Medical Coverage Policy | Extracorporeal Shock Wave Treatment for Plantar Fasciitis and Other Musculoskeletal Conditions

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OVERVIEW

Extracorporeal shock wave therapy (ESWT) is a noninvasive method that may be used to treat pain using shock waves or sound waves that are directed from outside the body onto the area to be treated (e.g., the heel in the case of plantar fasciitis). Shock waves may be generated at high- or low-energy intensity, and treatment protocols may include more than one treatment. ESWT has been investigated for use in a variety of musculoskeletal conditions.

MEDICAL CRITERIA

Not applicable

PRIOR AUTHORIZATION

Not applicable

POLICY STATEMENT

Medicare Advantage Plans

Extracorporeal shock wave therapy, using either a high- or low-dose protocol or radial ESWT, is not covered as a treatment of musculoskeletal conditions, including but not limited to plantar fasciitis; tendinopathies including tendinitis of the shoulder, tendinitis of the elbow (lateral epicondylitis), Achilles tendinitis, and patellar tendinitis; spasticity; stress fractures; delayed union and nonunion of fractures; and avascular necrosis of the femoral head, as the evidence is insufficient to determine that the technology results in an improvement in the net health outcome.

Commercial Products

Extracorporeal shock wave therapy, using either a high- or low-dose protocol or radial ESWT, is considered not medically necessary as a treatment of musculoskeletal conditions, including but not limited to plantar fasciitis; tendinopathies including tendinitis of the shoulder, tendinitis of the elbow (lateral epicondylitis), Achilles tendinitis, and patellar tendinitis; spasticity; stress fractures; delayed union and nonunion of fractures; and avascular necrosis of the femoral head, as the evidence is insufficient to determine that the technology results in an improvement in the net health outcome.

COVERAGE

Benefits may vary between groups and contracts. Please refer to the appropriate Benefit Booklet, Evidence of Coverage, or Subscriber Agreement for applicable not medically necessary/not covered benefits/coverage.

BACKGROUND

Chronic musculoskeletal conditions

Chronic musculoskeletal conditions (eg, tendinitis) can be associated with a substantial degree of scarring and calcium deposition. Calcium deposits may restrict motion and encroach on other structures, such as nerves and blood vessels, causing pain and decreased function. One hypothesis is that disruption of calcific deposits by shock waves may loosen adjacent structures and promote resorption of calcium, thereby decreasing pain and improving function.

Plantar Fasciitis
Plantar fasciitis is a very common ailment characterized by deep pain in the plantar aspect of the heel, particularly on arising from bed. While the pain may subside with activity, in some patients the pain may persist, interrupting activities of daily living. On physical examination, firm pressure will elicit a tender spot over the medial tubercle of the calcaneus. The exact etiology of plantar fasciitis is unclear, although repetitive injury is suspected. Heel spurs are a common associated finding, although it has never been proven that heel spurs cause the pain and asymptomatic heel spurs can be found in up to 10% of the population.

Tendinitis and Tendinopathies
Common tendinitis and tendinopathy syndromes are:

- Lateral epicondylitis ("tennis elbow")
- Shoulder tendinopathy
- Achilles tendinopathy
- Patellar tendinopathy ("jumper's knee")

Fracture Nonunion and Delayed Union
The following criteria are used to define fracture nonunion:

- At least 3 months have passed since the date of fracture;
- Serial radiographs have confirmed that no progressive signs of healing have occurred;
- The fracture gap is 1 cm or less; and
- The patient can be adequately immobilized and is of an age likely to comply with non-weight bearing.

Delayed union can be defined as a decelerating healing process, as determined by serial radiographs, together with a lack of clinical and radiologic evidence of union, bony continuity, or bone reaction at the fracture site for no less than 3 months from the index injury or the most recent intervention. (In contrast, nonunion serial radiographs show no evidence of healing.)

Other Musculoskeletal and Neurologic Conditions
Other musculoskeletal conditions include medial tibial stress syndrome, osteonecrosis (avascular necrosis) of the femoral head, coccydynia, and painful stump neuromas. Neurologic conditions include spasticity, which refers to a motor disorder characterized by increased velocity-dependent stretch reflexes. It is one characteristic of upper motor neuron dysfunction, which may be due to a variety of pathologies.

