Original Article / *Orijinal Makale*
DOI: 10.5152/tftrd.2014.31643
Turk J Phys Med Rehab 2014;60:194-8
Türk Fiz Tıp Rehab Derg 2014;60:194-8

A Comparison of Laser and Extracorporeal Shock Wave Therapies in Treatment of Lateral Epicondylitis

Lateral Epikondilitte Lazer ve Ekstrakorporeal Şok Dalga Tedavisi Etkinliklerinin Karşılaştırılması

Gül DEVRİMSEL[1], Ayşegül KÜÇÜKALİ TÜRKYILMAZ[1], Murat YILDIRIM[2], Alper Murat ULAŞLI[3]
[1]*Department of Physical Medicine and Rehabilitation, Recep Tayyip Erdoğan University Faculty of Medicine, Rize, Turkey*
[2]*Clinic of Physical Medicine and Rehabilitation, Training and Research Hospital, Rize, Turkey*
[3]*Department of Physical Medicine and Rehabilitation, Afyon Kocatepe University Faculty of Medicine, Afyonkarahisar, Turkey*

Abstract

Objective: Lateral epicondylitis (LE) is a common painful problem of the elbow. This study was conducted to evaluate and compare the effectiveness of extracorporeal shock wave therapy (ESWT) and low-intensity laser therapy in LE treatment.
Material and Methods: The study included 60 LE patients. Subjects were divided into two groups randomly. Group 1 received ESWT, while group 2 received laser therapy. Presence of lateral epicondyle tenderness, elbow pain, and hand grip strength (HGS) were evaluated at the beginning and at 4 and 12 weeks. Elbow pain was evaluated with the Short-Form McGill pain questionnaire (SF-MPQ).
Results: The patients with tender lateral epicondyle were not significantly different between groups at each time point. Both groups had improvement on HGS evaluated at the 4^{th} and 12^{th} weeks, but in the ESWT group, the improvement was significantly higher. All SF-MPQ parameters improved significantly after each therapy evaluated at the 4^{th} and 12^{th} weeks. However, mean visual analog scale, present pain intensity, affective pain subscale, and total pain scale scores were significantly lower in the ESWT group at the 4^{th} and 12^{th} weeks.
Conclusion: Both ESWT and laser therapy are effective and safe treatment options for LE; however, ESWT seems to be more efficient in pain reduction and improvement of functions.
Key Words: Lateral epicondylitis, laser, ESWT, elbow

Özet

Amaç: Lateral epikondilit (LE), kolun yaygın ağrılı bir problemidir. Bu çalışmadaki amacımız, ekstrakorporeal şok dalga tedavisi (ESWT) ve düşük doz lazer tedavisinin etkinliğini araştırmak ve tedavi etkinliklerini karşılaştırmaktır.
Gereç ve Yöntemler: Çalışmaya alınan 60 hasta randomize olarak 30 kişilik iki gruba ayrıldı. Birinci gruba ESWT, diğerine lazer tedavisi uygulandı. Hastalar başlangıçta, 4 ve 12. haftalarda lateral epikondilde hassasiyet varlığı, dirsekte ağrı ve el kavrama gücü (EKG) parametreleri ile değerlendirildi. Dirsekteki ağrı Kısa form-McGill ağrı anketi (KF-MAA) ile değerlendirildi.
Bulgular: Tedavi sonrasındaki kontrollerde lateral epikondil hassasiyetinde, gruplar arasında anlamlı farklılık saptanmadı. Dördüncü ve 12. haftalarda yapılan değerlendirmelerde her iki grupta gelişmeler görüldü, fakat bu düzelme ESWT grubunda daha belirgindi. Kısa form-McGill ağrı anketinin tüm parametrelerinde 4 ve 12. haftalarda her iki tedavide anlamlı iyileşmeler elde edildi. Bununla birlikte KF-MAA'nın görsel ağrı skalası, total ağrı yoğunluğu, toplam ağrı oranı ve affektivite alt skala skorları 4 ve 12. haftalarda ESWT grubunda anlamlı oranda daha düşük idi.
Sonuç: Ekstrakorporeal şok dalga tedavisi ve lazer tedavileri, LE'de etkili ve güvenli yöntemlerdir. Ancak ağrının azalması ve fonksiyonel iyileşmede ESWT daha etkili görünmektedir.
Anahtar Kelimeler: Lateral epikondilit, lazer, ESWT, dirsek

