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# Results of the treatment of tennis elbow with extracorporal shock wave therapy: a preliminary report

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**ABSTRACT**

**Introduction**: Tennis elbow is a colloquial name of a common musculoskeletal disorder arising secondary to recurrent microtrauma of the upper extremity, particularly impacting the lateral epicondyle of the elbow. First-line treatment of the condition is conservative, with many methods which are mostly effective. Extracorporal shock wave therapy (ESWT) is one of these methods, which has shown its effectiveness in several clinical trials. The objective of this study was assessment of the effectiveness of ESWT for tennis elbow in a short (4 weeks) follow-up.

**Patients and methods**: Eleven patients, 8 female and 3 male with a mean age of 55 years, with tennis elbow were treated with ESWT. Each patient received 3 local applications of 2000 shocks, with 1-week interval between the sessions. The measurements included pain at rest and at movements in Numeric Rank Scale (NRS), grip strength and function of the hand with the quick-DASH questionnaire. The patients were assessed before start of the treatment (baseline) and 1 week after the last application (final assessment).

**Results**: At the last assessment at 4 weeks, all but 1 patients experienced a major and statistically significant pain relief, increase of grip strength and improvement of function of the hand. In 1 patient the treatment failed. No adverse events associated with shock-wave therapy have been reported.

**Conclusion**: Tennis elbow treatment with ESWT is effective and free of adverse events.

**Keywords**: tennis elbow; conservative treatment; extracorporal shock wave therapy; outcome assessment.

## INTRODUCTION

Tennis elbow (lat. *epicondylitis lateralis*) is the colloquial name of a condition of inflammatory and degenerative aetiology, affecting the attachments of the extensor carpi ulnaris and extensor digitorum communis muscles to the lateral epicondyle of the humerus. This is the most common cause of pain felt in the elbow joint area. Although the Latin name *epicondylitis* suggests an inflammatory aetiology of the disease, it actually has an overload-degenerative aetiology, and the changes concern the attachment of the extensor muscles of the radial wrist [1, 2, 3]. The characteristics of the disease are described in Table 1. Degenerative changes in the attachment of muscles to the lateral epicondyle are a consequence of micro-injuries and overload, occurring especially in:

- alternating extension and supination of the wrist (e.g. working with a screwdriver);
- carrying heavy objects with your elbows straight;
- bouncing a tennis ball (performing alternating flexion and extension of the elbow, while holding the racket shaft with a strong grip).

People who work at a computer (secretaries, office workers) also suffer from the disease, due to the specific arrangement of the hands when typing on a computer keyboard, which causes tension in the muscle attachment. In some situations, it can be considered an occupational disease.

**TABLE 1. Characteristic features of tennis elbow**

| |
|---|
| It mainly affects middle-aged men (approx. 40–50 years old) |
| The course of the disease varies. Most patients present to the doctor after a few months symptoms, but some may have bothersome symptoms and tolerate them for years, until moment of significant exacerbation |
| Sometimes severe pain occurs after performing a specific movement and persists, forcing patient to seek help in the emergency („acute" tennis elbow) |
| In about 30% of patients with tennis elbow, other hand diseases coexist, e.g. carpal tunnel syndrome, wrist, golf elbow, trigger finger or de Quervain's disease |

Symptoms and diagnostics. Tennis elbow is diagnosed on the basis of clinical symptoms and signs that are listed in Table 2. In most cases, such a clinical picture is sufficient to establish a confident diagnosis, but in doubtful cases, ultrasound or even magnetic resonance imaging (MRI) can be performed. Ultrasound shows degenerative changes and fluid effusion in the area of attachments of the extensor muscles to the lateral epicondyle. Radial tunnel syndrome should be considered in the differential diagnosis, especially if standard treatment fails [2, 4]. Treatment of tennis elbow. The disease is usually treated conservatively. Table 3 lists and describes conservative treatments, of which steroid injection is the most commonly used. Conservative treatment requires patience. If the cause of the disease is specific and repetitive hand movements