Treatment
Most cases of plantar fasciitis are treated with conservative therapy, including rest or minimization of running and jumping, heel cups, and nonsteroidal-anti-inflammatory drugs. Local steroid injection may also be used. Improvement may take up to 1 year in some cases. For tendinitis and tendinopathy syndromes, conservative treatment often involves rest, activity modifications, physical therapy, and anti-inflammatory medications.

Extracorporeal Shock Wave Therapy
Also known as orthotripsy, extracorporeal shock wave therapy (ESWT) has been available since the early 1980s for the treatment of renal stones and has been widely investigated for the treatment of biliary stones. ESWT uses externally-applied shock waves to create a transient pressure disturbance, which disrupts solid structures, breaking them into smaller fragments, thus allowing spontaneous passage and/or removal of stones. The mechanism by which ESWT might have an effect on musculoskeletal conditions is not well-defined.

Other mechanisms are also thought to be involved in ESWT. Physical stimuli are known to activate endogenous pain control systems, and activation by shock waves may "reset" the endogenous pain receptors. Damage to endothelial tissue from ESWT may result in increased vessel wall permeability, causing increased

diffusion of cytokines, which may in turn promote healing. Microtrauma induced by ESWT may promote angiogenesis and thus aid in healing. Finally, shock waves have been shown to stimulate osteogenesis and promote callous formation in animals, which is the rationale for trials of ESWT in delayed union or nonunion of bone fractures.

There are 2 types of ESWT: focused and radial. Focused ESWT sends medium- to high-energy shockwaves of single pressure pulses lasting microseconds, directed on a specific target using ultrasound or radiographic guidance. Radial ESWT (RSW) transmits low- to medium-energy shockwaves radially over a larger surface area. The U.S. (United States) Food and Drug Administration (FDA) approval was first granted in 2002 for focused ESWT devices and in 2007 for RSW devices.

Currently, 6 focused ESWT devices have been approved by FDA through the premarket approval process for orthopedic use:

- OssaTron® device (HealthTronics) - Approval date: 2000. Delivery system: Electrohydraulic. Indications: chronic proximal plantar fasciitis, i.e., pain persisting >6 months and not responding to conservative management; lateral epicondylitis
- Epos™ Ultra (Dornier) - Approval date: 2002. Delivery system: Electromagnetic. Indications: plantar fasciitis.
- Sonocur® Basic (Siemens) - Approval date: 2002. Delivery system: Electromagnetic. Indications: chronic lateral epicondylitis (unresponsive to conservative therapy for >6 months)
- Orthospec™ Orthopedic ESWT (Medispec) - Approval date: 2005. Delivery system: Electrohydraulic spark-gap. Indications: Chronic proximal plantar fasciitis in patients ≥18 years of age.
- Orbasone™ Pain Relief System (Orthometrix) - Approval date: 2005. Delivery system: High-energy sonic wave. Indications: Chronic proximal plantar fasciitis in patients ≥18 years of age.
- Duolith® SD1 Shock Wave Therapy Device (Storz Medical AG) - Approval date: 2016. Delivery system: Electromagnetic. Indications: Chronic proximal plantar fasciitis in patients ≥18 years of age with history of failed alternative conservative therapies >6 mo

Both high-dose and low-dose protocols have been investigated. A high-dose protocol consists of a single treatment of high-energy shock waves (1300mJ/mm-2). This painful procedure requires anesthesia. A low-dose protocol consists of multiple treatments, spaced one week to one month apart, in which a lower dose of shock waves is applied. This protocol does not require anesthesia. The FDA-labeled indication for the OssaTron and Epos Ultra devices specifically describes a high-dose protocol, while the labeled indication for the Sonocur device describes a low-dose protocol.

In 2007, Dolorclast® (EMS Electro Medical Systems), a radial ESWT, was approved by FDA through the premarket approval process. Radial ESWT is generated ballistically by accelerating a bullet to hit an applicator, which transforms the kinetic energy into radially expanding shock waves. Radial ESWT is described as an alternative to focused ESWT and is said to address larger treatment areas, thus providing potential advantages in superficial applications like tendinopathies. The FDA-approved indication is for the treatment of patients 18 years and older with chronic proximal plantar fasciitis and a history of unsuccessful conservative therapy.

