A FORM OF AUGMENTED SOFT TISSUE MOBILIZATION IN THE TREATMENT OF LATERAL EPICONDYLITIS

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The purpose of this study was to assess the efficacy of a traditional lateral epicondylitis physical therapy protocol and an augmented soft tissue mobilization (ASTM) physical therapy protocol. A total of 4 diagnosed lateral epicondylitis patients were randomly assigned to either a Traditional or ASTM physical therapy protocol. A middle digit isokinetic dynamometer was used to record third digi-eccentric torque and power date. Maximal grip strength test and Borg Pain Scale were also administered to the patients at five times during the course of therapy at four week intervals after the initial test. At the end of the fourth week of testing, 83% of the cases receiving the ASTM therapy were resolved, and 42% of the cases receiving the Traditional therapy were resolved. The unresolved cases were subsequently crossed over to the opposite therapy protocol for an additional four weeks of therapy and testing. At the end of the additional therapeutic treatment, 82% of the Traditional to ASTM crossover cases and 25% of the ASTM to Traditional crossover cases were successfully resolved. Statistically significant differences between treatments were indicated for middle finger power, grip strength and perceived pain.

Key Words: lateral epicondylitis, physical therapy, soft tissue mobilization.

Lateral epicondylitis, a cumulative trauma tendinitis disorder, challenges the clinician daily. Prolonged pain and disability from lateral epicondylitis (tennis elbow) affects approximately 50% of all sports enthusiasts and 11% of the nation's industrial work force (9). At the present time, the greater weight of evidence indicates that lateral epicondylitis appears to start as a microtear, usually in the origin of the extensor carpi radialis brevis muscle, with a formation of subsequent fibrosis and granulation tissue as a consequence of repetitive trauma (13). Microscopy of excised tissue has revealed that inflammation and degeneration of all tissues about the elbow can occur in isolation or in combination with bursitis, microtendonous tears, myofascitis, calcification, and nerve entrapment (13) Lee (13) describes these findings as degenerative changes, with inflammation of the tissues secondary to traumatic tears of the degenerated elements. Coonrad and Hooper (2) believe that this syndrome is initiated by macroscopic or microscopic tears where changes of degeneration or aging have occurred.

Traditional therapeutic techniques have been proven to be disappointing in many cases. In a meta analysis of therapeutic treatment for lateral epicondylitis of the elbow, Labelle, et al. (12) reviewed 185 articles published from 1966 to 1990. Labelle, et al. concluded that there is not enough scientific evidence to favor any particular type of treatment for acute lateral epicondylitis. Over 40 different treatments for lateral epicondylitis have been reported in the literature (12). These include anti-inflammatory drugs, steroids, many physiotherapy techniques, case immobilization, orthoses, surgical operations and less conventional methods such as radiotherapy, acupuncture and vitamins.

Treatment of tendinitis by cross friction massage has been advocated by Cyriax (3) and is currently being applied extensively in clinical practice. Only one study (18), however, has addressed the benefits of friction massage in conjunction with lateral epicondylitis. Anecdotally, we have noted clinical improvements with the use of an augmented form of soft tissue mobilization. Augmented soft tissue mobilization (ASTM) is a form of aggressive massage which we have successfully been using in a clinical setting to treat a variety of tendinitis/tendinosis related muculoskeletal disorders. We theorize that the ASTM therapeutic technique allows the therapist to introduce more effectively a specific and controlled amount of microtrauma and subsequent capillary leakage that induces a localized inflammatory response.

The inflammatory response is the initial step in the body's healing cascade and immune/reparative system.

The purpose of this study was to compare the strength and pain perception of a group of patients receiving a traditional llateral epicondylitis physical therapy protocol and a group of patients receiving an experimental physical therapy protocol (ASTM).

METHODS

Subjects

Patients were evaluated by a physician trained in primary care sports medicine, musculoskeletal medicine and orthopedics. Inclusion criteria included: pain over the lateral epicondyle. Positive resisted middle digit extension test with the elbow fully extended and positive resisted wrist extension with the elbow fully extended and normal AP and lateral x-ray. Subjects with a history of upper extremity paresthesias, direct trauma, radicular symptoms, carpal tunnel syndrome and connective tissue diseases were excluded from the study. Other physical exclusion factors consisted of medial epicondylitis, sensory changes, ulnar neuritis, decreased range of motion (lacking greater than 10% full extension or flexion less that 110 degrees), steroid injection within previous eight weeks and radiographic evidence of degenerative joint disease.

