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Chronic Lateral Epicondylitis: Comparative Effectiveness of a Home Exercise Program Including Stretching Alone versus Stretching Supplemented with Eccentric or Concentric Strengthening

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ABSTRACT: The objective of this study was to evaluate the effectiveness of eccentric strengthening. Ninety-four subjects (50 men) with chronic lateral epicondylitis were allocated randomly into three groups: stretching, concentric strengthening with stretching, and eccentric strengthening with stretching. Subjects performed an exercise program for six weeks. All three groups received instruction on icing, stretching, and avoidance of aggravating activities. The strengthening groups received instruction on isolated concentric and eccentric wrist extensor strengthening, respectively. At six weeks, significant gains were made in all three groups as assessed with pain-free grip strength, Patient-rated Forearm Evaluation Questionnaire, Disabilities of the Arm, Shoulder, and Hand questionnaire, Short Form 36, and visual analog pain scale. No significant differences in outcome measures were noted among the three groups. Although there were no significant differences in outcome among the groups, eccentric strengthening did not cause subjects to worsen. Further studies are needed to assess the unique effects of a more intense or longer eccentric strengthening program for patients with lateral epicondylitis.

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Lateral epicondylitis (tennis elbow), one of the most common conditions of the upper extremity,[1–7] affects 1–3% of the general population.[1,8] Most persons are 40–60 years old, with both males and females equally affected.[7,9] Lateral epicondylitis is reported in 59 per 100,000 workers,[5] with more than 70% of cases being occupation related. The principal cause of lateral epicondylitis is thought to be degeneration of the proximal wrist extensor tendons, specifically the extensor carpi radialis brevis tendon.[4,6,7,9–13]

Multiple therapeutic interventions have been recommended for the management of chronic lateral epicondylitis.[4,6,9,10] Chard and Hazleman[3] reported more than 40 different treatments. There is no consensus about the most efficacious intervention strategy.[9–11,14] Smidt et al.[15] compared physical therapy, corticosteroid injections, and a "wait-and-see policy." Corticosteroid injections were more effective at six weeks, but subjects had a higher recurrence rate at one year. The outcome of physical therapy at one year was slightly better than the wait-and-see policy but not statistically significant. A recent systematic review concluded that there was insufficient evidence to support most physical therapy intervention strategies for patients with lateral epicondylitis.[16]

One method of treatment for lateral epicondylitis and other tendinopathies that has gained recent attention is eccentric strengthening. Because lateral epicondylitis and other tendinopathies are degenerative conditions of the tendon with few inflammatory

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cells,[11,17] the theoretical effectiveness of anti-inflammatory treatments is doubtful. However, there are many theories supporting eccentric strengthening. Eccentric strengthening loads the musculotendinous unit to induce hypertrophy and increased tensile strength, reducing the strain on the tendon during movement.[18,19] An eccentric contraction may provide a greater stimulus for the tendon cells to produce collagen and trains the tendon to withstand a greater force than encountered in the inciting activity.[19,20] The most recent theory is that eccentric strengthening decreases the neovascularization believed to be a causative factor in painful tendinopathies.[21,22] With an eccentric strengthening program, subjects who improved demonstrated decreased neovascularization, but subjects who did not improve had no change in neovascularization.[21,22] Two recent studies of eccentric strengthening in Achilles tendinopathy reported a significant decrease in and normalization of the size of the tendon after 12 weeks of eccentric exercise therapy.[23,24]

Several studies have suggested that eccentric strengthening is beneficial for improving outcomes in patellar and Achilles tendinopathies.[12,18,23–26] In one randomized controlled clinical trial, Niesen-Vertommen et al.[12] compared concentric and eccentric strengthening in subjects with Achilles tendinitis. The eccentric group had significantly less pain at the end of the 12-week training session. Alfredson[21] has well-documented research supporting the use of eccentric strengthening in achilles tendinopathy.

There are very few research studies on the effect of eccentric strengthening for patients with lateral epicondylitis. Using a randomized controlled trial, Svernlov and Adolfsson[27] compared 12 weeks of contract–relax stretching to eccentric strengthening for lateral epicondylitis. At three months, both groups had less pain and increased grip strength, but there were no significant differences between the two groups. However, at six months, 71% of subjects in the eccentric group had completely recovered compared with only 39% in the stretching group. Compared with the control group, the eccentric group had significant improvement in grip strength. Although these values appear markedly different, the number of subjects was small and the difference was not statistically significant.