during professional work or recreation, it is necessary to modify the way you perform movements to relieve the load at muscle attachments to the lateral epicondyle. Physical therapy and exercises to strengthen the wrist extensor muscles are also helpful in preventing the recurrence. Surgical treatment is only considered after conservative treatments have failed. Operation consists in detachment (separation) of attachments of the extensor carpi ulnaris (ECU) tendon from the lateral epicondyle of the humerus [1]. Over a period of last 15 years, extracorporal shock wave therapy (ESWT) has been used to treat some tendinopathies and enthesopathies, including tennis elbow. Beneficial effect of this therapy consists in promotion of soft-tissue healing by immediately inhibiting pain receptors, reducing inflammatory cytokines, enhancing angiogenesis, boosting cellular proliferation and extracellular matrix synthesis [2, 3].

**TABLE 2. Symptoms and signs of tennis elbow**

| |
|---|
| Tenderness over the lateral epicondyle |
| Pain on the lateral side of the elbow that occurs when the wrist and the whole limb move |
| Radiating the pain into forearm and/or arm |
| The pain intensifies when the hand is clenched and the grip is firm |
| Weaker grip and reduced dexterity of the hand |
| Methods of treatment of tennis elbow: physical therapy (iontophoresis, laser, magnetic field, cryotherapy), tourniquets, immobilization of the wrist in moderate extension. Improvement is temporary, but in some patients may be permanent and this treatment can be repeated many times |
| Injection of the steroid into the area of the greatest pain, after which the symptoms disappear for up to a year, and in some patients (about 30%) the improvement is permanent |
| Injection of platelet-rich plasma that stimulate repair processes. The effectiveness is similar to that of an injectable steroid, but they do not have adverse effects |
| Extracorporeal shock wave therapy |

The objective of this study was assessment of the effectiveness of ESWT for tennis elbow in a short-term follow-up.

## MATERIALS AND METHODS

Over the period of 1 year (2020), 16 patients diagnosed tennis elbow were treated in authors' institution by local application of the shock wave. Of this number 11 patients, 8 female and 3 male with a mean age of 55 (range 32–73) years completed the follow-up visits and this group is the subject of analysis. Right elbow was involved in 4 patients and left in 7 patients. Duration of the disease until the start of treatment was a mean of 8 (range 3–26) months. The diagnosis of tennis elbow was made based on clinical symptoms and signs listed in Table 2. No additional imaging tests (i.e. USG) were performed to confirm clinical diagnosis.

All patients were examined before the start of treatment (baseline) and 1-week after the third application of the shock-wave, at 4 weeks. The measurements included pain experienced by the patients at rest and at movements (in Numeric Rank Scale – NRS, range 0–10), grip strength with Jamar dynamometer in kG, and function of the hand with the quickDASH (Disability of Arm, Shoulder and Hand) questionnaire. Additionally, the pain experienced by the patients during shock-wave application was recorded. The quickDASH is a validated and widely used 11-item questionnaire that measures upper-extremity specific symptoms and disability. The score of this questionnaire reflects the ability to use the limb in performing daily activities. The basic version consists of 30 items, while the short version (quickDASH) consists of 11 items. Each item is scored from 1–5, where 1 means no complaints or non-restricted performance of a given activity, while 5 means severe complains or inability to perform a given activity. The "raw" quickDASH score ranges from 11–55 points. The score is then converted by dividing the "raw" value by the number of questions the patient answered, subtracting from the quotient of 1 and multiplying the result by 25. The obtained range of values is from 0–100 points, with a lower score indicating overall better function of the extremity, while higher score indicating worse function. All clinical assessments and shock-wave applications were performed by the same person (HM).

### Intervention

The PiezoWave device (Richard Wolf, Germany) was used to administer the treatment of ESWT (Fig. 1). The patient's hand was stabilized with the extremity on a table, flexed in the elbow joint. The transducer was placed over the site of tenderness on the lateral epicondyle (Fig. 2). Each patient received 3 local applications of 2000 shocks at a pressure of 2 bars and frequency 8 Hz, lasting approximately 8 min, with 1-week interval between the sessions.


