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Treatment of Lateral Epicondylitis of the Elbow With Shock Waves

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In a prospective clinical study, the effectiveness of shock wave treatment for lateral epicondylitis in 56 elbows in 53 patients (27 men and 26 women) with an average age of 46 years was investigated. Three patients received treatment for both elbows. Each elbow was treated with 1000 impulses of shock waves at 14 kV. A 100-point scoring system was used for evaluation including 40 points for pain, 30 points for function, 20 points for strength, and 10 points for elbow motion. The intensity of pain was measured using a visual analogue scale from 0 to 10. The overall results were 13.2% excellent, 44.7% good, 36.8% acceptable, and 5.3 unchanged in 35 patients with 12 weeks followup; 30.8% excellent, 42.3% good, and 26.9% acceptable in 25 patients with 24 weeks followup. Considerable improvement was observed from 6 weeks to 6 months after the treatment. None of the patients' symptoms became worse. The results of nine patients who also received a second treatment were good in three patients, acceptable in five patients, and unchanged in one patient. There was no device-related problems, systemic, or local complications. Shock wave therapy may offer a new and safer nonoperative treatment for patients with lateral epidoncylitis of the elbow.

The diagnosis of lateral epicondylitis of the elbow is relatively straightforward, but the treatment often is challenging.[3–5,10,11] Many conservative treatments have been suggested including nonsteroidal antiinflammatory drugs, ultrasound, low-dose laser therapy, steroid injection, functional brace, forearm straps, and manipulative treatment, but none has shown consistent and promising results and the best method of treatment has not been established.[1,3,9,10] Operative intervention has been advocated but the outcome of surgical treatment is inconsistent and unpredictable.[17] Shock wave application has been shown to be effective in the treatment of patients with nonunions of long bone fractures and calcifying tendinitis of the shoulder and for relief of chronic pain in the heel and elbow[6,7,13–16] It provides a new treatment modality for lateral epicondylitis of the elbow. The purpose of the current study was to evaluate the effectiveness of shock waves in the treatment of patients with lateral epicondylitis of the elbow.

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MATERIALS AND METHODS

Inclusion criteria included an established diagnosis of lateral epicondylitis of the elbow for which the patient did not respond to at least 6 months of conservative treatment. Conservative treatments included nonsteroidal antiinflammatory drugs, corticosteroid injections, physical therapy, exercise program, and functional elbow brace. Surgery was considered in each patient because of lack of response to conservative treatments. Exclusion criteria included patients younger than 18 years, local infection, a cardiac arrhythmia or pacemaker, pregnancy, and patients with proven arthritis of the elbow. Between August 1998 and May 1999, 53 patients with 56 elbows with refractory lateral epicondylitis were treated with shock waves using an OssaTron orthotriptor (High Medical Technology, Kreuzlingen, Switzerland). In three patients, both elbows were treated. There were 27 men and 26 women with an average age of 46 years (range 25–66 years). The right to left ratio was 36 to 20. The average duration of the condition was 10.5 months (range, 6–24 months). Approximately ½ the patients also had received treatment with herbal medicines. All patients discontinued their current treatment including nonsteroidal antiinflammatory drugs for 2 weeks before treatment.

Treatment was done on an outpatient basis using a local anesthetic (2% xylocaine). The treatment area was focused with a control guide of the OssaTron machine and surgical lubrication gel was placed on the skin at the contact area. Each elbow received 1000 impulses of shock waves at 14 kV generator voltage (0.18 mJ/mm^2 energy flux density). Nine patients (nine elbows) also received a second treatment 30 to 60 days after the first treatment. Vital signs and local pain were monitored throughout the course of treatment.

Approximately ¾ of the patients had some discomfort at the treatment site. There were no systemic or local complications such as swelling, ecchymosis, or hematoma for which the patients required special treatment. Two patients had local reddening that resolved spontaneously after 48 hours. After shock wave treatment, patients were sent home with an ice pack and nonnarcotic analgesics. Nonsteroidal antiinflammatory drugs were not prescribed. Followup was scheduled for 6, 12, and 24 weeks.