A total of 42 subjects (18 female and 24 male) met the inclusion criteria. Table 1 presents the subjects' physical characteristics. The subjects were randomly assigned to either a Traditional physical therapy program (phonophoresis and Traditional cross fiction massage) or the ASTM protocol.

Instrumentation

MDD TEST. The middle digit isokinetic test measured the eccentric load that the middle digit extensor muscles could tolerate without the loss of contact with dynamometer. The dynamometer's reliability and validity were previously established. A middle digit isokinetic dynamometer (MDD) was interfaced with a Tenex 386 computer including a math co-processor and an A-D board (CIO-DASCS Computer Boards Inc.). Four strain gauges (Omega SG-3/120-LY13) forming a load cell were mounted on the middle finger testing device. Computer software was developed to operate the test and to record third digit eccentric torque, joint angle and power data. The data acquisition rate was 50 Hz.

The patient's third finger length was determined and the length of the lever arm was adjusted to the length of the finger. Finger length, the distance between the center of the third finger's metacarpal phalangeal joint to the distal end of the finger, was measured with a sliding finger caliper. The patient then placed the dorsal surface of the third finger against the load cell. The second and fourth fingers were positioned against two position monitoring switches. The computer began the test. The lever arm speed was 2.5 deg/s.

Grip Strength. A maximal grip strength test was administered with the elbow extended. A Jamar hand dynamometer (TEC, Corp., model J00105, Clifton, NJ) was used to determine grip strength. The dynamometer was adjusted for hand size, and subsequent tests were performed at the same setting.

Pain Index and Resolution Criteria. Pain rankings were obtained from a 10 category Borg pain scale. The subjects were asked to rate their perceived level of pain during activity and during the testing. The values were manually recorded.

Lateral epicondylitis resolution criteria were: (a) minimal to no pain over the lateral epicondyle to palpation. (b) pain free resisted middle digit extension with elbow fully extended, and (c) pain free resisted wrist extension with elbow fully extended.

Functional testing. The subjects were also asked to rate on a five category scale their perceived pain as they performed the following tasks: shaking hands, turning a door knob, turning a key in a door, lifting and carrying a briefcase, pulling a door open, pushing a door closed, lifting a weighted coffee cup and turning a screwdriver.

Therapy. Subjects were treated three times weekly in the Traditional group and two times weekly in the ASTM group. This discrepancy was due to the fact that patients could not tolerate the augmented soft tissue mobilization three times weekly. The treatment protocols of the two groups differed only in the modality/soft tissue mobilization technique employed. The Traditional protocol, and adapted from Gould (8) included phonophoresis with 10% hydrocortisone at 1.2 Wcm 2 continuous output for five minutes to the lateral epicondyle, followed by cross friction massage to the tender area at the lateral epicondyle for 5 minutes. The nontraditional protocol subsituted ASTM to the arm from the wrist to the mid upper-arm for 5 minutes in place of the phonophoresis and cross friction massage.

ASTM is a form of deep tissue massage which utilizes instruments to assist in the identification and treatment of areas of soft tissue fibrosis. Instruments were designed with a blunt edge along convex and concave surfaces and were applied to the skin to mobilize the underlying soft tissue. Cocoa butter was used as a lubricant between the skin and the instruments. Soft tissue from the joint above the affected joint to the joint below the affected joint was evaluated for soft tissue changes, and these areas were targeted for subsequent treatments. Treatments lasted approximately 5 minutes and consisted of 5-10 passes of the instruments over the areas of soft tissue changes.