The goal of the present study was to compare the outcomes (strength, pain, function) of a six-week home program of stretching exercises alone and stretching exercises supplemented with either eccentric or concentric exercises.

METHODS

The institutional review board of Mayo Foundation approved the study. Subjects with chronic (>3 mo) lateral elbow pain were recruited through advertising at our institution and in local health clubs. Subjects fulfilling inclusion and exclusion criteria were invited to participate in the trial. Written, informed consent was obtained before participation in the study. Before inclusion in the study, all subjects were examined by one of the authors (JAM-S, MPS, or KWA) to confirm the diagnosis of lateral epicondylitis.

Our selection criteria were based on the presence of pain, tenderness, and positive pain provocative maneuvers because these criteria have been used in other studies.[27–29] Inclusion criteria were as follows: 1) pain localized to the lateral elbow (one or both arms), 2) continuous symptoms present for more than three months, and 3) maximal tenderness localized to the lateral epicondyle and pain with two of the following three maneuvers: resisted wrist extension, resisted middle finger extension, or chair lift test. The chair lift test is performed by lifting the back of a chair with a three-finger (thumb and index and long fingers) pinch and the elbow fully extended.[30,31] The position of the upper extremity with the hand in palmar flexion, the wrist in ulnar deviation, and the forearm pronated in conjunction with forceful gripping is thought to maximally load the common extensor tendon and thus produce pain.[32] A testing system simulating the chair lift test has been shown to be reliable and reproducible.[32] Although the chair lift test is a common clinical test, the specific type of chair is not described in the literature. We performed the test with a standard office chair that had a back 44 inches high and 4 inches thick. The chair was sufficiently heavy that subjects could not lift it (≥40 lb). We do not believe that these exact measurements are important and that most standard office chairs could be used. Subjects stood behind the chair so that they were at ease with their shoulder flexed to about 90° in front of them comfortably, elbow straight, and fingers gripping the chair. They were then told that although they would not be able to lift the chair, they were to attempt to lift it.

Exclusion criteria were as follows: 1) substantial osteoarthritis, rheumatoid arthritis, or inflammatory arthropathy affecting the elbow or wrist; 2) connective tissue disease; 3) diffuse pain syndrome (e.g., generalized tension myalgia or fibromyalgia); 4) carpal tunnel syndrome; 5) cervical radiculopathy; 6) history of fracture of the radius, ulna, or humerus with resultant deformity of the affected extremity; 7) numbness or tingling of the dorsum of the forearm or hand of the involved extremity; 8) pending litigation (other than workers' compensation) related to elbow pain; 9) inability to perform the strengthening exercises because of excessive pain; and 10) unable to return for follow-up evaluation.

After the subjects were stratified by gender and workers' compensation status, they were randomly assigned to one of three treatment groups: stretching and other conservative therapy ("stretching group"), stretching plus a concentric strengthening program ("concentric group"), or stretching plus an eccentric strengthening program ("eccentric strengthening group"). We chose to use stretching in the control group because this is the standard of care at our institution and a recommended component of lateral epicondylitis treatment.[33] It is unknown whether most eccentric strengthening programs include stretching, because this usually is not specified. Stanish et al.[19] do include stretching in their eccentric protocol.

At the initial visit and at six-week follow-up, pain-free grip (PFG) strength was measured, and each subject completed the Patient-rated Forearm Evaluation Questionnaire[28] (PRFEQ), Disabilities of the Arm, Shoulder, and Hand (DASH) questionnaire,[34] Short Form 36 (SF-36),[35] and visual analog pain scale (VAS).[36] At six weeks, subjects were also asked, "How satisfied are you with the results of the treatment you have received for your elbow pain?" Choices were "very satisfied," "somewhat satisfied," "neither," "somewhat dissatisfied," and "very dissatisfied."

Pain-free grip was measured with an electronic dynamometer (NK Biotechnical Corporation, Minneapolis, MN). The device was calibrated before testing. After the proper technique (elbow extended and forearm in neutral position) was demonstrated, subjects were instructed to grip the instrument with increasing force, stopping immediately when pain was first sensed in the lateral elbow. The average of three trials was recorded. A negative difference score reflects an increase in pain-free strength after treatment.