The evidence is insufficient to determine that the technology results in an improvement in the net health outcome for individuals who have the following:

- plantar fasciitis
- lateral epicondylitis
- shoulder tendinopathy
- Achilles tendinopathy
- patellar tendinopathy

- medial tibial stress syndrome
- osteonecrosis of the femoral head
- nonunion or delayed union
- spasticity

CODING

The following CPT codes are not covered for Medicare Advantage Plans and not medically necessary for Commercial Products:

28890 Extracorporeal shock wave, high energy, performed by a physician, requiring anesthesia other than local, including ultrasound guidance, involving the plantar fascia.

0101T Extracorporeal shock wave therapy; involving musculoskeletal system, not otherwise specified (Revised text 1/01/2022)

0102T Extracorporeal shock wave therapy; performed by a physician, requiring anesthesia other than local, involving lateral humeral epicondyle (Revised text 1/01/2022)

There is no specific CPT code for low-energy or radial ESWT. The unlisted CPT code for general musculoskeletal procedure (20999) should be used.

RELATED POLICIES

Medicare Advantage Plans National and Local Coverage Determinations

PUBLISHED

Provider Update, October 2022
Provider Update, January 2022
Provider Update, February 2021
Provider Update, January 2020
Provider Update, January 2019

REFERENCES

1. Dizon JN, Gonzalez-Suarez C, Zamora MT, et al. Effectiveness of extracorporeal shock wave therapy in chronic plantar fasciitis: a meta-analysis. Am J Phys Med Rehabil. Jul 2013; 92(7): 606-20. PMID 23552334
2. Aqil A, Siddiqui MR, Solan M, et al. Extracorporeal shock wave therapy is effective in treating chronic plantar fasciitis: a meta-analysis of RCTs. Clin Orthop Relat Res. Nov 2013; 471(11): 3645-52. PMID 23813184
3. Zhiyun L, Tao J, Zengwu S. Meta-analysis of high-energy extracorporeal shock wave therapy in recalcitrant plantar fasciitis. Swiss Med Wkly. 2013; 143: w13825. PMID 23832373
4. Yin MC, Ye J, Yao M, et al. Is extracorporeal shock wave therapy clinical efficacy for relief of chronic, recalcitrant plantar fasciitis? A systematic review and meta-analysis of randomized placebo or active-treatment controlled trials. Arch Phys Med Rehabil. Aug 2014; 95(8): 1585-93. PMID 24662810
5. Lou J, Wang S, Liu S, et al. Effectiveness of Extracorporeal Shock Wave Therapy Without Local Anesthesia in Patients With Recalcitrant Plantar Fasciitis: A Meta-Analysis of Randomized Controlled Trials. Am J Phys Med Rehabil. Aug 2017; 96(8): 529-534. PMID 27977431
6. Sun J, Gao F, Wang Y, et al. Extracorporeal shock wave therapy is effective in treating chronic plantar fasciitis: Ameta-analysis of RCTs. Medicine (Baltimore). Apr 2017; 96(15): e6621. PMID 28403111
7. Li S, Wang K, Sun H, et al. Clinical effects of extracorporeal shock-wave therapy and ultrasound-guided local corticosteroid injections for plantar fasciitis in adults: A meta-analysis of randomized controlled trials. Medicine (Baltimore). Dec 2018; 97(50): e13687. PMID 30558080
8. Xiong Y, Wu Q, Mi B, et al. Comparison of efficacy of shock-wave therapy versus corticosteroids in plantar fasciitis: a meta-analysis of randomized controlled trials. Arch Orthop Trauma Surg. Apr 2019; 139(4): 529-536. PMID30426211