Both groups received a cold pack to the elbow for 5 minutes prior to treatment, followed by the assigned modality or soft tissue mobilization technique. They then performed the following stretches, using the other hand to provide a 30 second passive stretch: wrist flexion with the elbow extended, wrist extension with the elbow extended, and a triceps stretch. Progressive resistive exercises were then performed by both groups including wrist flexion, wrist extension, pronation/supination., triceps extension and grip. Resistance was initiated at a comfortable load and performed for 1 set of 10 repetitions. The repetitions were progressed to 2 sets of 15 repetitions. When tolerated the weight was increased and the repetitions decreased to 10 repetitions. Exercises were performed within the patients' pain tolerance, with repetitions or weights reduced as necessary to control pain. Following the strengthening exercises, the patients repeated their stretching regime and then received a cold pack to the elbow for five minutes. Both groups were instructed to repeat the stretching exercises four times daily at home.

Procedures

After the physician's evaluation, the subjects were scheduled at the physical therapy center for testing and therapy. Subjects filled out a questionnaire reporting their perceived pain using the Borg scale. The subjects then performed and rated their pain during the lifting, pushing, pulling and turning tasks. The grip test and MDD test were then performed.

After the initial tests the subjects were retested at the end of the first week of therapy and again at the end of the fourth week of therapy. If the condition was resolved at the end of the fourth week, therapy was discontinued and the patients were retested again four and eight weeks after resolution.

If the condition was not satisfactorily resolved at the end of eight weeks (4 weeks of therapy and 4 weeks of home exercise) the subjects participated in four additional weeks of the opposite therapy program (i.e. the patients receiving ASTM therapy crossed over to Traditional therapy, and the subjects receiving Traditional therapy crossed over to ASTM therapy). Figiure 1 illustrates the group assignments.

Statistical Analysis

Means and standard deviations were computed for all data. Repeated measures two-way anlysis of variance were used to compare MDD and grip dynamometer data for the two treatments (Traditional and ASTM) over time (initial, 4, 8, and 12 week sessions). The same ANOVA statistical procedures were utlized to compare the crossover treatment data over a period of 16 weeks. If the ANOVA were significant, a Newman Keul post hoc comparisons test was used to determine which means were significantly different. Chi square statistical procedures were employed on subjective evaluation of pain data. For all analyses the level of significance was set a priori at $P<0.05$. Sigmastad (?) statistical software (Jandel Scientific Software, San Rafael, CA) was used for all analyses.

RESULTS

Resolution

Figure 1 identifies the number of cases per treatment group that were resolved. At the end of the fourth week of this study, 83% of the ASTM therapy cases and 42% of the Traditional therapy cases were successfully resolved. The unresolved cases (36%) participated in an additional four weeks of the opposite therapeutic treatment. At the end of the additional therapy, 82% of the crossover Traditional to ASTM cases, and 25% of the crossover ASTM to Traditional cases were resolved.

MDD Torque

Figure 2 presents the MDD torque mean values for the four treatment groups (i.e., ASTM Traditional, crossover ASTM to Traditional and crossover Traditional to ASTM). All treatment values were within one standard deviation of each other. Therefore, statistical analysis (ANOVA) indicated no significant difference between any treatment groups. The Crossover ASTM to Traditional between sessions torque values showed significant improvement between the initial test and each of the following testing sessions: 4^{th}, 12^{th} and 16^{th} week sessions.

Power

In addition to the determination of torque, the MDD measured finger isokinetic eccentric extension power. Figure 3 presents the mean power values for the four treatment groups. All treatment group's power values with the exception of the Crossover Traditional to ASTM improved over the course of this study. Statistical analysis indicated a statistically significant ($p<.01$) difference between the ASTM and Traditional treatments as well as between the two crossover treatments.

ANOVA and Newman Keul post hoc procedures indicated a significant ($p<.05$) improvement (25% increase) between the initial and final ASTM treatment sessions. Likewise there were significant ($p<.03$) improvements (31%increase) between sessions for the Crossover ASTM to Traditional treatment. The Crossover ASTM to Traditional treatment group's power values were inconsistent. The values increased steadily to the 4^{th} week (the week of crossover), and during the 8th week the values decreased 33% followed by a significant improvement during the 12th and 16th week session values.

Grip Strength

Figure 3 illustrates the mean grip strength values for each treatment group. Statistical analysis indicated a significant ($p<.01$) difference between the two crossover treatment groups. Over the course of this study all treatment group grip strength values significantly ($p<.05$) improved with the exception of the Crossover ASTM to Traditional. The Crossover ASTM to Traditional group grip strength values followed the same increase and decrease patterns that were indicated in the torque and power data (i.e., steady increase followed by sudden decrease in strength and finally an increase in strength).