Address for Correspondence / Yazışma Adresi: Gül Devrimsel, MD, Department of Physical Medicine and Rehabilitation, Recep Tayyip Erdoğan University School of Medicine, Rize, Turkey. Phone: +90 464 213 04 92 E-mail: g.devrimsel@hotmail.com
Received/Geliş Tarihi: May/Mayıs 2013 Accepted/Kabul Tarihi: November/Kasım 2013

Introduction

Lateral epicondylitis (LE) is a common painful problem of the elbow. The pain is derived from the origin of the wrist and finger extensors and is more pronounced during repetitive, forceful wrist extension or pronation and supination, during exercise or occupational use (1). LE is defined as pain on the lateral epicondyle generated by palpation of the lateral epicondyle, resistive wrist, and middle finger extension and hand grip (2). Angiofibroblastic hyperplasia and microtears mostly of extensor carpi radialis tendon origin were shown to have a role in the pathogenesis (3). Hand grip strength measurement and Thomson and Mill's tests are commonly used diagnostic procedures together with lateral epicondyle tenderness (4). The treatment of LE includes corticosteroid injections, splinting, physical therapy modalities, and surgery (5,6).

Extracorporeal shock wave therapy (ESWT) seems to be an efficient treatment modality in various conditions, including rotator cuff tendinopathies, lateral epicondylitis, and plantar fasciitis (3). ESWT serves as an alternative treatment modality in patients who reject surgical treatment (7).

Low-intensity laser therapy for the management of lateral epicondylitis has conflicting results (8,9); however, in the meta-analysis by Tumilty et al. (10), the authors determined that low-intensity laser therapy with an appropriate dose regimen may be an efficient treatment modality in treatment of tendinopathies. No study has compared the effectiveness of these novel treatment modalities so far. Therefore, this study was conducted to evaluate and compare the effectiveness of ESWT and low-intensity laser therapy in lateral epicondylitis treatment.

Material and Methods

The study included 60 patients diagnosed with LE, aged between 18-60 (mean 39.0±9.3) years. The Southampton diagnostic criteria were used for LE diagnosis (lateral epicondyle pain and tenderness and pain during resistive wrist dorsiflexion) (11). Patients with cervical radiculopathy, elbow deformity, history of diabetes mellitus, hypo- or hyperthyroidism, history of malignancy, chronic inflammatory diseases, and pregnancy were excluded. Patients who received corticosteroid injections to the lateral epicondyle within 6 weeks were also excluded. All patients filled an informed consent form. The local ethics committee of our university approved the present study, and written consent was obtained from all participants (09/03/2012, No: 2012/27). The demographic data of the patients were recorded, and patients were randomized into two groups consisting of 30 patients. Patients in group 1 received ESWT, while the second group of patients received low-intensity laser therapy. Presence of lateral epicondyle tenderness, elbow pain, and hand grip strength (HGS) measured with a dynamometer were evaluated before the treatment and the 4th and 12th weeks. Elbow pain was evaluated with the short-form McGill pain questionnaire (SF-MPQ) (12,13). The patients were also asked to score their elbow pain on a 10-cm visual analog scale (VAS) (14).

Lateral epicondyle tenderness was evaluated by palpation of the distal lateral epicondyle with thumb and noted as 'present' or 'absent' (15). HGS was measured according to recommendations of the American Society of Hand Therapists with a Jamar hand dynamometer. The mean of three measurements held with one moment interval was used (16,17).

Table 1. The demographic data of the patients in each group and the significance of the difference between groups.

	ESWT group	Laser group	p
Gender	22 F/8 M	20 F/10 M	0.576
Age	37.76±8.52	40.30±10.00	0.296
Weight	76.46±10.13	73.30±9.89	0.170
Length (cm)	166.50±8.89	164.77±9.41	0.313
BMI (kg/m^2)	27.46±1.80	26.88±1.31	0.158
Right/left elbow	24/6	22/8	0.54

Values are represented as mean±standard deviation.
BMI: body-mass index; ESWT: extracorporeal shock wave therapy

Treatment Protocol

For the shock wave therapy group, 2000 shock waves with 1.6 bar intensity and 16 Hz frequency were applied three times in 3 weeks with a 1-week interval by using a Masterpuls MP2004 radial shock wave therapy system (Storz Medical, Swiss) (18).

