

● *Original Contribution*

EFFECTS OF EXTRACORPOREAL SHOCK WAVE THERAPY ON FUNCTIONAL AND STRENGTH RECOVERY OF HANDGRIP IN PATIENTS AFFECTED BY EPICONDYLITIS

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Abstract—Extracorporeal shock wave therapy (ESWT) is effective in the treatment of tendinopathy. We designed a prospective observational clinical study to assess the correlation between clinical and functional measures and recovery of strength after ESWT for epicondylitis. We analyzed 26 patients. We measured progressive improvement in visual analogue scale values ($p < 0.0005$) and Mayo Elbow Performance Index scores ($p = 0.004$) for the pathologic limb. Monitoring of handgrip failed to reveal changes in values at any follow-up ($p > 0.05$). We found no correlation between degree of clinical function and muscle deficit during follow-up. After ESWT, there was a tendency toward a decrease in grip strength, especially in the dominant limb. This could be related to the effects of ESWT, which reduces spasticity in painful hypertonic muscles. These data may be useful in defining the expectations for function during ESWT for epicondylitis, particularly for elite athletes. (E-mail: angelanotarnicola@yahoo.it) © 2014 World Federation for Ultrasound in Medicine & Biology.

Key Words: Extracorporeal shock waves therapy, Epicondylitis, Grip strength, Hypertonic muscles.

INTRODUCTION

Lateral epicondylitis (also known as tennis elbow) is characterized by flogosis and degeneration of the tendon at the origin of the wrist extensor muscles on the lateral epicondyle of the humerus (Kraushaar and Nirschl 1999; Roetert et al. 1995). It is usually caused by repetitive wrist extension that leads to an overuse injury, followed by microtearing of the extensor carpi radialis brevis and, occasionally, the extensor digitorum communis and the extensor carpi radialis longus (Morris and Jobe 1989), which are all activated during gripping (van Elk et al. 2004). At the beginning, it is the activation of inflammation cascade after the angiofibroblastic degeneration that leads to tendinosis (Kraushaar and Nirschl 1999). It has been thought that the pain is due to the existence of free nerve endings in the aponeurosis and granulation tissue around the lateral epicondyle (Goldie 1964),

the presence of substance P receptors within the extensor origin and increased levels of the excitatory neurotransmitter glutamate (Alfredson et al. 2000; Ljung et al. 2004). The inflammation process on the muscle tendon unit of the extensor muscle in the wrist is responsible for a decrease in handgrip strength and daily and work disability (Borkholder 2004; Wuori et al. 1998).

Shock waves (SWs) are defined as transient pressure oscillations that propagate in three dimensions and typically bring about a clear increase in pressure within a few nanoseconds (Hundt 1974). There are very rapidly rising positive pressure impulses from 5 to 120 MPa in around 5 ns, followed by a decrease to a negative pressure of -20 MPa (Staudenraus 1995). When a SW bombards a tissue, we must consider the presence of two effects: the stress-related phenomenon induced by the ultrashort rise time of about 5 ns and the cavitation bubbles produced at the interface between the solid and the surrounding liquid. These two physical effects work synergistically to produce the SW action. Extracorporeal shock wave therapy (ESWT) stimulates soft tissue healing primarily by inhibiting afferent pain receptor function within the

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first hour (Maier *et al.* 2003), and then, in the next few days, by downregulating the expression of inflammatory cytokines (Moretti *et al.* 2008) and enhancing angiogenesis (Ma *et al.* 2007), and, around the 28th to 30th day, by improving cellular proliferation and synthesis of the extracellular matrix (Bosch *et al.* 2009). In the management of this tendinopathy, the effectiveness of ESWT has been assessed in previous randomized controlled clinical trials, yielding a success rate ranging from 43% to 75% (Haake *et al.* 2002a; Rompe *et al.* 1996a). In patients affected by epicondylitis and treated with SWs, researchers measured muscular strength at both recruitment and at follow-up (Krischek *et al.* 1999; Lebrun 2005; Melikyan *et al.* 2003; Pettrone and McCall 2005), with conflicting results. In some studies they discovered an increase in strength (Lebrun 2005; Pettrone and McCall 2005), although there were not many statistically significant differences compared with the placebo control group. In other studies they found no difference between the pretreatment results and those at follow-up after shock wave therapy (Melikyan *et al.* 2003). Other authors found a decrease in muscular strength at the checkup after ESWT (Krischek *et al.* 1999).