Functional Tests

The frequency distribution of the patients' perceived pain at the end of treatment is presented in Table 2. A ten category Borg scale was used to determine the pain; however, there were no values greater than six on the final test. Chi square analysis indicated a significant difference ($p<00$) between the ASTM and Traditional treatments and between the crossover ASTM to Traditional and the crossover Traditional to ASTM treatment groups.

DISCUSSION

The objective data presented in this study provided mixed support for the subjective date. The non crossover patients' MDD power and perceived pain data indicated a significant difference between treatments. In contrast, the grip strength and MDD torque data indicated that there was not statistically significant difference between the treatments studied; however, both treatments were associated with strength increases.

The crossover patients' data were equally mixed. The grip strength and MDD power crossover data indicated a significant difference between treatments and sessions with the crossover to Traditional patients making the greater gain. The MDD torque data indicated no significant difference between treatments but a difference between sessions. Perceived pain data on the other hand indicated a significant difference between the two crossover treatments.

Stratford (19) indicated that the maximum grip test does not appear to be a stable measure and overestimates lateral epicondylitis patients' improvement. The difference between the dependent variables described in this study would tend to support Stratford's grip strength observation. Grip strength may be a stable measure in other types of hand and wrist afflictions; however, grip strength may have limited appropriate value in lateral epicondylitis research evaluations. Although the majority of the lateral epicondylitis research employed pain scales as the outcome measure (1,4,7,10,11,15,16), several studies (5,18,20) used grip strength. Without exception, the lateral epicondylitis studies which used grip strength as the outcome measure found strength improved and no significant difference between experimental treatments. It is possible, therefore, that research in this area may have been impeded by the quality of the measurement tool used. Perhaps then the conclusion of Labelle et al. (12) that there is not enough evidence to favor any particular type of treatment for acute lateral epicondylitis is tainted by the sensitivity of the grip strength measurement instrument or by the use of maximal vs. pain free grip strength.

The isokinetic torque data represents the peak value as the middle finger moved through the range of motion. The torque data did not appear to demonstrate any change between pre and post or between type of treatments. Further examination of each patient's isokinetic torque curves indicated the curves were not smooth. There were several detectable breaks. Dvir (6), in an isokinetic study of patellofemoral pain syndrome, observed irregularities in the moment curve which took the form of dips in the otherwise generally convex, smooth shape of this curve. Dvir noted that irregularities in the moment curve were associated with pain. Dvir suggested that isokinetic evaluation of quadriceps function should be done in conjunction with pain ratings. It is possible that tendinitis patients are able to exert maximum strength but with considerable pain. The peak torque measure, like the maximum grip strength measure, may not be sensitive to the amelioration of lateral epicondylitis.

The power, defined as torque times angular velocity, may be the more appropriate measurement for monitoring lateral epicondylitis patients' improvement. The changes in velocity due to dips in the torque curves are reflected in the power date. It is possible, in this situation, that both torque and pain are encompassed in power determinations

The pain index assessment data indicate that the ASTM appears to resolve lateral epicondylitis to a greater extent than the traditional physical therapy techniques. ASTM is not a therapy unto itself rather it is a change in the therapists' view and a valuable new modality. Where we once tried to eliminate inflammation, we now utilize it to help stimulate collagen turnover and healing. The soft tissue mobilization performed with solid blunt edged instruments theoretically induces localized microtrama and stimulates the inflammatory process which in turn produces the healing cascade including the phagocytosis of damaged inappropriate connective tissue. We encouraged patients in both treatments to maintain their normal activities as tolerated. In addition, a stretching program was included in both treatments to ensure that new connective tissue and collagen were laid down along appropriate lines of force so as not to compromise length-tension relationships and so that the remodeling of the connective tissue structures occurred in a more functional pattern allowing cross linking of new collagen. By encouraging the new connective tissue to be remodeled in a functionally oriented pattern, length-tension relationships of muscles can be optimized and abnormal tension/mechanical forces across joints can be relieved. In chronic tendinitis, we theorize that ASTM initiates the inflammatory process in a tissue that has long since become degenerative rather than inflammatory. By inflaming the tissue in a controlled manner, the first step in the healing process is initiated.