The second group of patients received 10 sessions of low-dose-regimen laser therapy with 3.6 joule intensity, 500 Hz frequency, and 850 nm wavelength, which was applied for 40 seconds in each session by using a Chattanooga (USA) (19).

All patients used 10-cm lateral epicondyle bandages in the treatment period, while none of them received analgesic or anti-inflammatory drugs and received exercise programs.

Statistical Analysis

Statistical Package for the Social Sciences 12.0 for Windows (SPSS, IL, USA) was used for the statistical analysis. The normality of the distribution for all variables was determined with the Kolmogorov-Smirnov test. Gender of the study groups was compared by using the chi-square test. Student t-test was used for normally distributed variables, and Mann-Whitney U test was used for nonparametric variables. Pre- and post-treatment variables within groups were compared with paired t-test and Wilcoxon test. Proportions of LE tenderness between groups were compared with McNemar test. The statistically significant point was set at <0.05.

Results

Sixty patients aged between 18-60 years with the diagnosis of lateral epicondylitis were recruited into this study. The demographic data are outlined in Table 1. No treatment-associated complication was observed in either group. Mean disease duration of the patients in group 1 (ESWT) was 14.16±7.06 months (range 5-31) and 13.43±7.46 months (range 4-33) in group 2 (laser) (p=0.697).

All patients had lateral epicondyle tenderness before treatment, and on the 4th week, 11 patients (36.6%) in the ESWT group and 15 patients (50%) in the laser therapy group had tenderness, while at the 12th week, only 2 patients (6.6%) in the

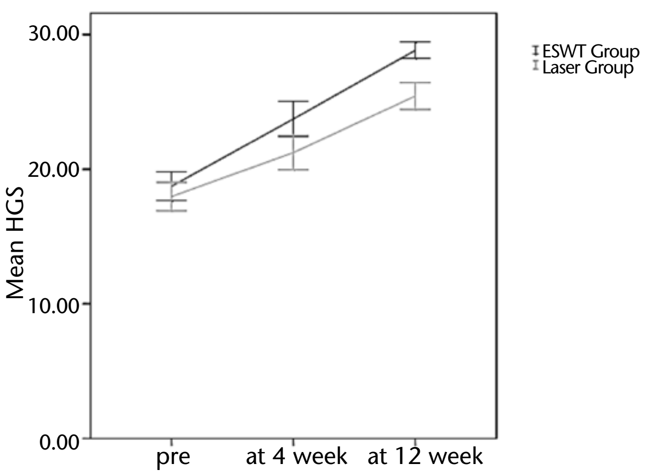

Figure 1. Line plot of the mean hand grip strength (HGS) scores in the pre-treatment phase, at 4-week follow-up, and at 12 weeks of review in both groups

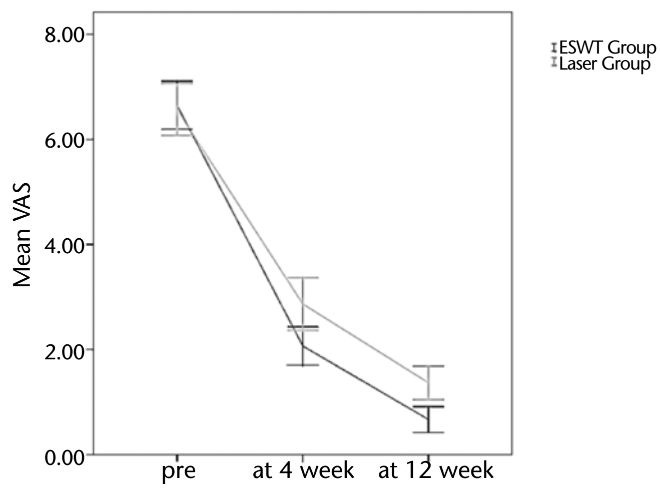

Figure 2. Line plot of the mean visual analog scale (VAS) scores in the pre-treatment phase, at 4-week follow-up, and at 12 weeks of review in both groups

first group and 4 patients (13.3%) in the second group still had tenderness. The ratio of the patients with a tender lateral epicondyle was not significantly different between groups at each time (p=0.35, p=0.43, respectively).