The present work was designed to study the effects of SWs on grip strength in the treatment of epicondylitis. We monitored the treated patients using two different functional scales, the Mayo Elbow Performance Index and the Disability of Arm, Shoulder and Hand (DASH) questionnaire. A dynamometric evaluation was able to analyze the time/strength signal of handgrip measuring the maximum force. At the same time, it compared the two limbs and their capacity to develop auxotonic contraction and maintain the isometric contraction.

METHODS

The study was conducted according to the Declaration of Helsinki, the guidelines for Good Clinical Practice, and the Consolidated Standards of Reporting Trials Statement guidelines (available at URL <http://www.consort-statement.org>). This study was approved by the local ethics committee. Prior informed consent to take part was given by all participants. This prospective observational clinical study was aimed at assessing the correlation between clinical and functional measures and recovery of strength after ESWT for epicondylitis.

For this study, lateral epicondylitis was defined as tenderness located 1 to 2 cm distal to the lateral epicondyle and pain with passive wrist flexion and active and resisted wrist extension (Borkholder 2004). The diagnosis was confirmed by response to at least two of the following functional tests: Cozen's test, Mill's maneuver, Thomson's test and the middle-finger extension test (Buckup 1995). All patients underwent radiography of the affected

elbow, which excluded fracture. Magnetic resonance imaging (MRI) scans and additional imaging studies were performed on a case-by-case basis at the discretion of the treating physician. A prior ultrasound study, performed on all patients, and, if necessary, MRI excluded the presence of concomitant thickening of the proximal course of the tendon and any partial lesions of the tendon.

Inclusion criteria

To be included in the study, patients had to be 18 to 70 y of age; had to have been diagnosed with epicondylitis at least 6 mo, on the basis of clinical symptoms and instrumental tests; have a visual analogue scale (VAS) score >4; have an indication to receive shock waves therapy for epicondylitis; be willing to participate in the study; and be able to comprehend the instructions given by the tester.

Exclusion criteria

The exclusion criteria were: contra-indications to ESWT (neoplasia or current or previous infections of the affected area, history of epilepsy, coagulopathies, cardiac pacemaker, pregnancy); bilateral symptoms; a total Mayo score <25 and for each of the three subscales (joint movement, stability, ability), scores <5; history of previous elbow tendon surgery or peritendinous injections (local anesthetic and/or corticosteroids) administered within the previous 4 wk; treatment with the same therapy within the last 2 mo; congenital or acquired deformities of the upper limb; and upper quadrant neuromusculoskeletal disorders that might affect grip strength.

We recruited patients who reported pain, quantified with the VAS scale. Excluding patients with a low Mayo score allowed us to exclude individuals with serious disabilities caused by trauma or congenital pathologies. The DASH questionnaire was administered after recruitment. The score on this scale did not constitute a criterion for inclusion or exclusion.

Recruitment

The patients were recruited from the ESWT Service, Orthopedic Unit, General Hospital, Bari (Italy), which is one of the reference centers for this therapy in Southern Italy. Between December 2010 and October 2011, 52 consecutive patients were evaluated in this unit with a diagnosis of epicondylitis; 29 fit the inclusion criteria, but one subject declined for personal reasons. Two patients dropped out at the subsequent follow-ups (FUs). At the last FU, 26 patients (ranging from 33 to 67 y) were analyzed as the experimental group (EG). All participants were right hand dominant. The right elbow was affected in 14 cases, and the left elbow in 12 cases.

The control group (CG) included 648 healthy patients, matched for gender and age with the EG, taking part in the more extensive group recruited by the

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