9. Gollwitzer H, Saxena A, DiDomenico LA, et al. Clinically relevant effectiveness of focused extracorporeal shockwave therapy in the treatment of chronic plantar fasciitis: a randomized, controlled multicenter study. J Bone Joint Surg Am. May 06 2015; 97(9): 701-8. PMID 25948515
10. Gerdesmeyer L, Frey C, Vester J, et al. Radial extracorporeal shock wave therapy is safe and effective in the treatment of chronic recalcitrant plantar fasciitis: results of a confirmatory randomized placebo-controlled multicenter study. Am J Sports Med. Nov 2008; 36(11): 2100-9. PMID 18832341
11. Food and Drug Administration. Summary of safety and effectiveness data: Orthospec TM Orthopedic ESWT. 2005; https://www.accessdata.fda.gov/cdrh_docs/pdf4/P040026b.pdf. Accessed May 3, 2022.
12. Food and Drug Administration. Summary of safety and effectiveness: Orbasone Pain Relief System. 2005; https://www.accessdata.fda.gov/cdrh_docs/pdf4/P040039b.pdf. Accessed May 2, 2022.
13. Radwan YA, Mansour AM, Badawy WS. Resistant plantar fasciopathy: shock wave versus endoscopic plantar fascial release. Int Orthop. Oct 2012; 36(10): 2147-56. PMID 22782376
14. Eslamian F, Shakouri SK, Jahanjoo F, et al. Extra Corporeal Shock Wave Therapy Versus Local Corticosteroid Injection in the Treatment of Chronic Plantar Fasciitis, a Single Blinded Randomized Clinical Trial. Pain Med. Sep2016; 17(9): 1722-31. PMID 27282594
15. Lai TW, Ma HL, Lee MS, et al. Ultrasonography and clinical outcome comparison of extracorporeal shock wave therapy and corticosteroid injections for chronic plantar fasciitis: A randomized controlled trial. J Musculoskelet Neuronal Interact. Mar 01 2018; 18(1): 47-54. PMID 29504578
16. Xu D, Jiang W, Huang D, et al. Comparison Between Extracorporeal Shock Wave Therapy and Local Corticosteroid Injection for Plantar Fasciitis. Foot Ankle Int. Feb 2020; 41(2): 200-205. PMID 31744313
17. Cinar E, Saxena S, Uygur F. Combination Therapy Versus Exercise and Orthotic Support in the Management of Pain in Plantar Fasciitis: A Randomized Controlled Trial. Foot Ankle Int. Apr 2018; 39(4): 406-414. PMID 29327602
18. Bahar-Ozdemir Y, Atan T. Effects of adjuvant low-dye Kinesio taping, adjuvant sham taping, or extracorporeal shockwave therapy alone in plantar fasciitis: A randomised double-blind controlled trial. Int J Clin Pract. May 2021;75(5): e13993. PMID 33410228
19. Buchbinder R, Green SE, Youd JM, et al. Shock wave therapy for lateral elbow pain. Cochrane Database Syst Rev.Oct 19 2005; (4): CD003524. PMID 16235324
20. Dingemanse R, Randsdorp M, Koes BW, et al. Evidence for the effectiveness of electrophysical modalities for treatment of medial and lateral epicondylitis: a systematic review. Br J Sports Med. Jun 2014; 48(12): 957-65.PMID 23335238
21. Zheng C, Zeng D, Chen J, et al. Effectiveness of extracorporeal shock wave therapy in patients with tennis elbow:A meta-analysis of randomized controlled trials. Medicine (Baltimore). Jul 24 2020; 99(30): e21189. PMID32791694
22. Yoon SY, Kim YW, Shin IS, et al. Does the Type of Extracorporeal Shock Therapy Influence Treatment Effectiveness in Lateral Epicondylitis? A Systematic Review and Meta-analysis. Clin Orthop Relat Res. Oct 2020; 478(10): 2324-2339. PMID 32332245
23. Karanasios S, Tsamasiotis GK, Michopoulos K, et al. Clinical effectiveness of shockwave therapy in lateral elbow tendinopathy: systematic review and meta-analysis. Clin Rehabil. Oct 2021; 35(10): 1383-1398. PMID 33813913
24. Yao G, Chen J, Duan Y, et al. Efficacy of Extracorporeal Shock Wave Therapy for Lateral Epicondylitis: A Systematic Review and Meta-Analysis. Biomed Res Int. 2020; 2020: 2064781. PMID 32309425
25. Yan C, Xiong Y, Chen L, et al. A comparative study of the efficacy of ultrasonics and extracorporeal shock wave in the treatment of tennis elbow: a meta-analysis of randomized controlled trials. J Orthop Surg Res. Aug 06 2019;14(1): 248. PMID 31387611
26. Xiong Y, Xue H, Zhou W, et al. Shock-wave therapy versus corticosteroid injection on lateral epicondylitis: a meta-analysis of randomized controlled trials. Phys Sportsmed. Sep 2019; 47(3): 284-289. PMID 30951399
27. Aldajah S, Alashram AR, Annino G, et al. Analgesic Effect of Extracorporeal Shock-Wave Therapy in Individuals with Lateral Epicondylitis: A Randomized Controlled Trial. J Funct Morphol Kinesiol. Mar 18 2022; 7(1). PMID35323612