There was no significant difference between two groups in terms of initial mean HGS values (p=0.303). Both groups had improvement on HGS evaluated at the 4th and 12th weeks, but the mean HGS value in the ESWT group was significantly higher than the laser therapy group (p=0.007, p<0.001, respectively) (Figure 1).

Short-form McGill pain questionnaire (SF-MPQ) subscales scores were calculated and compared between two groups at each time point (Table 2). All SF-MPQ parameters improved significantly after each therapy evaluated at the 4th and 12th weeks (p<0.001). Although mean VAS, present pain intensity (PPI), affective pain subscale (SF-MPQ APS), and total pain scale scores (SF-MPQ TPS) were not differing between groups initially, at the 4th and 12th weeks, these scores were significantly lower in the ESWT group (Figure 2). Mean sensory pain subscale (SF-MPQ SPS) scores were similar in two groups initially and at the 4th week after the therapy, but it was lower in the ESWT group at the 12th week. Additionally, the differences in study parameters measured initially and 12 weeks after treatment were calculated and compared between groups. The improvements in HGS, VAS, SF-MPQ APS, and SF-MPQ PPI were significantly higher in the ESWT group (p<0.001, p=0.004, p=0.029, and p=0.047, respectively), while the differences of improvements in SF-MPQ SPS and SF-MPQ TPS did not reach a significant value (p=0.131 and p=0.074).

In both groups, significant improvements in HGS, VAS, and all subscales of the SF-MPQ evaluated at the 4th and 12th weeks, compared to the initial measurements (p<0.001 for all) were observed. The improvements regarding HGS, VAS, and all subscales of the SF-MPQ after the 12th week were also significant compared to the 4th week (p<0.001 for all).

Discussion

Elimination of pain and improvement in physical function with a reduction of inflammation are the main goals of LE treatment. There was overall improvement in both the ESWT and low-intensity laser treatment groups evaluated at 4 and 12 weeks after completion of the treatment, while patients in the ESWT group had less pain and higher HGS.

Lateral epicondylitis has a 1%-3% prevalence in the general population, while this percentage increases in subjects aged between 30-60 (2). The dominant hand is more frequently affected generally, which is explained by the role of physical stress in the pathogenesis of LE (2,19). In the current study, LE was more frequent in the dominant side of the patients.

Although there are a few reviews and meta-analyses regarding conservative treatment of LE, there is still inadequate evidence regarding the management of LE (20).

Extracorporeal shock wave therapy was shown to initiate angiogenesis and increase blood flow through the tendon-bone area by improvement in angiogenic growth factors on the Achilles tendons of rabbits; accordingly, inflamed tissues were regenerated and pain was alleviated (21,22). Recent studies demonstrated that ESWT was an effective treatment option in calcific tendinitis of the rotator cuff and chronic plantar fasciitis (23). In the study by Chen et al. (24), ESWT was shown to be an effective treatment modality in Achilles tendinitis. ESWT was also demonstrated to be an effective and reliable option in chronic LE (25,26).

In their placebo-controlled study conducted in patients with LE, Rompe et al. (27) reported improved upper extremity function evaluated 3 months after the therapy in the ESWT group, similar to results of this study. Furia et al. (28) assessed pain and physical function after ESWT treatment and reported improved

Table 2. Hand grip strength and short-form Mc-Gill pain questionnaire subscale scores measured at certain time points and the significance level of the differences between groups at these time points

		ESWT	LASER	p
HGS	Before treatment	18.73±2.87	17.96±2.83	0.303
	4th week	23.73±3.52	21.23±3.44	0.007
	12th week	28.83±1.64	25.43±2.67	<0.001
VAS	Before treatment	6.65±1.22	6.56±1.30	0.800
	4th week	2.06±0.9	2.86±1.35	0.012
	12th week	0.66±0.66	1.36±0.85	<0.001
SF-MPQ PPI	Before treatment	2.93±1.04	2.86±0.86	0.905
	4th week	1.40±0.81	1.90±0.84	0.020
	12th week	0.60±0.56	1.00±0.58	0.011
SF-MPQ SPS	Before treatment	13.76±6.33	14.13±4.72	0.800
	4th week	7.60±4.41	9.50±4.55	0.106
	12th week	4.23±2.20	6.16±2.42	0.002
SF-MPQ APS	Before treatment	4.36±2.41	3.93±2.06	0.398
	4th week	1.46±0.73	2.30±0.79	<0.001
	12th week	0.90±0.75	1.53±0.93	0.008
SF-MPQ TPS	Before treatment	18.13±8.58	18.06±6.69	0.973
	4th week	9.13±4.86	11.83±5.02	0.039
	12th week	5.13±2.58	7.70±3.10	<0.001