A 100-point scoring system was used for evaluation which included 40 points for pain, 30 points for function, 30 points for strength, and 10 points for range of elbow motion. When assessing pain, 10 points were allocated for pain at rest, 10 points were allocated for pain while stretching, 10 points were allocated for pressure pain, and 10 points for chair test pain. Chair test pain is the pain elicited by lifting a 3.5-kg chair on one leg with the shoulder anteflexed 60° and the elbow in extension. With the function scores, 10 points were allocated for pain at work, 10 were allocated points for pain during social and sporting activities, and 10 points were allocated for pain at night. The strength scores were assessed with 10 points for a clenched test and 10 points for resistance to wrist extension. When assessing the range of elbow movement, 5 points were allocated for extension and 5 points were allocated for flexion. The intensity of pain was measured with a visual analogue scale from 0 to 10 points. To maintain a consistent scoring system, the visual analogue scale scores were reversed by assigning 0 points for severe pain and 10 points for no pain. This change did not alter or affect the statistical significance of the current study.

RESULTS

Six patients (seven elbows) were excluded because of inadequate followup and lack of evaluation scores. The remaining 47 patients (49 elbows) were included in the analysis 6 weeks after treatment. The scores before and after treatment were compared statistically using a paired t test and statistical significance was set at a p value of < 0.05. The average pain scores were 16.7 ± 7.0 (range, 4–31) before treatment and 25.3 ± 7.2 (range, 8–39) after treatment ($p < 0.001$). After treatment, the improvement in pain at rest, pain while stretching, pressure pain, and chair test pain was statistically significant ($p < 0.001$). The average functional scores were 14.5 ± 5.4 (range, 7–29) before treatment and 20.8 ± 5.8 (range, 8–30) after treatment ($p < 0.001$). The improvement seen in pain at work, during social and sporting activities, and at night was statistically significant ($p < 0.001$). The scores for range of elbow motion were 9.7 ± 0.7 (range, 7–10) before treatment, and 9.9 ± 0.2 (range, 9–10) after treatment ($p = 0.026$). The average total

scores were 41.0 ± 10.3 (range, 22–75) before treatment and 64.4 ± 13.2 (range, 39–95) after treatment ($p < 0.001$). The results of different scores at 6 weeks are shown in Tables 1A and 1B.

An excellent result was defined as when a patient had no pain, had full motion, and full activity; a good result was defined as when the patient had occasional soreness, good motion, and good activity; an acceptable result was defined as when the patient had some discomfort after prolonged activities; and an unchanged result was defined as when the patient had pain and limited activity. The overall results were excellent in one patient (one elbow) (2%), good in 16 patients (17 elbows) (34.7%), ac-

TABLE 1A. The Results of Pain Scores and Functional Scores at 6 Weeks

Pain Scores and Functional Scores	Before Treatment	After Treatment
Number of patients/elbows	47/49	47/49
Pain scores	16.7 ± 7.1 (range, 4–31)	25.3 ± 7.2 (range, 8–39)
Pain at rest	5.8 ± 2.0 (range, 3–10)	7.5 ± 1.9 (range, 4–10)
Pain while stretching	4.3 ± 2.2 (range, 1–8)	6.5 ± 2.0 (range, 2–10)
Pressure pain	3.1 ± 2.2 (range, 1–8)	5.4 ± 2.0 (range, 1–9)
Chair test pain	3.5 ± 2.0 (range, 1–8)	6.0 ± 2.2 (range, 2–10)
Functional scores	14.5 ± 4.6 (range, 7–29)	20.8 ± 5.8 (range, 8–30)
Pain at work	4.0 ± 2.3 (range, 1–9)	6.3 ± 2.5 (range, 2–10)
Pain during social and sporting activities	4.8 ± 1.9 (range, 1–9)	5.5 ± 2.0 (range, 2–10)
Pain at night	5.8 ± 2.5 (range, 2–10)	7.8 ± 2.0 (range, 3–10)