Each patient received written instructions with pictorial illustrations specific for his or her treatment protocol. Home therapy and exercises were demonstrated by one of the authors. All three groups were instructed in conservative measures. They were told to avoid precipitating and exacerbating activities. They were allowed to use a counterforce strap as needed. We allowed use of the strap because in our clinical practice many patients use this as a self-treatment, and we did not want to deprive them of it. An instruction sheet on self-applied ice massage was given, and subjects were told to perform this three times per day. The ice massage technique involved filling a paper cup with water, freezing it solid, and rubbing the ice in a circular motion on the painful area until the area became numb. All subjects were also instructed on stretching of the wrist extensors. The wrist extensors were stretched in standing position with the shoulder flexed to 90°, the elbow extended, and the opposite hand pulling the wrist into flexion. Twice a day, subjects performed three repetitions held for 30 seconds, with a 30-second rest between repetitions.

Subjects in the strengthening (concentric and eccentric) groups were instructed in a progressive, purely concentric or eccentric strengthening program. Each subject received handouts depicting the performance of the concentric or eccentric strengthening exercises, the stretches, and the application of ice for the group. Subjects were asked to perform the home program and to complete an exercise log for six weeks. Remuneration was offered to subjects who completed the initial questionnaires and to those who completed the six-week questionnaires and exercise logs.

Each subject in the strengthening (concentric and eccentric) groups was provided with an elastic resistance band (Upper Body Resistive Xercise Kit, Sports Medical Rehab, Northbrook, IL) to perform the exercises. We chose elastic resistance bands because we thought it would make the experiment more reproducible. The majority of patients we evaluate do not have free weights or other resistance equipment at home. Thus, as part of their therapy, we provide patients with resistance bands. The strengthening exercises were performed in a seated position, with the elbow flexed, the forearm resting on the thigh, and the hand extending beyond the edge of the thigh to allow full wrist motion during exercise (Figures 1 and 2). The resistance band was held by the handle and fixed on the floor with the ipsilateral foot.

Concentric exercise was performed with the forearm in pronation by moving slowly from full passive wrist flexion to full wrist extension (Figures 1A and 1B). The wrist was returned passively to full flexion after tension on the band was released by the opposite hand, so the band was lax and resisted eccentric contraction did not occur during the return to wrist flexion (Figures 1C and 1D). The eccentric exercise was performed by first putting the pronated wrist into full extension by lengthening the band with the opposite hand so that it was lax and, thus, resisted concentric contraction did not occur during wrist extension (Figures 2A and 2B). Next, the band was slowly lowered from full wrist extension to full wrist flexion (Figures 2C and 2D). For each repetition, the band was lengthened by the opposite hand to position the wrist in extension without resistance on the band.

Subjects in the strengthening (concentric and eccentric) groups performed three sets of ten repetitions once daily, with two to five minutes of rest between sets. The appropriate resistance band (light, medium, or heavy) was determined by a ten-repetition trial. The length of the resistance band was adjusted so that it was somewhat difficult to perform ten repetitions. During the initial trial, the length of the resistance band was marked with a permanent ink marker to avoid variability of resistance between exercise sessions. Empirically, a lighter resistance band was tried on smaller subjects or those with

