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Translational Study of Low-end Shoulder Joint Rehabilitation Robot Device : Study protocol

Soo-bin Im[1*], Kyoung-Soub Lee[2], Hyung-Soon Park[2], Yeongwook Kim[1], Min Kyun Sohn[1†]

Chungnam National University Hospital, Department of Rehabilitation Medicine[1], Korea Advanced Institute of Science and Technology (KAIST), Department of Mechanical Engineering[2]

Background

Due to the aging, changes in lifestyle, and the increase in sports activities, the number of patients with various shoulder disorder are increasing. As the interest in shoulder rehabilitation increases, various rehabilitation robots have been developed to treat effectively and to replace the physical training effort of a therapist. The purpose of this study is to validate the tracking performance of newly developed shoulder joint rehabilitation robot device through clinical trials and to find the optimal damping value. And we will carry out a follow-up study to upgrade the product in consideration of the service environment and user experience analysis for commercialization and application in clinical practice.

Methods/Design

In the conventional continuous passive motion (CPM), because the axis of CPM is fixed, it cannot follow the natural movement of the shoulder axis. Therefore, we have developed a prototype of the low-end shoulder joint rehabilitation robot device (Rafael smart shoulder®, Fig. 1). It has improved tracking mechanism and alignment by using the passive shoulder joint tracker and the actuator. The passive shoulder joint tracker consists of an XY table-shaped horizontal tracker and single-degree of freedom (DOF) vertical tracker with gravity compensation mechanism (Fig. 2). Ten patients who are suffering from shoulder joint disorder by stroke (n=5) or adhesive capsulitis (n=5) will be enrolled in this study. Subjects will be tested in three exercise modes (Fig. 3). In passive joint stretching mode, we will measure the differences between conventional CPM and Rafael smart shoulder® about tracking error, forces applied to the robot, and comparison between the joint angle of the device and of the subject during flexion, abduction, external rotation, and internal rotation. In isometric exercise and isokinetic exercise mode, it will be only tested in Rafael smart shoulder®. In isometric exercise mode, the forces applied to the robot and the external sensors are measured, and the degree of postural change will be measured during flexion, abduction, and extension in neutral position. In isokinetic exercise mode, tracking error, forces applied to the robot, and the difference between the joint angle of the robot and subject will be measured in two angular velocities (120 deg/s and 60 deg/s) and four motions (flexion/extension, abduction/adduction). Before the measurement, patient was informed about various shoulder joint movements.

Discussion

Rafael smart shoulder® allows various rotational, transitional movements of the shoulder joint using one active actuator, and we have confirmed the possibility of effectively responding to various symptoms of shoulder joint disorders. Completion of this study will contribute to achieving optimal performance of Rafael smart shoulder®. And, if it is commercialized, it is expected to be more cost effective, lighter, less bulky and widely available than conventional CPM.

Acknowledgment

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Fig. 1. Low-end rehabilitation robot system

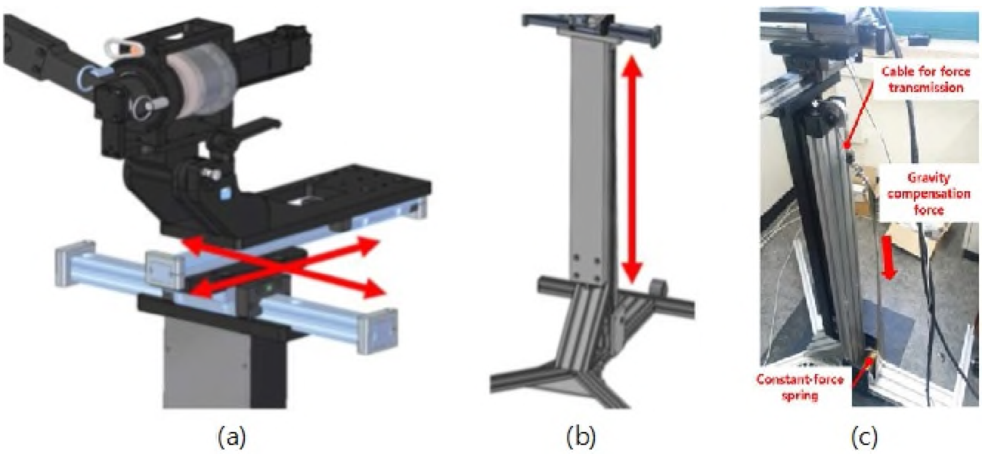

Fig. 2. Passive shoulder joint tracker with gravity compensation mechanism: (a) Horizontal tracker (b) Single-DOF vertical tracker (c) Gravity compensation mechanism

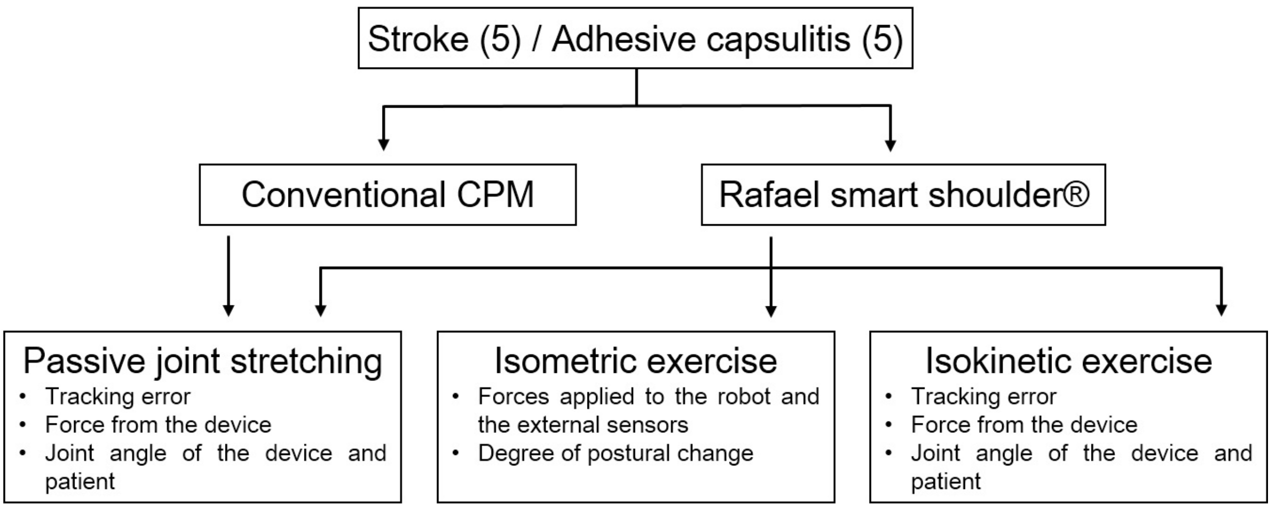

Fig. 3. Flow-chart of patients included with stroke or adhesive capsulitis with shoulder joint disorder.