28. Guler T, Yildirim P. Comparison of the efficacy of kinesiotaping and extracorporeal shock wave therapy in patients with newly diagnosed lateral epicondylitis: A prospective randomized trial. Niger J Clin Pract. May 2020; 23(5):704-710. PMID 32367880
29. Yang TH, Huang YC, Lau YC, et al. Efficacy of Radial Extracorporeal Shock Wave Therapy on Lateral Epicondylosis, and Changes in the Common Extensor Tendon Stiffness with Pretherapy and Posttherapy in Real-Time Sonoelastography: A Randomized Controlled Study. Am J Phys Med Rehabil. Feb 2017; 96(2): 93-100. PMID27323324
30. Capan N, Esmaeilzadeh S, Oral A, et al. Radial Extracorporeal Shock Wave Therapy Is Not More Effective Than Placebo in the Management of Lateral Epicondylitis: A Double-Blind, Randomized, Placebo-Controlled Trial. Am J Phys Med Rehabil. Jul 2016; 95(7): 495-506. PMID 26544854
31. Lizis P. Analgesic effect of extracorporeal shock wave therapy versus ultrasound therapy in chronic tennis elbow. J Phys Ther Sci. Aug 2015; 27(8): 2563-7. PMID 26357440
32. Gunduz R, Malas FU, Borman P, et al. Physical therapy, corticosteroid injection, and extracorporeal shock wave treatment in lateral epicondylitis. Clinical and ultrasonographical comparison. Clin Rheumatol. May 2012; 31(5):807-12. PMID 22278162
33. Staples MP, Forbes A, Ptasznik R, et al. A randomized controlled trial of extracorporeal shock wave therapy for lateral epicondylitis (tennis elbow). J Rheumatol. Oct 2008; 35(10): 2038-46. PMID 18792997
34. Blue Cross and Blue Shield Association Technology Evaluation Center (TEC). Extracorporeal shock wave treatment for musculoskeletal indications TEC Assessments. 2003; Volume 18: Tab 5.
35. Pettrone FA, McCall BR. Extracorporeal shock wave therapy without local anesthesia for chronic lateral epicondylitis. J Bone Joint Surg Am. Jun 2005; 87(6): 1297-304. PMID 15930540
36. Wu YC, Tsai WC, Tu YK, et al. Comparative Effectiveness of Nonoperative Treatments for Chronic Calcific Tendinitis of the Shoulder: A Systematic Review and Network Meta-Analysis of Randomized Controlled Trials. Arch Phys Med Rehabil. Aug 2017; 98(8): 1678-1692.e6. PMID 28400182
37. Arirachakaran A, Boonard M, Yamaphai S, et al. Extracorporeal shock wave therapy, ultrasound-guided percutaneous lavage, corticosteroid injection and combined treatment for the treatment of rotator cuff calcifictendinopathy: a network meta-analysis of RCTs. Eur J Orthop Surg Traumatol. Apr 2017; 27(3): 381-390. PMID27554465
38. Ioppolo F, Tattoli M, Di Sante L, et al. Clinical improvement and resorption of calcifications in calcific tendinitis of the shoulder after shock wave therapy at 6 months' follow-up: a systematic review and meta-analysis. Arch Phys Med Rehabil. Sep 2013; 94(9): 1699-706. PMID 23499780
39. Yu H, Cote P, Shearer HM, et al. Effectiveness of passive physical modalities for shoulder pain: systematic review by the Ontario protocol for traffic injury management collaboration. Phys Ther. Mar 2015; 95(3): 306-18. PMID25394425
40. Verstraelen FU, In den Kleef NJ, Jansen L, et al. High-energy versus low-energy extracorporeal shock wave therapy for calcifying tendinitis of the shoulder: which is superior? A meta-analysis. Clin Orthop Relat Res. Sep2014; 472(9): 2816-25. PMID 24872197
41. Bannuru RR, Flavin NE, Vaysbrot E, et al. High-energy extracorporeal shock-wave therapy for treating chronic calcific tendinitis of the shoulder: a systematic review. Ann Intern Med. Apr 15 2014; 160(8): 542-9. PMID24733195
42. Huisstede BM, Gebremariam L, van der Sande R, et al. Evidence for effectiveness of Extracorporal Shock-Wave Therapy (ESWT) to treat calcific and non-calcific rotator cuff tendinosis--a systematic review. Man Ther. Oct 2011;16(5): 419-33. PMID 21396877
43. Kvalvaag E, Roe C, Engebretsen KB, et al. One year results of a randomized controlled trial on radial Extracorporeal Shock Wave Treatment, with predictors of pain, disability and return to work in patients with subacromial pain syndrome. Eur J Phys Rehabil Med. Jun 2018; 54(3): 341-350. PMID 28655271
44. Kvalvaag E, Brox JI, Engebretsen KB, et al. Effectiveness of Radial Extracorporeal Shock Wave Therapy (rESWT)When Combined With Supervised Exercises in Patients With Subacromial Shoulder Pain: A Double-Masked, Randomized, Sham-Controlled Trial. Am J Sports Med. Sep 2017; 45(11): 2547-2554. PMID 28586628
45. Kim EK, Kwak KI. Effect of extracorporeal shock wave therapy on the shoulder joint functional status of patients with calcific tendinitis. J Phys Ther Sci. Sep 2016; 28(9): 2522-2524. PMID 27799684