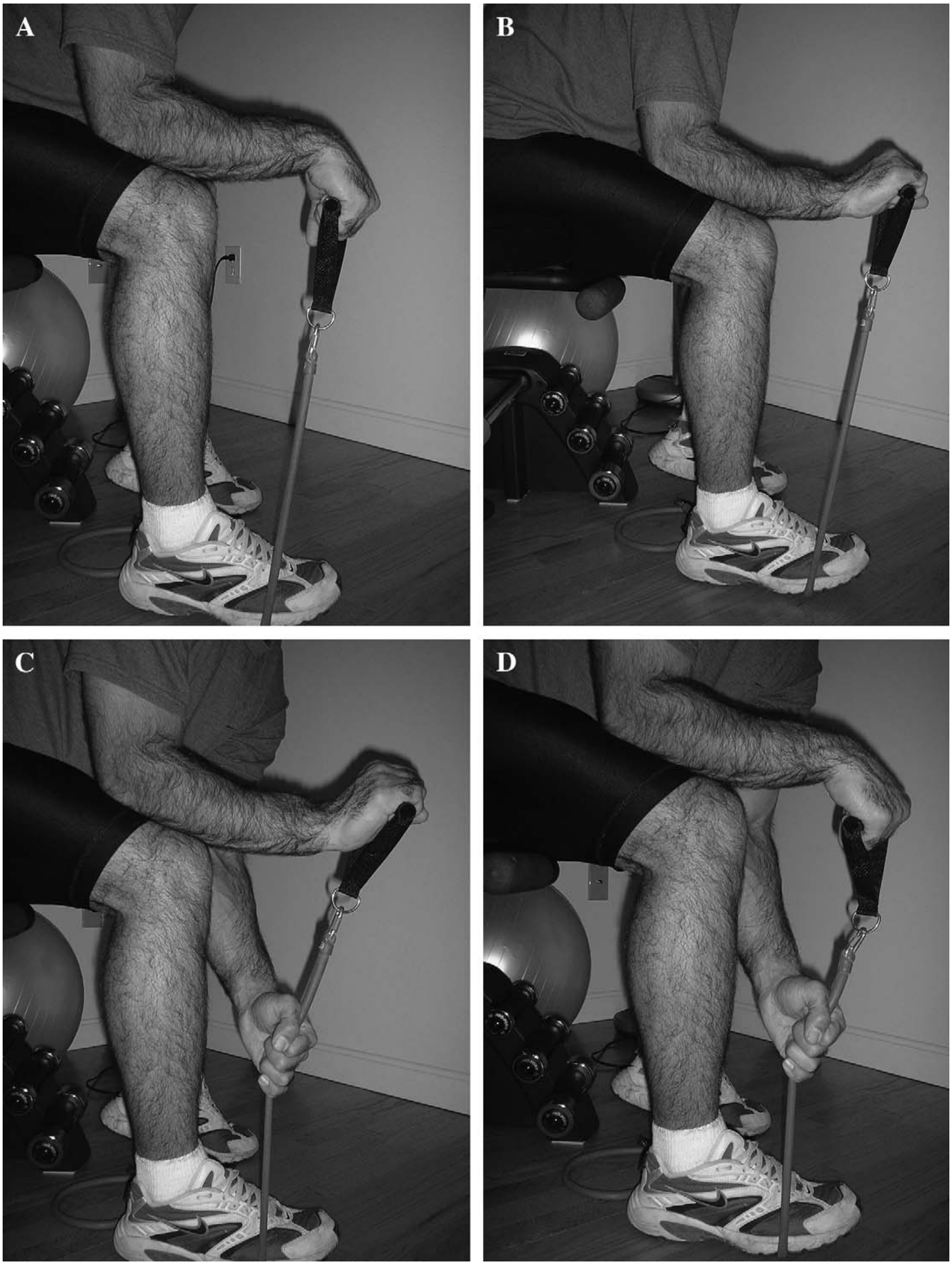

*FIGURE 1. (**A** and **B**) Concentric contraction against resistance. (**C** and **D**) The band remains lax by lengthening with the opposite hand during return to wrist flexion so that a resisted eccentric contraction does not occur.*

more pronounced pain. Subjects who had severe pain with the use of the lightest resistance band were instructed to perform the exercises without the resistance band and to begin using the lightest resistance band one week later if the pain was not worse. Subjects were instructed to increase the resistance in the band when they could perform three sets easily and without a notable increase in pain. The resistance was increased by shortening the band in 1-inch increments from the initial length mark.

Subjects were reevaluated at two and six weeks after randomization and initiation of treatment. The two-week follow-up was conducted by telephone. If needed, the subjects were evaluated in person to review the exercise technique. Also, subjects were reminded to complete and return the exercise log. At