One major dilemma in any interpretation of the crossover treatment data is the unknown residual effect of the prior treatment. It is possible that the treatment was successful and that the patients simply responded to the treatment after testing. A second factor which may have affected the crossover data was that the patients were aware of the failure of the first treatment and adjusted their performance to reflect the failure. The case in point is the ASTM crossover to Traditional data. At the end of the ASTM treatment the MDD and grip strength data dropped suddenly and then returned to steady increases in performance. This drastic change in performance may be related to a Hawthorne Effect.

In terms of costs/outcomes the ASTM based rehabilitation approach to yield superior results. The outcome data indicated that the ASTM treatment achieved greater clinical success (83% resolution) than the Traditional treatment (42% resolution). This higher achievement of the ASTM was acquired in fewer physical therapy visits than the traditional approach (two therapy sessions/week opposed to three therapy sessions/week). In addition, the ASTM treatment fosters faster rehabilitation, recovery and ultimately a return to a higher level of function I individuals who have experienced chronic lateral epicondylitis.

Two areas in this study present potential confounding variables. Both the traditional protocol and the ASTM technique were applied by the same two researchers. This presents two potential problems. The first and most obvious is the potential for the researcher to be prejudiced for or against one of the treatment protocols. The second potential problem is that since both researchers had worked with both the traditional treatment techniques and the ASTM, a variable such as pressure applied during cross friction may have increased to more closely simulate the microtrauma theoretically applied during ASTM.

The second area which can be questioned will be the choice of what is the "traditional" treatment for lateral epicondylitis. Based on a literature search it was difficult to establish what the traditional protocol should be. The protocol chosen was taken from a text edited by two well-known physical therapists (8). It was modified to utilize ice prior to treatment for anesthetic purposes as well as to include hydrocortisone cream 10% in conjunction with the ultrasound. Also, the use of the tennis elbow splint was eliminated due to the inability of enforcing consistent use by subjects with differing job and athletic restrictions. The issue of whether iontophoresis, high volt galvanic stimulation, microcurrent or a variety of other modalities could have been incorporated into the traditional protocol is a valid point.

In conclusion, this study has demonstrated that the ASTM treatment shows promise as a means to resolving a somewhat persistent clinical problem. In view of the relief of symptoms in the majority of patients, the ASTM teatment offer a viable alternative to traditional treatment techniques

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Table 1. Physical Characteristics of Subjects mean and standard deviation values.

	Height Mean (cm) (Std. dev)	Weight Mean (kg) (Std. dev)	Age Mean (yrs) (Std. dev)	Number of Subjects
A.S.T.M.	175.56	88.75	46.04	Male = 16
	(12.22)	(15.86)	(7.50)	Female = 7
Traditional	162.9	78.86	45.00	Male = 8
	(25.81)	(18.16)	(5.91)	Female = 11

Table 2. Final test Borg Scale perceived pain frequency distributions

	Scale						
	0	1	2	3	4	5	6
	ASTM*						
Pain in Activity	62.1	27.6	5.3	0.0	0.0	0.0	0.0
Pain in Rest	83.7	16.3	0.0	0.0	0.0	0.0	0.0
	TRADITIONAL*						
Pain in Activity	25.0	25.0	12.5	25.0	0.0	12.5	0.0
Pain in Rest	42.0	12.5	20.0	12.5	12.5	0.0	0.0
	TRADITIONAL to ASTM*						
Pain in Activity	45.4	36.4	0.0	0.0	0.0	0.0	0.0
Pain in Rest	81.2	0.0	18.2	18.2	0.0	0.0	0.0
	ASTM to TRADITIONAL*						
Pain in Activity	25.0	0.0	0.0	0.0	25.0	50.0	0.0
Pain in Rest	50.0	0.0	0.0	25.0	0.0	0.0	0.0

*significant difference between treatments

FIGURE LEGENDS

Figure 1. Schematic diagram showing the number of subjects assigned to each treatment group. Resolution cases are indicated.

Figure 2. MDD torque mean values for each treatment group and each session.

Figure 3. MDD power (w –03) mean values for each treatment group and each session.

Figure 4. Grip strength mean values for each treatment group and session.