ESWT: extracorporeal shock wave therapy; HGS: hand grip strength; VAS: visual analog scale; SF-MPQ PPI: short-form McGill pain questionnaire present pain intensity subscale; SF-MPQ SPS: short-form McGill pain questionnaire sensory pain subscale; SF-MPQ APS: short-form McGill pain questionnaire affective pain subscale; SF-MPQ TPS: short-form McGill pain questionnaire total pain score. All values are represented as mean±standard deviation

function and decreased pain 12 weeks after ESWT without any treatment-associated complication.

Although ESWT was found to be an effective and reliable treatment option in LE, there is still uncertainty in the treatment intensity, number of sessions needed, length of treatment, and treatment periods (the time interval between two sessions). Likewise, in clinical trials, optimal treatment intensity was not established (2). This can explain the ineffective results in certain studies (29,30). In the study by Rompe et al. (31) in tennis elbow, patients were divided into two groups. The first group had 30 shock waves per session, while the second group had 3000 shock waves per session. They reported that functional recovery and pain reduction was better in the second group evaluated at the 3rd and 12th weeks.

Laser therapy stimulates cell metabolism, increases blood supply via capillary and arteriolar vasodilatation, and increases pain threshold in algotrophic nerve fibers and results in analgesic effects (32). As a result, it is an effective treatment in tissue regeneration and pain management (33). Previous studies reported that laser therapy was more effective in decreasing pain and increasing HGS compared to placebo in patients with LE (33,34). On the other hand, Konstantinovic et al. (35) compared laser therapy with corticosteroid injections in patients with LE. They reported that two treatment regimens had similar analgesic effects, while with the combination treatment, they obtained superior improvements. In a recent meta-analysis, laser therapy for LE has been demonstrated to have statistically significant effects in pain relief, increasing grasp force and increasing ROM of wrist joints (36). In their placebo-controlled study, Emanet et al. (37) reported significant improvements in patients treated with laser therapy. In accordance with previous studies, the current study revealed that laser therapy decreases lateral epicondyle pain and tenderness and increases HGS.

Conclusion

Both ESWT and laser therapy are effective and safe treatment options for LE; however, ESWT is more efficient in reducing pain and improving function. To obtain more definite conclusions and establish appropriate treatment regimens, future RCTs examining different intensities with larger samples and long-term follow-up periods as well are needed.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of Recep Tayyip Erdogan of University (09/03/2012, Decision No: 2012/27).

Informed Consent: Written informed consent was obtained from patients who participated in this study.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept - G.D.; Design - G.D., A.K.T., M.Y.; Supervision - G.D.; Materials - G.D., A.K.T., M.Y.; Data Collection and/or Processing - G.D., A.K.T., M.Y.; Analysis and/or Interpretation - G.D., A.M.U.; Literature Review - G.D., A.M.U.; Writer - G.D.; Critical Review - G.D., A.K.T.

Conflict of Interest: Authors reported no conflicts of interest.

Financial Disclosure: The authors declared that this study has received no financial support.

Etik Komite Onayı: Bu çalışma için etik komite onayı Recep Tayyip Erdoğan Üniversitesi’nden alınmıştır (09/03/2012, Karar No: 2012/27).

Hasta Onamı: Yazılı hasta onamı bu çalışmaya katılan hastalardan alınmıştır.

Hakem değerlendirmesi: Dış bağımsız.