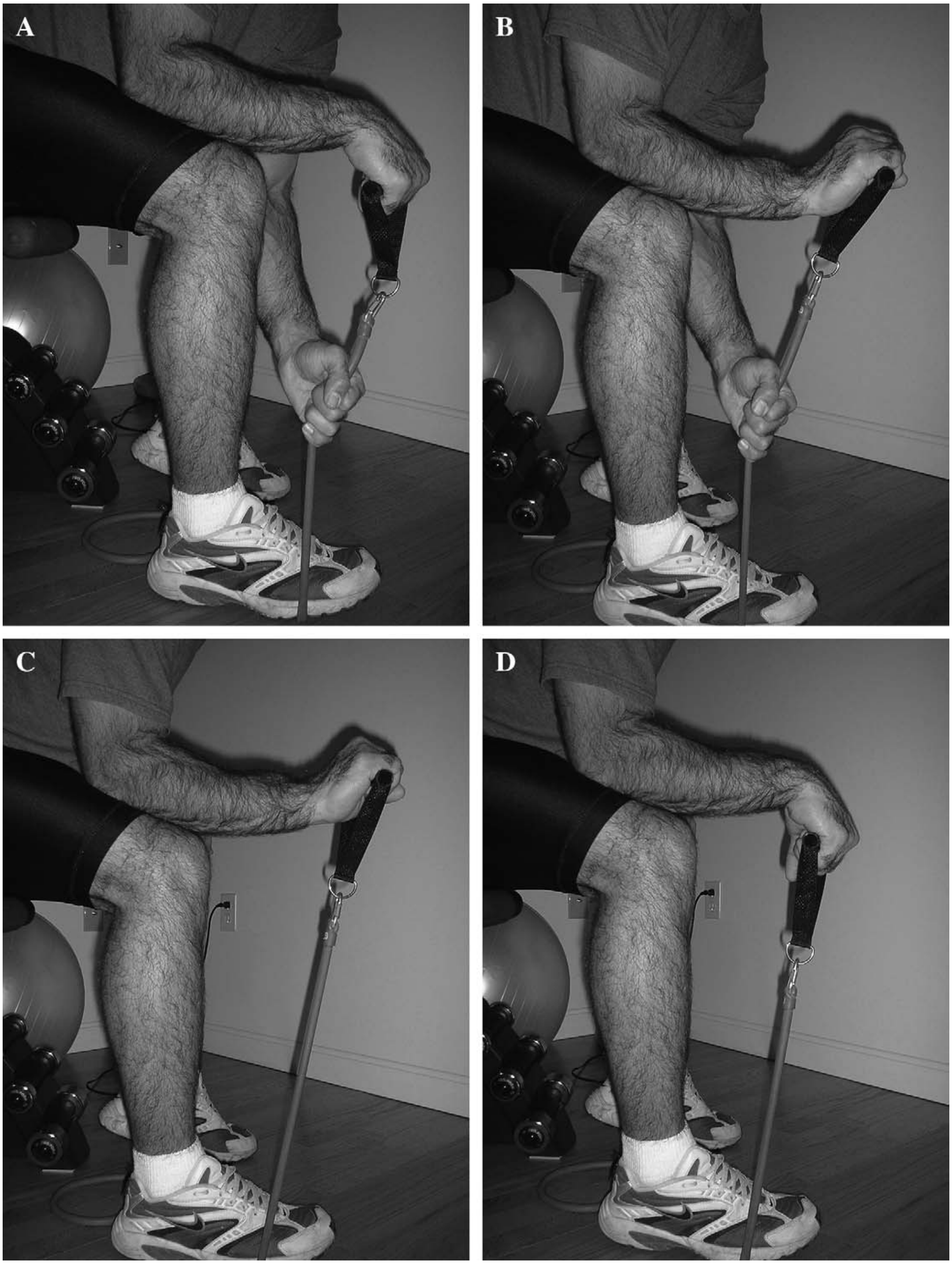

*FIGURE 2. Eccentric contraction against resistance. (**A** and **B**) The wrist is extended while the band is lengthened with the other hand so that it is lax. (**C** and **D**) The eccentric contraction then occurs against resistance.*

the six-week follow-up evaluation, PFG was measured, and the PRFEQ and VAS were completed.

Statistics

For power calculation, we used PFG because descriptive statistics were available in the literature for this variable. A sample size of 27 subjects per treatment group was needed to have an 80% chance of detecting a mean difference in PFG between groups of 6.8 kg of force at six weeks, assuming a two-sided, two-sample t-test and an α of 0.05. The SD of 8.72 kg (assumed common for the three groups) used in this estimate was from the work of Stratford et al.[29] Assuming a 10% dropout rate, our enrollment goal was at least 30 subjects in each of the three groups (90 subjects total).

