 kg (106 lb) on the right (increased 15.5 kg) and 54 kg (120 lb) on the left (increased 6 kg).

Normal precautions must be taken when computer activity is added to a patient’s program. Grip strength must be at least 25 kg (55 lb) so that the patient can tolerate the activity. Skin condition must be monitored because the strong force may cause irritation. As mentioned previously, time limits may have to be set to prevent overexertion. Occasionally, patients may require support in overcoming their anxiety about using the computer.

Summary
The computer grippers have been successful in providing an easily operated, enjoyable, purposeful activity for end-stage grip strengthening for patients preparing to return to heavy industry. Because computer games maintain the patient’s attention for long periods, this adaptation is excellent for building endurance.

Acknowledgments
I thank the Department of Occupational Therapy for the moral support they provided, the Department of Biomedical Engineering for the design and fabrication of the switches, and the Department of Library Services for their assistance in locating the computer program references. I gratefully acknowledge the guidance of Dr. Helene Polajtako at the University of Western Ontario. I also thank Ralph Jennings for the line diagram.

References


