Development and assessment of the automatic rehabilitation

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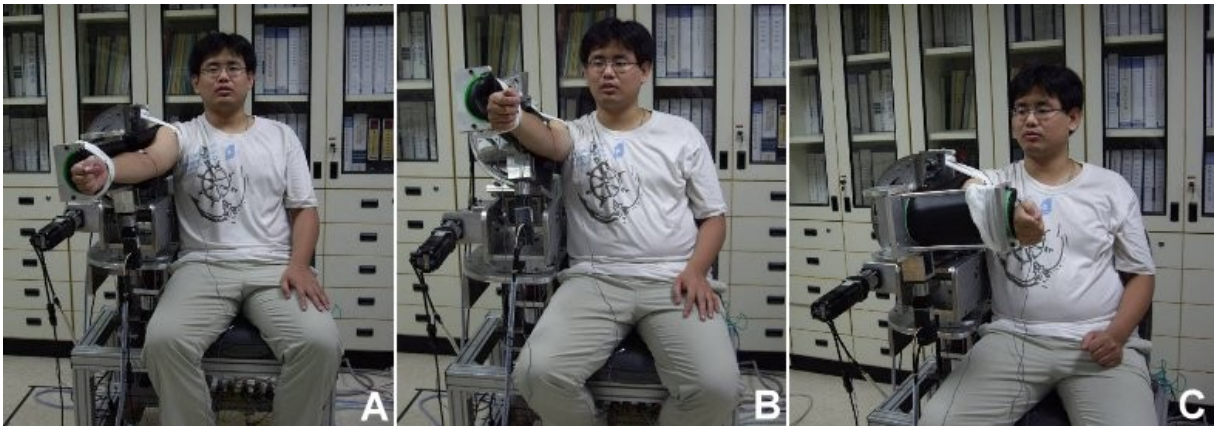
Introduction: Frozen shoulder is a very commonly seen degenerative disorder of the shoulder in elderly, and the patient generally suffer from fibrosis of the joint capsule, causing painful stiff and contracture, subsequently affecting the daily activity. Physical therapy is one of the main trends in treatment of frozen shoulders, and the therapists generally use manual traction in addition to passive motion of the shoulder joints, to increase the range of motion. However, the force of traction as well as the extent of motion yet cannot be accurately controlled with manual manipulation, and the therapist generally needs years of training to reach a satisfactory result. Owing to the above clinical problems, an automatic rehabilitation machine for upper limb has designed and developed, and its function has also been assessed with normal subjects.

Materials & Methods: An automatic rehabilitation robot has been designed, and the prototype has been developed. The robot consists of four main modules, which are 1) the base elevator module that brings adjusts the entire robot vertically to achieve the best comfort for the patient during sitting position, 2) the shoulder joint motion module that controls the elevation and abduction of shoulder joint, 3) the elbow flexion module that controls the flexion motion of elbow joint during shoulder traction, and 4) the shoulder traction module that brings a traction force to the shoulder joint. Functional assessments have been carried out with four healthy volunteers (3 men and 1 woman), and the correlations of the traction force and the output voltage of the motor, as well as the angle of motion between the robot and volunteers were assessed. During the passive shoulder motion brought by the robot, a fixed traction force can also be exerted to the tested subjects according to the change of the voltage measured by the server motor.



Results: The relation between the traction force and output voltage by the server motor was y=25.622x2 + 8.6083x-1.4648, for which y was the traction force (Nt), and x was the voltage (V). The correlation equation of angular motion in shoulder joint was y=1.0243x + 0.3637 with a relative coefficient of 0.9995, where y was the angle measured on the tested subjects, while x was that measured on the robot. The average traction distance under a force of 15kg was 75.3mm for the robot, and 7.4mm for the tested subjects. Interestingly, the largest distance was found in the female volunteer.

Conclusion: In this study, a robot for rehabilitation of shoulder joint has been developed, and its function has been assessed. A good and reliable correlation has been found in the joint motion between the robot and the tested subjects, and it is feasible to perform passive joint motion while constantly applying a certain traction force to the patient, which hopefully, will be more beneficial than just doing passive shoulder elevation.