Continuous baseline characteristics (age, height, and weight) as well as PFG, VAS, total PRFEQ, and DASH function measures were compared among the three groups using a one-way analysis of variance (ANOVA) in an intention-to-treat analysis. Discrete baseline characteristics of sex, handedness, side of elbow pain, elbow pain on the dominant side, pain duration longer than 12 months, and whether the patient was receiving workers' compensation at the time of enrollment were compared among the three groups using a chi-square test or the Fisher exact test as appropriate. We have chosen to report unadjusted p-values because all pairwise comparisons were of a priori interest.

Subjects who did not complete the six weeks of follow-up or were less than 70% compliant with their exercise protocol were considered dropouts and were not included in the analysis of the six-week results. Failure to return the questionnaire or enter daily data for ten consecutive days was considered noncompliance and also resulted in exclusion. There were 13 dropouts at six weeks, and they were compared with the remaining subjects at six weeks to assess possible bias.

The six-week data for the 13 dropouts were analyzed in two ways. The first analysis was intent-to-treat; the six-week data were assumed to have been equal to baseline, that is, assuming no change. The second analysis of the change from baseline to six weeks included only the 81 subjects with complete data. The two analyses had essentially the same results; therefore, we have chosen to report the first method, the intent-to-treat analysis.

The change in outcome measures from baseline to six weeks was assessed within each of the three treatment groups using a paired t-test, a test for nonzero change. The magnitude of the change in outcome was compared among the three treatment groups using a one-way ANOVA. The α level was set at 0.05 for statistical significance.

RESULTS

Ninety-four subjects (50 men [53.2%]) were enrolled into the study. The mean age $\pm$ SD was 45.5 ± 7.7 years. Of the subjects, 89 (94.7%) were right handed and 70 (74.5%) had lateral epicondylitis in the dominant upper extremity. Before the study, 69 subjects (73.4%) had sought treatment for elbow pain. Two percent of the subjects were involved in a workers' compensation claim. With the dropouts excluded, there were no significant differences between the three groups in sex, mean age, handedness, involvement of the dominant extremity, previous treatment, and workers' compensation claim. With the dropouts included, there were no significant differences among the three groups except for two variables. The mean age (43.1 years) of the conservative (stretching) group was significantly younger than that of the concentric (47.0) and eccentric (46.6) groups ($p = 0.035$). The dominant extremity was affected in 58% of the eccentric group compared with 87% and 79% in the concentric and conservative groups, respectively ($p = 0.03$). There were only two subjects under workers' compensation: one in the eccentric group and one in the stretching group. Because of the small number, these subjects were not analyzed separately.

Eighty-one subjects (86%) completed the six-week study: 26 (87%) of the 30 subjects in the concentric group, 27 (87%) of the 31 in the eccentric group, and 28 (85%) of the 33 in the conservative group. The difference in the dropout rate among the groups was not significant ($p = 0.96$). Only one subject (eccentric group) did not comply with the exercise program. Four subjects discontinued the study for unspecified reasons (one in the conservative group, two in the concentric group, and one in the eccentric group); four subjects had worsening of symptoms and decided to try other, alternative management (one in the conservative group, two in the concentric group, and one in the eccentric group). Four subjects did not return for follow-up (two in the conservative group, one in the concentric group, and one in the eccentric group). Dropouts were not statistically different from the remaining subjects in any of the baseline characteristics or in the initial outcome measures.

None of the baseline measures of the outcome variables was significantly different among treatment groups (Table 1). At six weeks, the within–treatment group improvement in PFG, VAS, and DASH scores and SF-36 subscales (pain and physical functioning) was significant for all groups (Table 1).

DISCUSSION

All three treatment groups exhibited improvement in outcome. Although our results did not demonstrate a significant difference among the three groups at six weeks, that the eccentric group was not significantly worse than the other groups is an important finding. Eccentric strengthening often causes increased pain, and some believe that pain is an integral component of the treatment.[18] This pain potentially could cause patients to abandon their eccentric strengthening program. The frequency of subjects in the eccentric group who dropped out was not significantly different from that of the other groups. Thus, subjects in the eccentric group were able to continue their rehabilitation program and to have outcomes similar to those of subjects in the concentric and conservative groups.