46. Kim YS, Lee HJ, Kim YV, et al. Which method is more effective in treatment of calcific tendinitis in the shoulder? Prospective randomized comparison between ultrasound-guided needling and extracorporeal shock wave therapy. J Shoulder Elbow Surg. Nov 2014; 23(11): 1640-6. PMID 25219475
47. Schofer MD, Hinrichs F, Peterlein CD, et al. High- versus low-energy extracorporeal shock wave therapy of rotator cuff tendinopathy: a prospective, randomised, controlled study. Acta Orthop Belg. Aug 2009; 75(4): 452-8. PMID19774810
48. Liu S, Zhai L, Shi Z, et al. Radial extracorporeal pressure pulse therapy for the primary long bicipital tenosynovitis a prospective randomized controlled study. Ultrasound Med Biol. May 2012; 38(5): 727-35. PMID 22425375
49. Mani-Babu S, Morrissey D, Waugh C, et al. The effectiveness of extracorporeal shock wave therapy in lower limb tendinopathy: a systematic review. Am J Sports Med. Mar 2015; 43(3): 752-61. PMID 24817008
50. Al-Abbad H, Simon JV. The effectiveness of extracorporeal shock wave therapy on chronic achilles tendinopathy: a systematic review. Foot Ankle Int. Jan 2013; 34(1): 33-41. PMID 23386759
51. Costa ML, Shepstone L, Donell ST, et al. Shock wave therapy for chronic Achilles tendon pain: a randomized placebo-controlled trial. Clin Orthop Relat Res. Nov 2005; 440: 199-204. PMID 16239807
52. Rasmussen S, Christensen M, Mathiesen I, et al. Shockwave therapy for chronic Achilles tendinopathy: a double-blind, randomized clinical trial of efficacy. Acta Orthop. Apr 2008; 79(2): 249-56. PMID 18484252
53. Abdelkader NA, Helmy MNK, Fayaz NA, et al. Short- and Intermediate-Term Results of Extracorporeal Shockwave Therapy for Noninsertional Achilles Tendinopathy. Foot Ankle Int. Jun 2021; 42(6): 788-797. PMID 33451253
54. Pinitkwamdee S, Laohajaroensombat S, Orapin J, et al. Effectiveness of Extracorporeal Shockwave Therapy in the Treatment of Chronic Insertional Achilles Tendinopathy. Foot Ankle Int. Apr 2020; 41(4): 403-410. PMID 31924120
55. Lynen N, De Vroey T, Spiegel I, et al. Comparison of Peritendinous Hyaluronan Injections Versus Extracorporeal Shock Wave Therapy in the Treatment of Painful Achilles' Tendinopathy: A Randomized Clinical Efficacy and Safety Study. Arch Phys Med Rehabil. Jan 2017; 98(1): 64-71. PMID 27639439
56. Liao CD, Xie GM, Tsauo JY, et al. Efficacy of extracorporeal shock wave therapy for knee tendinopathies and other soft tissue disorders: a meta-analysis of randomized controlled trials. BMC Musculoskelet Disord. Aug 02 2018;19(1): 278. PMID 30068324
57. van Leeuwen MT, Zwerver J, van den Akker-Scheek I. Extracorporeal shockwave therapy for patellar tendinopathy: a review of the literature. Br J Sports Med. Mar 2009; 43(3): 163-8. PMID 18718975
58. Thijs KM, Zwerver J, Backx FJ, et al. Effectiveness of Shockwave Treatment Combined With Eccentric Training for Patellar Tendinopathy: A Double-Blinded Randomized Study. Clin J Sport Med. Mar 2017; 27(2): 89-96. PMID27347857
59. Smith J, Sellon JL. Comparing PRP injections with ESWT for athletes with chronic patellar tendinopathy. Clin J Sport Med. Jan 2014; 24(1): 88-9. PMID 24366015
60. Newman P, Waddington G, Adams R. Shockwave treatment for medial tibial stress syndrome: A randomized double blind sham-controlled pilot trial. J Sci Med Sport. Mar 2017; 20(3): 220-224. PMID 27640922
61. Rompe JD, Cacchio A, Furia JP, et al. Low-energy extracorporeal shock wave therapy as a treatment for medial tibial stress syndrome. Am J Sports Med. Jan 2010; 38(1): 125-32. PMID 19776340
62. Barnes M. Letter to the editor. "Low-energy extracorporeal shock wave therapy as a treatment for medial tibial stress syndrome". Am J Sports Med. Nov 2010; 38(11): NP1; author reply NP1-2. PMID 20971968
63. Hao Y, Guo H, Xu Z, et al. Meta-analysis of the potential role of extracorporeal shockwave therapy in osteonecrosis of the femoral head. J Orthop Surg Res. Jul 03 2018; 13(1): 166. PMID 29970103
64. Zhang Q, Liu L, Sun W, et al. Extracorporeal shockwave therapy in osteonecrosis of femoral head: A systematic review of now available clinical evidences. Medicine (Baltimore). Jan 2017; 96(4): e5897. PMID 28121934