TABLE 1B. The Results of Strength Scores and Elbow Motion Scores at 6 Weeks

Strength Scores and Elbow Motion Scores	Before Treatment	After Treatment
Number of patients/elbows	47/49	47/49
Strength scores	10.6 ± 3.3 (range, 2–18)	14.3 ± 3.5 (range, 8–20)
Clench test	5.2 ± 1.58 (range, 1–8)	7.0 ± 1.85 (range, 4–10)
Thomsen test	5.9 ± 1.9 (range, 1–8)	7.3 ± 1.8 (range, 4–10)
Elbow motion scores	9.7 ± 0.7 (range, 7–10)	9.9 ± 0.2 (range, 9–10)
Extension	5.0 (range, 5–5)	5.0 ± 0 (range, 5–5)
Flexion	4.7 ± 0.7 (range, 2–5)	4.94 ± 0.24 (range, 4–5)

ceptable in 18 patients (19 elbows) (38.8%) and unchanged in 12 patients (12 elbows) (24.5%). None of the patients' symptoms became worse. Twenty-six patients with 26 elbows (53.1%) showed at least 50% improvement by 6 weeks.

Thirty-five patients (38 elbows) were assessed 12 weeks after treatment. The difference between scores before and after treatment were compared statistically using a paired t test, and statistical significance was set at a p value of < 0.05. The average pain scores were 17.9 ± 7.3 (range, 4–31) before treatment and 30.1 ± 6.9 (range, 16–40) after treatment ($p < 0.001$). After treatment, the reduction in pain at rest, pain while stretching, pressure pain, and chair test pain was statistically significant ($p < 0.001$). The average functional scores were 15.3 ± 5.6 (range, 7–29) before treatment and 24.5 ± 5.2 (range, 13–30) after treatment ($p < 0.001$). The average strength scores were 11.2 ± 3.4 (range, 2–18) before treatment and 16.7 ± 3.4 (range, 9–20) after treatment ($p = 0.021$). The improvement in clench test and Thomsen test after treatment was statistically significant ($p < 0.001$). The average scores for range of elbow motion were 9.6 ± 0.9 (range, 6–10) before treatment and 10.0 ± 0 (average, 10) after treatment ($p = 0.021$). The average total scores were 42.2 ± 12.7 (range, 22–85) before treatment and 77.6 ± 13.5 after treatment ($p < 0.001$). The overall results were excellent in five patients (five elbows) (13.2%), good in 16 patients (17 elbows) (44.7%), acceptable in 12 patients (14 elbows) (36.8%) and unchanged in two patients (two elbows) (5.3%). None of the patients' symptoms became worse. Twenty-three patients with 23 elbows (60.5%) had at least 50% improvement by 12 weeks. The results of various scores at 12 weeks are summarized in Tables 2A and 2B.

When the results of 38 elbows at 12 weeks were compared with the results at 6 weeks, there was a statistically significant difference in pain scores at 6 weeks (26.7 ± 7.2) versus those at 12 weeks (30.2 ± 7.0) ($p < 0.001$). The functional scores at 6 weeks were 21.7 ± 6.1 versus 24.5 ± 5.3 at 12 weeks ($p < 0.001$). The total scores at 6 weeks were 65.8 ± 77.6 versus 77.6 ± 13.7 at 12 weeks ($p < 0.001$). These findings suggest that the effects of