Although our study did not demonstrate an increased benefit to eccentric strengthening, a

TABLE 1. **Outcome Measures at Baseline and Change from Baseline to Six Weeks***

	Mean Baseline Data ± SD	*Comparison of Baseline Data among Three Groups, p-value†*	*Mean Value ± SD at Six Weeks*	*Percent Change from Baseline*	*Difference from Baseline to Six Weeks within Groups ± SD*	*Difference from Baseline to Six Weeks within Groups, p-value‡*	*Difference among Groups, p-value†*
PFG							
Stretching	23 ± 15		30 ± 17	30	−6.7 ± 7.0	<0.01	
Concentric	17 ± 9.7	0.23	25 ± 12	47	−7.4 ± 8.3	<0.01	0.44
Eccentric	22 ± 12		26 ± 14	18	−4.2 ± 6.1	<0.01	
VAS							
Stretching	48 ± 21		25 ± 24	−48	23 ± 21	<0.01	
Concentric	49 ± 21	0.79	35 ± 25	−29	14 ± 27	<0.01	0.33
Eccentric	46 ± 20		24 ± 24	−48	23 ± 24	<0.01	
Total PRFEQ							
Stretching	3.7 ± 1.7		1.5 ± 1.6	−43	1.5 ± 1.6	<0.01	
Concentric	3.8 ± 1.7	0.47	1.3 ± 1.8	−34	1.3 ± 1.8	<0.01	0.87
Eccentric	3.3 ± 1.5		1.2 ± 1.7	−36	1.2 ± 1.7	<0.01	
DASH function							
Stretching	27 ± 14		15 ± 14	−44	11 ± 12	<0.01	
Concentric	26 ± 13	0.83	17 ± 14	−35	8.4 ± 10	<0.01	0.66
Eccentric	25 ± 13		16 ± 15	−36	9.3 ± 14	<0.01	

DASH = Disabilities of the Arm, Shoulder, and Hand; PFG = pain-free grip; PRFEQ = Patient-rated Forearm Evaluation Questionnaire; VAS = visual analog pain scale.
*Data are presented with dropouts included.
†p using a one-way analysis of variance.
‡p using a paired t-test.

longer-term study in lateral epicondylitis is imperative. A study by Svernlov and Adolfsson[27] is the only one to have evaluated long-term outcome after eccentric strengthening. Although it appeared that the eccentric group did better than the contract–relax group at six months, the number of subjects was small and there was no significant difference. Some studies on eccentric strengthening for tendinopathy have evaluated subjects for 12 weeks or longer.[18] All the studies that have demonstrated a benefit for Achilles tendinopathy have included at least three months of strengthening.[12,18,23,24,26] One problem with a longer study will be that patients with lateral epicondylitis do improve over time,[15] and it may be difficult to detect a difference in groups.

Possibly we did not detect a difference among the three groups for other reasons. Because the exercise program was not supervised, there may have been noncompliance not reported by subjects or there may have been poor exercise technique. We reviewed the patients' technique personally during the first visit and the six-week follow-up visit. We also telephoned subjects two weeks after they started the study to ensure that they were comfortable with the technique and intensity of the exercise. All the subjects included in the data analysis returned the required exercise log, and it appeared that compliance was good except for one subject who was removed from the study.

Another reason strengthening may not have been helpful is that we decided not to have subjects exercise through pain. The literature on whether to exercise through pain with eccentric strengthening is mixed. Stanish et al.,[19] among the first to describe eccentric exercise for tendinopathies, emphasized that exercises should be performed without pain. In a study that demonstrated an improvement in eccentric compared with concentric exercise for Achilles tendinopathy, the subjects did not progress to the next exercise level until there was minimal or no discomfort in the last set of repetitions.[12] In contrast, Alfredson[21] firmly believes in the importance of strengthening to pain in Achilles tendinopathy, and his results have been positive. We were concerned about a high dropout rate if subjects exercised to pain. Our clinical experience is that compliance decreases when patients exercise through pain. A study emulating Alfredson's technique for lateral epicondylitis is needed.