65. Alves EM, Angrisani AT, Santiago MB. The use of extracorporeal shock waves in the treatment of osteonecrosis of the femoral head: a systematic review. Clin Rheumatol. Nov 2009; 28(11): 1247-51. PMID 19609482
66. Sansone V, Ravier D, Pascale V, et al. Extracorporeal Shockwave Therapy in the Treatment of Nonunion in Long Bones: A Systematic Review and Meta-Analysis. J Clin Med. Apr 01 2022; 11(7). PMID 35407583
67. Zelle BA, Gollwitzer H, Zlowodzki M, et al. Extracorporeal shock wave therapy: current evidence. J Orthop Trauma. Mar 2010; 24 Suppl 1: S66-70. PMID 20182240
68. Wang CJ, Liu HC, Fu TH. The effects of extracorporeal shockwave on acute high-energy long bone fractures of the lower extremity. Arch Orthop Trauma Surg. Feb 2007; 127(2): 137-42. PMID 17053946
69. Cacchio A, Giordano L, Colafarina O, et al. Extracorporeal shock-wave therapy compared with surgery for hypertrophic long-bone nonunions. J Bone Joint Surg Am. Nov 2009; 91(11): 2589-97. PMID 19884432
70. Zhai L, Ma XL, Jiang C, et al. Human autologous mesenchymal stem cells with extracorporeal shock wave therapy for nonunion of long bones. Indian J Orthop. Sep 2016; 50(5): 543-550. PMID 27746499
71. Mihai EE, Dumitru L, Mihai IV, et al. Long-Term Efficacy of Extracorporeal Shock Wave Therapy on Lower Limb Post-Stroke Spasticity: A Systematic Review and Meta-Analysis of Randomized Controlled Trials. J Clin Med. Dec29 2020; 10(1). PMID 33383655
72. Cabanas-Valdes R, Serra-Llobet P, Rodriguez-Rubio PR, et al. The effectiveness of extracorporeal shock wave therapy for improving upper limb spasticity and functionality in stroke patients: a systematic review and meta-analysis. Clin Rehabil. Sep 2020; 34(9): 1141-1156. PMID 32513019
73. Jia G, Ma J, Wang S, et al. Long-term Effects of Extracorporeal Shock Wave Therapy on Poststroke Spasticity: A Meta-analysis of Randomized Controlled Trials. J Stroke Cerebrovasc Dis. Mar 2020; 29(3): 104591. PMID31899073
74. Kim HJ, Park JW, Nam K. Effect of extracorporeal shockwave therapy on muscle spasticity in patients with cerebral palsy: meta-analysis and systematic review. Eur J Phys Rehabil Med. Dec 2019; 55(6): 761-771. PMID 31615195
75. Lee JY, Kim SN, Lee IS, et al. Effects of Extracorporeal Shock Wave Therapy on Spasticity in Patients after Brain Injury: A Meta-analysis. J Phys Ther Sci. Oct 2014; 26(10): 1641-7. PMID 25364134
76. Vidal X, Marti-Fabregas J, Canet O, et al. Efficacy of radial extracorporeal shock wave therapy compared with botulinum toxin type A injection in treatment of lower extremity spasticity in subjects with cerebral palsy: A randomized, controlled, cross-over study. J Rehabil Med. Jun 30 2020; 52(6): jrm00076. PMID 32556354
77. Li G, Yuan W, Liu G, et al. Effects of radial extracorporeal shockwave therapy on spasticity of upper-limb agonist/antagonist muscles in patients affected by stroke: a randomized, single-blind clinical trial. Age Ageing. Feb27 2020; 49(2): 246-252. PMID 31846499
78. Wu YT, Yu HK, Chen LR, et al. Extracorporeal Shock Waves Versus Botulinum Toxin Type A in the Treatment of Poststroke Upper Limb Spasticity: A Randomized Noninferiority Trial. Arch Phys Med Rehabil. Nov 2018; 99(11):2143-2150. PMID 30392753
79. Vidal X, Morral A, Costa L, et al. Radial extracorporeal shock wave therapy (rESWT) in the treatment of spasticity in cerebral palsy: a randomized, placebo-controlled clinical trial. Neuro Rehabilitation. 2011; 29(4): 413-9. PMID22207070
80. Marwan Y, Husain W, Alhajji W, et al. Extracorporeal shock wave therapy relieved pain in patients with coccydynia: a report of two cases. Spine J. Jan 2014; 14(1): e1-4. PMID 24094989
81. Ahadi T, Hosseinverdi S, Raissi G, et al. Comparison of Extracorporeal Shockwave Therapy and Blind Steroid Injection in Patients With Coccydynia: A Randomized Clinical Trial. Am J Phys Med Rehabil. May 01 2022; 101(5):417-422. PMID 34091468
82. Jung YJ, Park WY, Jeon JH, et al. Outcomes of ultrasound-guided extracorporeal shock wave therapy for painful stump neuroma. Ann Rehabil Med. Aug 2014; 38(4): 523-33. PMID 25229031
83. Furia JP, Rompe JD, Maffulli N, et al. Radial Extracorporeal Shock Wave Therapy Is Effective and Safe in Chronic Distal Biceps Tendinopathy. Clin J Sport Med. Sep 2017; 27(5): 430-437. PMID 27893487