TABLE 2A. The Results of Pain Scores and Functional Scores at 12 Weeks

Pain Scores and Functional Scores	Before Treatment	After Treatment
Number of patients/elbows	35/38	35/38
Pain scores	17.9 ± 7.2 (range, 4–31)	30.1 ± 6.9 (range, 16–40)
Pain at rest	6.2 ± 2.1 (range, 3–9)	8.5 ± 1.7 (range, 5–10)
Pain while stretching	4.5 ± 2.3 (range, 1–8)	7.6 ± 1.9 (range, 4–10)
Pressure pain	3.4 ± 2.3 (range, 1–8)	6.7 ± 2.0 (range, 2–10)
Chair test pain	3.8 ± 2.2 (range, 1–8)	7.2 ± 2.1 (range, 4–10)
Functional scores	15.3 ± 5.6 (range, 7–29)	24.5 ± 5.2 (range, 13–30)
Pain at work	4.3 ± 2.5 (range, 1–18)	7.5 ± 2.2 (range, 3–10)
Pain during social and sporting activities	5.0 ± 2.1 (range, 1–9)	8.0 ± 1.9 (range, 3–10)
Pain at night	6.2 ± 2.5 (range, 2–10)	9.0 ± 1.6 (range, 5–10)

TABLE 2B. The Results of Strength Scores and Elbow Motion Scores at 12 Weeks

Strength Scores and Elbow Motion Scores	Before Treatment	After Treatment
Number of patients/elbows	35/38	35/38
Strength scores	10.95 ± 3.68 (range, 2–16)	17.56 ± 2.54 (range, 10–20)
Clench test	5.62 ± 1.66 (range, 2–8)	9.00 ± 1.26 (range, 5–10)
Thomsen test	5.33 ± 2.32 (range, 2–8)	8.95 ± 1.36 (range, 5–10)
Elbow motion scores	9.6 ± 0.9 (range, 6–10)	10.0 ± 0 (average, 10)
Extension	4.9 ± 0.7 (range, 1–5)	5.00 ± 0 (average, 5)
Flexion	4.7 ± 0.7 (range, 2–5)	5.00 ± 0 (average, 5)

shock waves on the improvement of lateral epicondylitis continued from 6 to 12 weeks.

Twenty-five patients with 26 elbows were followed up for 6 to 9 months. The scores before and after treatment were compared statistically using the Wilcoxon signed rank test, and statistical significance was set at a p value of < 0.05. The average pain scores were 19.0 ± 7.8 (range, 4–31) before treatment and 34.0 ± 5.3 (range, 20–40) after treatment ($p < 0.001$). After treatment, the reduction in pain at rest, pain while stretching, pressure pain, and chair test pain was statistically significant ($p < 0.001$). The average functional scores were 16.5 ± 5.6 (range, 7–29) before treatment and 26.4 ± 4.9 (range, 18–30) after treatment ($p < 0.001$). The improvement for pain at work, pain during social and sporting activities, and pain at night after treatment was statistically significant ($p < 0.001$). The average strength scores were 11.0 ± 3.6 (range, 2–18) before treatment and 17.6 ± 3.1 (range, 10–20) after treatment ($p < 0.001$). The improvement in clench test and Thomsen test after treatment was statistically significantly ($p < 0.001$). The average scores of elbow motion were 9.7 ± 0.8 (range, 7–10) before treatment and 10.0 ± 0 (average, 10) after treatment ($p = 0.066$). The average total scores were 41.0 ± 12.6 (range, 22–75) before treatment and 87.8 ± 12.0 (range, 58–100) after treatment ($p < 0.001$). The overall results of 26 patients by 6 months were excellent in eight patients (eight elbows) (30.8%), good in 10 patients (11 elbows) (42.3%) and acceptable in seven patients (seven elbows) (26.9%). None of the patients' symptoms became worse. Eighteen patients with 19 elbows (73.1%) had at least 50% improvement by 6 months. The results of various scores at 6 and 9 months are summarized in Tables 3A and 3B.

