

HAND AND WRIST EXTENSION EXERCISE DEVICE

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ABSTRACT

Wrist injuries are common. These injuries may be due in part to an imbalance between the strength of the flexor and extensor muscles of the hand and wrist. One method to reduce the likelihood of wrist injuries may be strengthening the extensor muscles. Products are available for exercising the extension muscles of the hand and wrist but are either not comprehensive for both the hand and wrist or are not simple ambidextrous interfaces. A hand and wrist exercise device was designed to allow strengthening and conditioning the extensor muscles of the hand and wrist in one motion. The exerciser serves as a preventative tool against wrist injuries.

BACKGROUND

Muscle imbalance across a joint has been shown to be associated with joint injury (1). Function of the hand is primarily in flexion during everyday activities. Overuse of the hand may lead to an abnormal imbalance between the flexor and extensor muscles. Manual wheelchair propulsion is a repetitive activity that requires use the flexor muscles of the hand and wrist. Strengthening the extensor muscles of the hand and wrist may decrease susceptibility to wrist injury.

Products are available for exercising the extension muscles of the hand and wrist. The Knuckle Bender Splint (Rolan) is a product designed to exercise the fingers in extension. It uses rubber band resistance between the palm of the hand and the back of the four fingers. The Hand Gym (Maddak, Inc.) also exercises the hand in extension using rubber band resistance. This product allows different finger joints to be exercised independently. The Flexend (Balance Systems, Inc) is a product that allows both the hand and wrist to be exercised simultaneously. The Flexend consists of a glove with an elastic band that attaches from the ends of each finger to a strap that is then secured around the biceps. The elastic bands pull the wrist and fingers into a flexed position.

Most of the products on the market focus on exercising either the hand or the wrist, but not both. Most products also lack the ability to adjust the applied resistance and are not ambidextrous. A need exists for a lightweight, variable-force hand and wrist exercise device that incorporates both finger extension and wrist extension.

STATEMENT OF THE PROBLEM

Products are available for exercising the extension muscles of the hand and wrist but are either not comprehensive for both the hand and wrist or are not simple ambidextrous interfaces. A need exists for a simple, effective exercise device for the extension of the hand and wrist.

DESIGN AND DEVELOPMENT

Design Requirements

To keep the device simple and natural to use, exercising the hand and wrist should be done in one fluid motion. One fluid motion allows the user to exercise efficiently thus reduce the amount of time needed to effectively strengthen the extensor muscles (2). The motion begins with the hand

and fingers in a natural flexion position and ends with the hand extended about the wrist and the fingers fully extended. The resistance of the device should be adjustable to allow users to strengthen as well as condition the extension muscles.

Concept Generation

Several different concepts were generated and evaluated for feasibility. Design attributes most heavily weighted during selection were the ability for a single continuous exercise motion, variable resistance mechanism, ambidextrous, comfortable, and intuitive to use. The design concept chosen incorporated all of these attributes (Figure 1). The design consists of a single device that can be used to exercise both the right and left hands. The hand is placed through the arm cuff, under the wrist lever and rests against the finger lever. The wrist lever is hinged about the arm cuff. Resistance is applied by a compression spring in the wrist resistance mechanism. The finger lever is hinged about the wrist lever, in order to provide independent motion of the hand and wrist. The finger resistance mechanism consists of a torsion spring with an adjustable pre-load. This design allows exercise of wrist extension, hand extension, or both using independent resistance mechanisms.

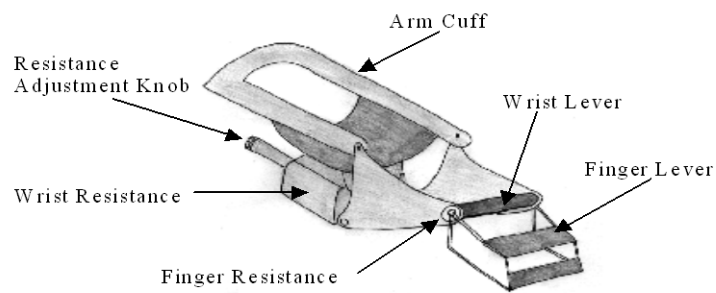


Figure 1. Preliminary Extension Exerciser Design

Functional Prototype

A functional prototype was developed and evaluated (Figures 2, 3). The arm cuff of the device consists of a molded, rigid plastic with foam applied to the areas where it contacts the arm. The arm cuff stabilizes the exercise device onto the arm during exercise and serves as a mounting location for the wrist pivot location. The wrist pivot allows for full range of motion of the wrist, from fully flexed to fully extended. The wrist resistance mechanism is mounted to a stationary point on the underside of the arm cuff. A cable is attached from the compression spring in the wrist resistance mechanism to the wrist lever. As the wrist is extended, the cable compresses the spring thereby applying resistance to the wrist. The wrist lever is a strap across the back of the hand. The strap allows for a more even distribution of pressure across the hand during use.

The finger resistance is provided by a secondary, smaller linear extension spring. The finger resistance spring is connected from the wrist lever to the finger lever, providing resistance to the hand, independent from the wrist resistance. The extension spring attachment location on the wrist lever is variable to allow for adjustment of the resistance pre-load. The finger lever is coated with foam over areas of contact with the hand to maximize comfort during use.

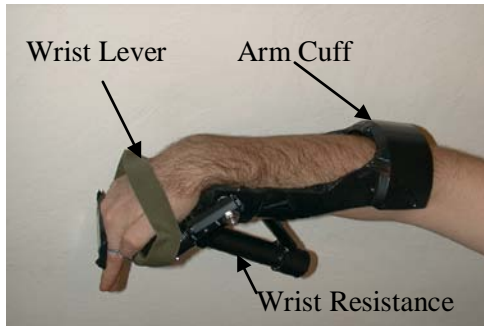


Figure 2. Hand and Wrist Flexed

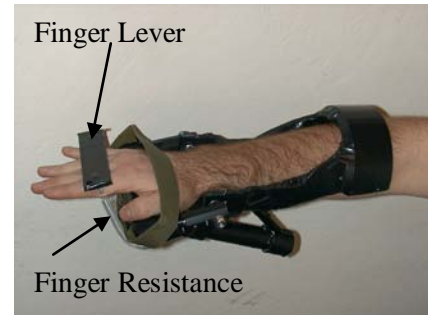


Figure 3. Hand and Wrist Extended

DISCUSSION

The functional prototype met the target design requirements. The arm cuff design is sturdy and the support points are well located. In addition, the arm cuff fits a wide range of forearm sizes. The finger lever is currently linked to the wrist lever only by the linear extension springs. The extension spring does not provide the structural integrity necessary to keep the finger lever from slipping off the fingers during use. Improvements will include developing a linkage to support the role of the spring. The ability to exercise the hand and wrist simultaneously results in a natural, effective and time efficient exercise experience.

Once the exerciser design is complete, potential users will evaluate it. Volunteers will be asked to use the exerciser for a period of one to two weeks. During the evaluation period, subjects will be asked to track their experiences with the device. Of particular interest are device comfort, ease of use, ease and appropriateness of resistance adjustment, aesthetics, and overall desire to use the device. Feedback from the user survey and supporting design information will be documented for future design iterations.

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