Yazar Katkıları: Fikir - G.D.; Tasarım - G.D.; Denetleme - G.D.; Kaynaklar - G.D.; Malzemeler - G.D., A.K.T., M.Y.; Veri toplanması ve/veya işlemesi - G.D., A.K.T., M.Y.; Analiz ve/veya yorum - G.D., A.M.U.; Literatür taraması - G.D., A.M.U.; Yazıyı yazan - G.D.; Eleştirel İnceleme - G.D., A.K.T.

Çıkar Çatışması: Yazarlar çıkar çatışması bildirmemişlerdir.

Finansal Destek: Yazarlar bu çalışma için finansal destek almadıklarını beyan etmişlerdir.

References

1. Cantürk F. Soft tissue rheumatism. İn: Beyazova M, Gökçe Kutsal Y, editors. Physical Medicine and Rehabilitation. İstanbul: Güneş Tıp Kitabevleri; 2011.p.2352-3.
2. Stasinopoulos D, Johnson MI. Effectiveness of extracorporeal shock wave therapy for tennis elbow (lateral epicondylitis). Br J Sports Med 2005;39:132-6. [CrossRef]
3. Sems A, Dimeff R, Iannotti JP. Extracorporeal shock wave therapy in the treatment of chronic tendinopathies. J Am Acad Orthop Surg 2006;14:195-204.
4. Gellman H. Tennis elbow (lateral epicondylitis).Orthop Clin North Am 1992;23:75-82.
5. Dingemanse R, Randsdorp M, Koes BW, Huisstede BM. Evidence for the effectiveness of electrophysical modalities for treatment of medial and lateral epicondylitis: a systematic review. Br J Sports Med 2014;48:957-65. [CrossRef]
6. Mandiroğlu S, Bal A, Gurçay E, Cakcı A. Comparison of the effects of non-steroidal anti-inflammatory drugs, steroid injection and physical therapy in lateral epicondylitis. Turk J Phys Med Rehab 2007;53:104-7.
7. Ozkut AT, Kilinçoğlu V, Ozkan NK, Eren A, Ertaş M. Extracorporeal shock wave therapy in patients with lateral epicondylitis. Acta Orthop Traumatol Turc 2007;41:207-10.
8. Stergioulas A. Effects of low-level laser and plyometric exercises in the treatment of lateral epicondylitis. Photomed Laser Surg 2007;25:205-13. [CrossRef]
9. Basford JR, Sheffield CG, Cieslak KR. Laser therapy: a randomized, controlled trial of the effects of lowintensity Nd: YAGlaser irradiation on lateral epicondylitis. Arch Phys Med Rehabil 2000;81:1504-10. [CrossRef]
10. Tumilty S, Munn J, McDonough S, Hurley DA, Basford JR, Baxter GD. Low level laser treatment of tendinopathy: a systematic review with meta-analysis. Photomed Laser Surg 2010;28:3-16. [CrossRef]
11. Walker-Bone K, Palmer KT, Reading I, Coggon G, Cooper C. Prevalence and impact of musculoskeletal disorders of the upper limb in the general population. Arthritis Rheum 2004;51:642-51. [CrossRef]
12. Melzack R. The short form mcgill pain questionnaire. Pain 1987;30:191-7. [CrossRef]
13. Yakut Y, Yakut E, Bayar K, Uygur F. Reliability and validity of the Turkish version short-form McGill pain questionnaire in patients with rheumatoid arthritis. Clin Rheumatol 2007;26:1083-7. [CrossRef]
14. Wewers ME, Lowe NK. A critical review of visual analogue scales in the measurement of clinical phenomena. Res Nurs Health 1990;13:227-36. [CrossRef]
15. Tuzun F. Local enjections. In: Beyazova M, Gokce Kutsal Y, editors. Physical Medicine and Rehabilitation. Ankara: Sun Medical Bookstore; 2000.p.738-47.
16. Haidar SG, Kumar D, Bassi RS, Deshmukh SC. Average versus maximum grip strength: which is more consistent? J Hand Surg Br 2004;29:82-4. [CrossRef]
17. Halpern CA, Fernandez JE. The effect of wrist and arm postures on peak pinch strength. J Hum Ergol 1996;25:115-30.
18. Rompe JD, Maffulli N. Repetitive shock wave therapy for lateral elbow tendinopathy (tennis elbow): a systematic and qualitative analysis. Br Med Bull 2007;83:355-78. [CrossRef]