**FIGURE 1.** The PiezoWave shock-wave generator with a transducer

**FIGURE 2.** Application of shock wave in tennis elbow

The approval of the Bioethical Council of the local Medical University was obtained in order to conduct this survey and informed consent was obtained from all subjects before enrolment.

### Statistical analysis

In order to calculate the distribution of the data, the Anderson–Darling test was used, for statistical significance a statistical test for data with a parametric distribution: paired T-test for paired data. For non-parametric distribution data, a Wilcoxon rank-test was performed for paired data. The statistical significance threshold was $p < 0.05$.

## RESULTS

The results of measurements taken in 11 patients before and 1 week after the third shock-wave application are presented in Table 4. Pain, both at rest and after load, decreased statistically significantly, and only 1 patient experienced moderate pain at rest, rated 6 on the NRS. The pain experienced at load of the extremity that usually provoke pain, decreased significantly in the majority of patients to the average value of NRS = 4 and only 1 patient still experienced strong pain during these movements, rated on 8 on the NRS. Patients felt pain when performing the first procedure, which they assessed as an average NRS = 5.9, while during the last procedure the pain decreased to NRS = 4.6 (difference non-significant). Grip strength improved after a series of 3 ESWT applications by an average of 3.9 kG, which was a statistically significant difference. Performance of daily activity tasks as assessed by the quickDASH questionnaire, improved statistically significantly by an average of 31 points. Only in 1 patient (the same whose pain did not dubside) function of the extremity did not improve (quickDASH 73). In summary, after 4 weeks from the start of ESWT, all but 1 patients experienced significant improvement, in terms of resolution of pain, stronger grip and better hand function. No adverse events associated with shock-wave therapy have been reported. All patients were satisfied with the treatment and declared that they would choose it again, in a case of recurrence. The patient in whom shock-wave therapy failed was given surgery.

**TABLE 3. Baseline and final findings measured in 11 patients in the study**

| Parameter | Baseline | | Final assessment | | p |
|---|---|---|---|---|---|
| | mean | range | mean | range | |
| Pain at rest (NRS) | 5,0 | 3–8 | 1,8 | 0–6 | 0,0004 |
| Pain at movement (NRS) | 8,3 | 5–10 | 4,0 | 1–8 | 0,003 |
| Pain at application | 5,9 | 3–10 | 4,6 | 1–10 | 0,16 |
| Grip strength (kG) | 17,6 | 8–30 | 21,5 | 12–32 | 0,02 |
| quickDASH score | 66 | 48–75 | 35 | 0–73 | 0,004 |

## DISCUSSION

The main impairments of tennis elbow are pain, decreased grip strength, and impaired unction of the upper limb. The main goals of therapy in this disease are to control pain and maintain or improve function. In most studies relief of pain at movements is the primary outcome measure, as once pain is controlled, function may be improved through exercises, to strengthen the elbow joint and extend the range of motion. Therefore treatment is focused on pain. Among the many treatments listed in Table 3, steroid injection in the area of the lateral epicondyle is the most commonly used. In most cases, it is an effective therapy and after 1–2 injections, the pain subsides. In addition to steroids, other injectables are used, such as platelet-rich plasma or hyaluronic acid, but their efficacy is overall not better than steroids. Steroid injections are easy available, simple, cheap and relatively safe, therefore quite popular [5, 6]. Other methods, are less commonly used because they require longer use, and sometimes, like ESWT, a special generator (the PiezoWave device) is necessary. However, since some patients have contraindications to steroid therapy or are afraid of injections, ESWT is a good alternative in these cases. The following paragraph presents an overview of the literature on the use of ESWT in tennis elbow.