84. Thomas JL, Christensen JC, Kravitz SR, et al. The diagnosis and treatment of heel pain: a clinical practice guideline-revision 2010. J Foot Ankle Surg. May-Jun 2010; 49(3 Suppl): S1-19. PMID 20439021
85. Schneider HP, Baca JM, Carpenter BB, et al. American College of Foot and Ankle Surgeons Clinical Consensus Statement: Diagnosis and Treatment of Adult Acquired Infracalcaneal Heel Pain. J Foot Ankle Surg. Mar 2018;57(2): 370-381. PMID 29284574
86. National Institute for Health and Care Excellence (NICE). Extracorporeal shockwave lithotripsy for calcific tendonitis (tendonopathy) of the shoulder [IPG21]. 2003; https://www.nice.org.uk/guidance/ipg21. Accessed May 2,2022.
87. National Institute for Health and Care Excellence (NICE). Extracorporeal shockwave therapy for refractory plantar fasciitis: guidance [IPG311]. 2009; https://www.nice.org.uk/guidance/ipg311. Accessed May 3, 2022.
88. National Institute for Health and Care Excellence (NICE). Extracorporeal shockwave therapy for refractory tennis elbow [IPG313]. 2009; https://www.nice.org.uk/guidance/ipg313. Accessed May 6, 2022.
89. National Institute for Health and Care Excellence (NICE). Extracorporeal shockwave therapy for refractory greater trochanteric pain syndrome [IPG376]. 2011; https://www.nice.org.uk/guidance/ipg376. Accessed May 4, 2022.
90. National Institute for Health and Care Excellence (NICE). Extracorporeal shockwave therapy for Achilles tendinopathy [IPG571]. 2016; https://www.nice.org.uk/guidance/ipg571. Accessed May 5, 2022.