When the results of 25 patients (26 elbows) at 6 months were compared with their results at 6 weeks, there was a statistically significant difference in pain scores at 6 weeks (28.6 ± 6.6) versus those at 6 months (34.0 ± 5.3) ($p < 0.001$). The functional scores at 6 weeks were 23.3 ± 5.2 versus 26.4 ± 3.9 at 6 months ($p = 0.002$). The total scores at 6 weeks were 68.1 ± 13.1 versus 87.8 ± 12 at 6 months ($p < 0.001$). When the results of 25 patients (26 elbows) at 6 months were compared with their results at 3 months, there was a statistically significant difference in pain scores at 3 months (31.9 ± 6.0) versus those at 6 months (33.9 ± 5.4) ($p = 0.003$). The functional scores at 3 months were 26.0 ± 4.2 versus 26.5 ± 3.9 at 6 months ($p = 0.194$). The total scores at 3 months were 80.0 ± 11.4 versus 88.0 ± 12.2 at 6 months ($p = 0.001$). The findings suggest that the effect of shock waves on the overall improvement of patients with lat-

TABLE 3A. The Results of Pain Scores and Functional Scores at 6 Months

Pain Scores and Functional Scores	Before Treatment	After Treatment
Number of patients/elbows	25/26	25/26
Pain scores	19.0 ± 7.8 (range, 4–31)	43.0 ± 5.3 (range, 20–40)
Pain at rest	6.8 ± 1.9 (range, 3–10)	9.1 ± 1.2 (range, 6–10)
Pain while stretching	4.6 ± 2.4 (range, 1–8)	8.4 ± 1.6 (range, 5–10)
Pressure pain	3.5 ± 2.4 (range, 1–8)	7.8 ± 1.8 (range, 3–10)
Chair test pain	4.1 ± 2.5 (range, 1–8)	8.4 ± 1.6 (range, 4–10)
Functional scores	16.5 ± 5.6 (range, 7–29)	24.5 ± 5.2 (range, 13–30)
Pain at work	4.4 ± 2.7 (range, 1–8)	8.4 ± 1.9 (range, 34–10)
Pain during social and sporting activities	5.5 ± 2.1 (range, 2–10)	8.8 ± 1.4 (range, 6–10)
Pain at night	6.7 ± 2.4 (range, 2–10)	9.6 ± 0.9 (range, 7–10)

eral epicondylitis continued from 6 weeks to 6 months. The magnitude of improvement was more dramatic in the early period from 6 weeks to 3 months and less dramatic from 3 months to 6 months because the majority of the patients had achieved significant improvement by 3 months. There were no device-related problems, systemic, or local complications. The overall results at 6 weeks, 12 weeks, and 6 months are summarized in Table 4.

Nine patients (nine elbows) had a second treatment 30 to 60 days after the first treatment because of unchanged results. The differences of various scores between the first and the second treatments were compared statistically using the Wilcoxon signed rank test and a statis-

TABLE 3B. The Results of Strength Scores and Elbow Motion Scores at 6 Months

Strength Scores and Elbow Motion Scores	Before Treatment	After Treatment
Number of patients/elbows	25/26	25/26
Strength scores	11.0 ± 3.6 (range, 2–18)	17.6 ± 3.1 (range, 10–20)
Clench test	5.6 ± 1.8 (range, 2–9)	8.8 ± 1.6 (range, 5–10)
Thomsen test	5.5 ± 2.1 (range, 2–8)	8.9 ± 1.5 (range, 5–10)
Elbow motion scores	9.7 ± 0.8 (range, 7–10)	10.0 ± 0 (average, 10)
Extension	5.0 ± 0 (average, 5)	5.00 ± 0 (average, 5)
Flexion	4.7 ± 0.8 (range, 2–5)	5.00 ± 0 (average, 5)