Another possible reason eccentric exercise was not effective is that lateral epicondylitis does not respond to such strengthening the same way as Achilles tendinopathy. As discussed in the Introduction, lateral epicondylitis should respond to eccentric exercise similarly to Achilles tendinopathy because they have similar histopathologic features.[11,17] However, perhaps the mechanism that produced benefit in Achilles tendinopathy does not apply to lateral epicondylitis. One theory about the effect in Achilles tendinopathy is that eccentric strengthening decreases harmful neovascularization, possibly because repetitive heel drops decrease blood flow. If this theory is correct, perhaps wrist flexion does not reduce blood flow and cause neovascularization as heel drop does. Another possible reason eccentric strengthening might have a different effect in lateral epicondylitis is that eccentric contraction is not a prominent component of the injury. Lateral epicondylitis is often related to forceful grip activities requiring isometric contraction of the wrist flexors and extensors. Perhaps isometric contractions would be more beneficial than eccentric ones in lateral epicondylitis.

Because subjects with lateral epicondylitis do improve over time,[15] we cannot be sure that the observed improvement was not due to the natural course of the condition regardless of treatment intervention. Similarly, because all subjects received stretching, icing, and education, we cannot be sure that these treatments did not affect outcome. A study including a control group without any intervention may be needed to differentiate spontaneous healing from response due to interventions. Another option would be to include a stretching group but exclude stretching from the eccentric and concentric groups.

Although no gold standard measure of outcome is available for lateral epicondylitis, we think that the measures we chose were appropriate. Several studies have reported that PFG is more reliable than maximal grip strength.[29,37] The PRFEQ was developed by Overend et al.[28] to assess average forearm pain for a one-week period. In a previous study, we demonstrated the reliability, reproducibility, and sensitivity of PRFEQ for subjects with lateral epicondylitis.[38] Because the PRFEQ focuses on the forearm, it is probably the best tool to study lateral epicondylitis. The DASH questionnaire is a region-specific outcome assessment tool that assesses the symptoms and functional status of patients with any upper extremity musculoskeletal condition.[34] The VAS[36] has also been used extensively in the evaluation of lateral epicondylitis.[29,39]

We believe that the method of resistance training with bands was the most appropriate technique for this study. First, many patients did not have access to free weights. Second, in this study and in many strength rehabilitation programs, the patients' perceived level of exertion dictates the amount of resistance they use. Thus, we doubt that using free weights or more objectively measuring a subject's effort would have been better in this study.

We believe that our results are applicable to other populations. Our selection criteria based on history and physical examination are similar to those of other studies.[27–29] Our scores on the PFG strength and PRFEQ are similar to those of other studies of lateral epicondylitis.[28,40] Comparison with DASH and VAS was not possible. With DASH, we could not find scores in the literature for lateral epicondylitis alone. For VAS, no papers used the same question and scoring.

CONCLUSION

Eccentric strengthening for the wrist extensors in subjects with lateral epicondylitis demonstrated improvement at six weeks but was not statistically different from that achieved with a conservative program with stretching or a concentric strengthening program. It is encouraging that the eccentric strengthening program was not associated with symptom exacerbation. Studies with longer-term outcome on eccentric strengthening in lateral epicondylitis are needed.

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JHT Read for Credit

Quiz: Article #010

Record your answers on the Return Answer Form found at the back of this issue. There is only one best answer for each question.

#1. The purpose of the study was to evaluate the effectiveness of:
  a. concentric strengthening
  b. stretching alone
  c. eccentric strengthening
  d. all of the above

#2. The results suggest:
  a. no significant difference between groups
  b. the eccentric group performed best
  c. the concentric group performed best
  d. the stretching group performed best

#3. The literature search revealed evidence that:
  a. stretching is damaging to the musculotendinous portion of the tissue
  b. concentric exercise decreases neovascularization
  c. eccentric strengthening should be done despite the presence of pain
  d. tendinopathies are degenerative in nature with few inflammatory cells

#4. The authors concluded that the optimal time for evaluating the effectiveness of eccentric strengthening for lateral epicondylitis is:
  a. 12 months
  b. 6 months
  c. longer than 6 weeks
  d. 6 weeks

#5. The method of providing resistance in their protocol was:
  a. free weights
  b. via rubber resistance bands
  c. isometric hold–relax techniques
  d. manual resistance

When submitting to the HTCC for recertification, please batch your JHT RFC certificates in groups of three or more to get full credit.