## LITERATURE REVIEW

In 1 of the older studies, Rompe et al., reported results of the treatment of 78 patients with tennis elbow by ESWT. The patients were tennis players with recalcitrant disease of at least 12 months' duration and experienced at least 2 conservative treatment failure. They were randomly assigned to receive either ESWT weekly for 3 weeks or an identical placebo (sham ESWT). The results assessed at 1 and 3 months showed significant improvements in pain score, functional activity score, specific activity and overall assessments evaluations of disease state in the ESWT group compared to the placebo group. The authors conclude that ESWT is a good choice for patients with chronic tennis elbow when other treatments fail [6].

Lee et al. compared results of the treatment of 12 patients with tennis elbow by ESWT (application once a week for 3 weeks) with 10 patients receiving local steroid (triamcinolone) injection. The results were assessed at 2 months. Both

groups showed significant resolution of pain and improvement in Nirschl score. The authors conclude ESWT can be a useful treatment in patients for whom local steroid injection is contraindicated [4]. In patients with no contraindications steroid injection offers rapid symptomatic relief, requiring fewer treatment sessions and lower costs. Conversely, ESWT may necessitate multiple sessions and higher costs [5].

Guler and Yildirim compared results of the treatment of 40 patients, who were randomly allocated to receive a 3-week treatment of either kinesiotaping for 5 days a week or ESWT once a week. The assessments included pain score, grip strength and quickDASH score at baseline, after 1 and 2 months. Both kinesiotaping and ESWT significantly reduced pain, improved grip strength and function as assessed with quickDASH, however, these improvements were more prominent in the kinesiotaping group. The authors conclude, that considering the feasibility and the low cost of kinesiotaping compared with ESWT, they recommend that the former treatment should be considered for treating patients with newly diagnosed tennis elbow [7].

The authors found 3 meta-analyses and systematic reviews on effectiveness of ESWT for tennis elbow. Main findings from these studies are reported below.

Yao et al. reported results of meta-analysis comparing outcomes of the treatment of tennis elbow by ESWT versus other non-invasive methods. A total of 13 articles with 1035 patients were included, of which, 501 patients received ESWT and 534 underwent other methods. The results of meta-analysis show that pain relief and improvement of grip strength were statistically significantly better in patients who received ESWT. This evidence shows that ESWT can more effectively relieve the pain and improve function by strengthen the grip than several other methods [8].

Zhang et al. reported results of a meta-analysis of randomized, controlled trials focused on the effectiveness of ESWT for tennis elbow. Nine studies involving a total of 715 patients were analysed. Of these studies, 6 compared ESWT with placebo, 1 compared ESWT with ultrasound, 1 compared ESWT with laser and the 1 compared different doses of ESWT. Results of 4 studies mentioned statistically significant pain relief after ESWT, compared with placebo at 3 months assessment. Three studies showed statistically significant improvement of grip strength after ESWT at 3 months, comparing to placebo. Three studies reported some adverse events after ESWT, including nausea, skin bruising, red spots, sweating and burning sensation, which all were transient. The authors conclude that ESWT effectively reduces the mean overall pain and is a good treatment option for tennis elbow [9].

Zheng et al. presented results of a meta-analysis of randomized, controlled trials comparing ESWT with steroid injections for chronic tennis elbow. A total of 6 studies were identified and analysed. The results of meta-analysis show that both ESWT and steroid injections are effective and safe in treating chronic tennis elbow. Compared with steroid injection, ESWT showed inferior short-term (1-month) but superior long-term (3-month and 6-month) outcomes regarding pain relief and function recovery, with a similar rate of mild adverse events [10].

The findings from literature review show that ESWT is effective for tennis elbow, although not better than other methods. The results of present study are consistent with the data from the literature. The studies cited in this review did not provide information on the recurrence rate following ESWT. Considering the relatively short follow-up period, amounting to 3–6 months in most studies, it can be expected that recurrences may occur at a later date.

Presented study has some limitations, including small sample of patients and relatively short, 1-month follow-up. Therefore these results should be considered a preliminary report. The authors are aware that enlargement of the patient group and extension of the observation time is necessary to make the results more reliable.

## CONCLUSION

Tennis elbow treatment with ESWT is effective and free of adverse events.

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