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Efficacy of informed versus uninformed physiotherapy on postoperative retear rates of medium-sized and large rotator cuff tears

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Background: It is important to perform the first 12 weeks of rehabilitation without risk of tearing a cuff tendon from its repair site. Our hypothesis was that performing early postoperative rehabilitation with a limitable pendulum exercise device can produce lower retear rate outcomes when it is combined with safe, informed physiotherapy compared with a standardized protocol of rehabilitation performed at home.
Methods: By using an asymmetric arm support brace and an advanced accelerometer, we attempted to determine the benefits of small pendulum exercises (proposed by Long et al). This study enrolled 24 patients to use a monitoring device in standardized small pendulum exercises. Clinical outcomes and magnetic resonance images were evaluated preoperatively and 12 weeks after surgery.
Results: While a patient performed pendulum exercises, a therapist used computer imagery to observe whether vertical acceleration was over a given threshold (identified as physiologic tremors), as a warning of and precaution associated with the increased risk of repair failure. Similar self-reported functional outcomes were reported in 2 areas. The rate of recurrent tears was significantly higher for both the medium-sized and large areas in the uninformed home rehabilitation group compared with the informed group.
Conclusion: The results of monitoring of pendulum exercises to develop informed physical therapeutic methodology were consistent with those of previously published literature. In this study, use of a monitoring device during early rehabilitation was associated with lower retear rates after rotator cuff repair.
Level of evidence: Level II, Randomized Controlled Trial, Treatment Study.

Keywords: Accelerometer; pendulum exercises; recurrence tear rate; rotator cuff repair

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The instruction in pendulum exercises in early rehabilitation after rotator cuff repair has been controversial because of the potential for recurring injury. However, Cuff and Pupello[8] suggested that pendulum exercises

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(as developed by Codman[18] in 1934) can be routinely combined with existing protocols and that they can play an important role in early-stage therapy to reduce edema and adhesion. Smith et al[23] have published electromyography data for immobilized shoulders to determine the safety of various activities after surgery (e.g., pendulum exercises should avoid a backward-pulling motion). A cadaveric study by Burkhart et al[5] also raised similar concerns, showing that pendulum exercises are correct only in a horizontal direction and using small circles. The authors warn that ''even a very small number of pendulum swings can cause disruption in repair'' if exercises are done using a backward-pulling motion.

Current postoperative standardized protocol uses the concept of evidence-based medicine,[3] and physical therapists will perform pendulum exercises immediately after rotator cuff repair. However, no previous studies have focused on attempts to monitor vertical acceleration with use of an accelerometer.[12] This study uses a valid accelerometer and a protocol of small pendulum exercises to develop a limitable pendulum exercise device[7] as proposed by Long et al.[17]

Our hypothesis was that performing early postoperative rehabilitation with a limitable pendulum exercise device and informed physiotherapy would produce lower retear rates than with a standardized protocol of rehabilitation at home. Therefore, the aim of this research was to determine the benefits of small pendulum (20 cm in diameter) exercises and properly informed physical therapists to minimize risks[11] and efficiently intervene in postoperative rehabilitation.

This study performed a prospective, case-controlled evaluation of patients' outcomes and retear rates involving 1 surgeon (W.C.S.) using mini-open double-row repair techniques. A standardized rehabilitation protocol at home was compared with an informed physiotherapy protocol that limits activities of daily living (ADLs) and pendulum exercise at an outpatient clinic.

Materials and methods

Inclusion and exclusion criteria

For the case-controlled informed physiotherapy study, 24 eligible subjects undergoing rotator cuff mini-open double-row repair were recruited from the waiting lists of a single orthopedic surgeon between February 2012 and September 2013. Independent, blind assessments, including magnetic resonance imaging (MRI) measurements for tear size, were performed preoperatively and 12 weeks after surgery. Subjects included those who had finished the first week of bedside rehabilitation using standardized protocol and had diagnostic evidence of a supraspinatus tear as well as stratified tear sizes from medium (1-3 cm) to large (3-5 cm), based on the longest transverse dimensions (identified with MRI[19]), to reach the strict inclusion criteria of the informed group. However, the tear size might be extended by up to 1 cm after débridement of the degenerated tendon edges.

Furthermore, 1 week after surgery, sonography assessments were required to make sure that no loosening of fixation or surgical failure had occurred after the first week of bedside rehabilitation exercise. The ultrasound images were obtained with a linear transducer (L12-5, phased array transducer) and an iU22 scanner (Philips Medical, Bothell, WA, USA). Each image was obtained along with the supraspinatus tendon to allow simultaneous visualization of the supraspinatus tendon, myotendinous junction, insertional footprint, suture anchor site, and peribursal tissues.[9] The images were obtained by 2 radiologists, both with >6 years of experience in musculoskeletal ultrasound assessment. Inclusion criteria included (1) an isolated full-thickness crescent-shaped[15] supraspinatus tear repaired with a mini-open anchor suture (double-row repair for medium to large tear) technique previously described; (2) special therapists who instructed the patients in how to carry out the small pendulum exercises after surgery while a researcher recorded data for each patient; (3) participating patients started rehabilitation between the second and sixth days after surgery (including instruction with the standardized postoperative protocol and the wearing of a provided sling for 6 weeks[13] that could be removed only to complete the exercises), with the patients' consent to be randomized into the informed group or the uninformed one; (4) an ultrasound examination to assess the suture without loose fixation at least 9 days after surgery; and (5) at least 3 months of clinical follow-up.[13]

Exclusion criteria included (1) repair of any previous shoulder injuries (including revision rotator cuff repairs and arthritis) performed along with the rotator cuff repair; (2) tears that had an L-shaped pattern, repaired along the longitudinal split, or tears that extended into the subscapularis or the infraspinatus; (3) evidence of referred pain to the shoulder for other reasons; (4) accompanying infection at the time of repair; (5) workers' compensation cases; and (6) loss of follow-up of the initial assessment of pendulum exercise. Informed group patients had the ability to provide their own transportation and to attend the outpatient clinic or aquatic therapy department 5 times a week for 3 months.

After completion of the initial assessment (University of California–Los Angeles [UCLA], American Shoulder and Elbow Surgeons [ASES], and Disabilities of the Arm, Shoulder, and Hand [DASH] scores), a letter of clinical trial consent was signed. Of these 28 repair patients, 24 patients (7 men, 17 women) met the inclusion and exclusion criteria and were included in this study and were to be monitored for at least 3 months postoperatively. Age of the patients averaged 65.6 years (range, 45-84 years). A simple randomization technique was used in a random-number table (odd: informed physiotherapy; even: uninformed rehabilitation at home) with final attendance case-controlled evaluation. Patient randomization was determined by the special therapists.

Instrumentation

The monitoring device[7] was designed with an accelerometer (ADXL345; Analog Devices, Norwood, MA, USA; range, ±2 g) as the key component to measure acceleration during the pendulum exercises. The accelerometer generated signals in the x-, y-, and z-axis directions with acceleration values indicated as ax, ay, and az. During the pendulum exercises, data were recorded at 100 Hz, and the resultant sum of the accelerations from the 3 axes was equal to 1 g (256 counts) when the acceleration was static, as determined by $\sqrt{(ax^2 + ay^2 + az^2)}$. The recording frequency had to be high enough