TABLE 4. The Overall Results at 6, 12 Weeks, and 6 Months

Results	6 Weeks	12 Weeks	6 Months
Number of patients/elbows	47/49	35/38	25/26
Excellent	2.0% (1/49)	13.2% (5/38)	30.8% (8/26)
Good	34.7% (17/49)	44.7% (17/38)	42.3% (11/26)
Acceptable	38.7% (19/49)	36.8% (14.38)	26.9% (7/26)
Unchanged	24.5% (12/49)	5.3% (2/38)	—

tical significance was set at a p value of < 0.05. The difference of pain scores between the first and the second treatments was statistically significant ($p = 0.048$). The changes in pain at rest, pain while stretching, pressure pain, and chair test pain from the first treatment to the second treatment were statistically significant ($p < 0.05$). The changes in functional scores and strength scores from the first treatment to the second treatment also were statistically significant ($p < 0.05$). The differences of total scores between the first and the second treatments was statistically significant ($p = 0.012$). The results of these nine patients (nine elbows) were good in three patients, acceptable in five, and unchanged in one. It is the authors' observation that patients who did not respond well to the first treatment, were likely to have additional improvement after a second treatment.

DISCUSSION

The causation of lateral epicondylitis of the elbow is multifactorial. Histologic evidence of vascular proliferation and focal hyaline degeneration in surgical specimens suggests that chronic refractory lateral epicondylitis is a degenerative rather than an inflammatory process.[11,12] The natural history of lateral epicondylitis of the elbow is uncertain and there is insufficient evidence to support any of the current methods of treatment.[10] Corticosteroid injection seems to be effective in the short-term from 2 to 6 weeks.[1] Topical diclofenac also provides effective short-term reduction in elbow pain.[2] Treatment with a low power laser seems to offer no advantage over the placebo.[9] Surgery becomes the only choice when patients do not respond to conservative treatment, but the success rate barely exceeds that of shock wave therapy, and surgery still can be performed if shock wave therapy fails.[7,17]

The mode of action of shock wave therapy is uncertain. It has been suggested that shock waves relieve pain by hyperstimulation analgesia.[7] Shock wave therapy has been shown to have an 80% success rate in the treatment of pseudarthrosis,[6,7,17] and a 56% to 90% success rate in the treatment soft tissue disease including calcifying tendinitis of the shoulder, tendinopathy of the elbow, and painful heels.[7,8,11,13,14] Levitt and Alvarez[11] reported that 11 of 20 patients with at least 50% improvement by 6 weeks, 14 had at least 50% improvement by 3 months and 16 had improved by 6 months; 85% of the original 20 patients were satisfied with the outcome. Rompe et al[13,14] reported a good or excellent outcome in 48% and an acceptable result in 42% at a final review at 24 weeks for 50 patients treated with 3000 impulses of shock wave therapy compared with 6% and 24%, respectively in patients who received 30 impulses.

The overall results of the current study were 36.7% excellent or good, 38.8% acceptable, and 24.5% unchanged at 6 weeks. By 12 weeks, however, 57.9% of patients had excellent or good results, 36.8% had acceptable results, and only 5.3% were unchanged. The results at 24 weeks were 73.1% excellent or good and 26.9% acceptable. None of the patients' symptoms became worse. It seemed that there was a substantial improvement in the symptoms between 6 to 12 weeks after treatment and the improvement continued beyond 24 weeks.

Nine patients received a second treatment because of an inadequate response to the first treatment and the results were five good, three acceptable, and one unchanged.

Although the early results have been encouraging, a longer followup is needed for final conclusions. No device-related problems and no systemic or local complications have been observed. The authors' early clinical results are comparable with the results of others and the success rates reported in the literature.[11,13,14] The authors observed that patients who did not respond well enough to the first treatment were likely to have improvement after a second treatment. It seemed that repeated shock wave treatments resulted in a cumulative positive effect on elbows with lateral epicondylitis. Low energy shock wave treatment seems to be effective for lateral epicondylitis of the elbow in selected patients. It is safe and complications are rare. This method seems to offer substantial advantages for the treatment of patients with lateral epicondylitis of the elbow.

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