19. Bjordal JM, Lopes-Martins RA, Joensen J, Couppe C, Ljunggren AE, Stergioulas A, et al. A systematic review with procedural assessments and meta-analysis of low level laser therapy in lateral elbow tendinopathy (tennis elbow). BMC Musculoskeletal Disord 2008;9:75. [CrossRef]
20. Smidt N, Assendelft WJ, Arola H, Malmivaara A, Greens S, Buchbinder R, et al. Effectiveness of physiotherapy for lateral epicondylitis: a systematic review. Ann Med 2003;35:51-62. [CrossRef]
21. Wang CJ, Wang FS, Yang KD, Weng LH, Hsu CC, Huang CS, et al. Shock wave therapy induces neovascularization at the tendon-bone junction. A study in rabbits. J Orthop Res 2003;21:984-9. [CrossRef]
22. Wang CJ. Extracorporeal shockwave therapy in musculoskeletal disorders. J Orthop Surg Res 2012;7:11. [CrossRef]
23. Speed CA. Extracorporeal shock-wave therapy in the management of chronic soft-tissue conditions. J Bone Joint Surg Br 2004;86:165-71. [CrossRef]
24. Chen YJ, Wang CJ, Yang KD, Kuo YR, Huang HC, Huang YT, et al. Extracorporeal shock waves promote healing of collagenase-induced Achilles tendinitis and increase TGF-beta1 and IGF-I expression. J Orthop Res 2004;22:854-61. [CrossRef]
25. Ko JY, Chen HS, Chen LM. Treatment of lateral epicondylitis of the elbow with shock waves. Clin Orthop Relat Res 2001;387:60-7. [CrossRef]
26. Pettrone FA, McCall BR. Extracorporeal shock wave therapy without local anesthesia for chronic lateral epicondylitis. J Bone Joint Surg Am 2005;87:1297-304. [CrossRef]
27. Rompe JD, Decking J, Schoellner C, Theis C. Repetitive low-energy shock wave treatment for chronic lateral epicondylitis in tennis players. Am J Sports Med 2004;32:734-43. [CrossRef]
28. Furia JP. Safety and efficacy of extracorporeal shock wave therapy for chronic lateral epicondylitis. Am J Orthop (Belle Mead NJ) 2005;34:13-9.
29. Haake M, König IR, Decker T, Riedel C, Buch M, Müller HH, et al. Extracorporeal shock wave therapy in the treatment of lateral epicondylitis: a randomized multicenter trial. J Bone Joint Surg Am 2002;84:1982-91.
30. Speed CA, Nichols D, Richards C, Humphreys H, Wies JT, Burnet S, et al. Extracorporeal shock wave therapy for lateral epicondylitis--a double blind randomised controlled trial. J Orthop Res 2002;20:895-8. [CrossRef]
31. Rompe JD, Hopf C, Küllmer K, Heine J, Bürger R, Nafe B. Low-energy extracorporal shock wave therapy for persistent tennis elbow. Int Orthop 1996;20:23-7. [CrossRef]
32. Hasford JR. Low energy Laser treatment of pain and wounds hype, hope, or hokum? Mayo Clin Proc 1986;61:671-8. [CrossRef]
33. Lam LK, Cheing GL. Effects of 904-nm low-level laser therapy in the management of lateral epicondylitis: a randomized controlled trial. Photomed Laser Surg 2007;25:65-71. [CrossRef]
34. Vasseljen OJ, Høeg N, Kjeldstad B, Johnsson A, Larsen S. Low level laser versus placebo in the treatment of tennis elbow. Scand J Rehabil Med 1992;24:37-42.
35. Konstantinovic L, Antonic M, Brdareski Z. The combination of low power laser therapy and local corticosteroid infiltration in the treatment of radiohumeral epicondylitis. Vojnosanit Pregl 1997;54:459-63.
36. Chang WD, Wu JH, Yang WJ, Jiang JA. therapeutic effects of low-level laser on lateral epicondylitis from differential ınterventions of chinese-western medicine: systematic review. Photomed Laser Surg 2010;28:327-36. [CrossRef]
37. Emanet SK, Altan LI, Yurtkuran M. Investigation of the effect of GaAs laser therapy on lateral epicondylitis. Photomed Laser Surg 2010;28:397-403. [CrossRef]