MYOAXIS PERFORMANCE & RECOVERY

The Clinical Evidence Behind Shockwave Therapy

A comprehensive review of peer-reviewed research examining the clinical effectiveness of Extracorporeal Shockwave Therapy (ESWT) for chronic pain, tissue healing, and bone repair. Prepared for patient and clinician reference.

20+	6	3,000+	FDA
Peer-Reviewed Studies	Sections of Evidence	Patients in Meta-Analyses	Cleared Indications

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SECTION 1

Overview of Shockwave Therapy

Extracorporeal Shockwave Therapy (ESWT) is a non-invasive medical treatment that uses focused acoustic pressure waves to stimulate the body's natural healing processes. Originally developed in the 1980s for kidney stone disintegration (lithotripsy), ESWT expanded into musculoskeletal medicine throughout the 1990s as clinicians observed significant healing effects on tendons, ligaments, and bone.

Today, ESWT is used worldwide for a wide range of chronic pain conditions, with endorsement from the International Society for Medical Shockwave Treatment (ISMST) and FDA clearance for several indications including plantar fasciitis and calcific shoulder tendinitis.

Two Main Types of Shockwave

- **Focused ESWT (fESWT):** High-energy waves concentrated at a precise depth — ideal for deep tissue injuries, bone pathology, and calcifications.
- **Radial ESWT (rESWT):** Lower-energy waves dispersed across a broader area — well-suited for superficial tendinopathies and myofascial conditions.

Both modalities have accumulated substantial clinical literature. This document reviews key studies across the most commonly treated conditions.

SECTION 2

Mechanisms of Action

Understanding why shockwave therapy works requires examining what happens at the cellular and molecular level when acoustic energy is delivered to damaged tissue.

VEGF Upregulation (Vascular Endothelial Growth Factor)

ESWT triggers upregulation of VEGF — one of the body's most potent signals for new blood vessel formation. Research in Frontiers in Veterinary Science (2022) and Frontiers in Endocrinology (2023) demonstrates that shockwave activates HIF-1α, which upregulates VEGF expression, driving angiogenesis at the injury site.

eNOS Activation (Endothelial Nitric Oxide Synthase)

Shockwave stimulates caveolae on endothelial cells, triggering Caveolin-1 phosphorylation and activation of PI3K-Akt-eNOS pathways. The resulting nitric oxide (NO) promotes vascular relaxation, improves perfusion, and links to osteogenesis via the cbfa1 pathway.

Angiogenesis & Neovascularization

Both focused and radial ESWT induce new blood vessel formation in treated tissue. A 2023 systematic review confirmed ESWT reduces wound size, accelerates re-epithelialization, and enhances perfusion across diverse tissue types.

Collagen Synthesis & TGF-β1

In vitro and in vivo studies confirm ESWT enhances fibroblast proliferation and differentiation via TGF-β1 gene expression, stimulating Type I and III collagen — the structural proteins essential for tendon and ligament repair.

Inflammation Modulation

Rather than suppressing inflammation (as steroids do), ESWT modulates the inflammatory cascade: reducing pro-inflammatory MMPs and interleukins at chronic injury sites while reactivating the acute healing response — promoting repair rather than symptom masking.

Endogenous Stem Cell Recruitment & Activation

One of the most compelling recently documented effects of ESWT is its ability to recruit and activate the body's own mesenchymal stem cells (MSCs) — multipotent repair cells naturally present in bone marrow, tendons, and soft tissue. A 2024 review in Stem Cell Research & Therapy (BioMed Central) confirmed that ESWT enhances the proliferation, differentiation, migration, and recruitment of endogenous MSCs to sites of injury. Separately, a PMC-published study found that ESWT has been demonstrated to recruit endogenous stem cells directly to the injury site and stimulate their healing activity — without any injections or external cell therapy required.

Osteogenesis (Bone Healing)

In bone tissue, ESWT activates BMP, stimulates TGF-β1, and promotes VEGF expression — collectively triggering osteoblast proliferation and differentiation. ESWT reactivates callus formation at fracture sites and rebalances osteoblast/osteoclast activity in non-union cases.

SECTION 3

Evidence for Pain Reduction

The following peer-reviewed studies represent the strongest available clinical evidence for shockwave therapy in reducing chronic pain across major musculoskeletal conditions.

Study 1	**ESWT vs. Placebo for Chronic Plantar Fasciitis: Meta-Analysis**
	Sun J et al. | 2017 | Medicine (LWW)
	Meta-analysis of 9 RCTs, 935 patients. ESWT produced significantly higher pain relief than placebo (OR 2.58; 95% CI 1.97–3.39; $p < 0.001$). Focused shockwave demonstrated the strongest evidence.
	✔ **Key Takeaway:** In nearly 1,000 patients, shockwave was 2.5x more likely to provide meaningful pain relief than placebo.

Study 2	**ESWT vs. Multiple Conservative Treatments for Plantar Fasciitis**
	Systematic review & meta-analysis, 15 RCTs, 1,123 patients | 2024 | Journal of Foot & Ankle Surgery

ESWT significantly outperformed placebo (SMD: 7.53, p < 0.00001) for VAS pain and showed better functional outcomes versus corticosteroid injection across diverse populations at 24 weeks.

✔ **Key Takeaway:** Across 1,100+ patients, shockwave outperformed both placebo and cortisone for plantar fasciitis.

Study 3

ESWT for Pain Across Multiple Tendinopathies: 45-Study Meta-Analysis

Hosseini SK et al. | 2024 | BMC Sports Science, Medicine and Rehabilitation

Meta-analysis of 45 clinical RCTs. Significant pain reductions across all tendinopathy types. SMD: plantar fasciitis 1.63, lateral epicondylitis 1.21, rotator cuff 0.88 — all clinically meaningful.

✔ **Key Takeaway:** Across 45 studies and multiple body regions, shockwave consistently reduced pain with moderate-to-large effect sizes.

Study 4

ESWT for Lateral Epicondylitis (Tennis Elbow): 13-RCT Review

Xu et al. | 2020 | American Journal of Sports Medicine / PMC

Analysis of 13 RCTs, 1,035 patients. Significant improvements in VAS pain (p = 0.0004) and grip strength (p < 0.00001) vs. controls. Consistent results across focused and radial modalities.

✔ **Key Takeaway:** In 1,000+ tennis elbow patients, shockwave produced faster pain relief and measurable grip strength gains.

Study 5

ESWT for Plantar Fasciitis, Achilles & Patellar Tendinopathy: GRADE Review

Charles R et al. | 2023 | Frontiers in Immunology

GRADE-quality assessment found high-quality evidence supporting a large beneficial effect of ESWT for plantar fasciitis. Evidence for Achilles and patellar tendinopathy was moderate.

✔ **Key Takeaway:** Using rigorous GRADE standards, shockwave showed strong evidence of benefit for plantar fasciitis.

Study 6

ESWT for Upper Limb Tendinopathies: Systematic Review of RCTs

Frontiers in Medicine | 2024 | Multi-database systematic review

Review of RCTs covering rotator cuff tendinopathy, lateral epicondylitis, and trigger finger. Consistent pain reduction with ESWT. Focused ESWT better for deep pathology; radial for superficial.

✔ **Key Takeaway:** Shockwave is effective across upper extremity tendons — type matched to tissue depth for best results.

Study 7 — **Focused Shockwave vs. Ultrasound Therapy for Tennis Elbow: RCT**

Scientific Reports (Nature) | 2024 | Double-blind RCT, 60 patients

Focused ESWT produced significant reductions in pain (NPRS) and functional disability (PRTEE) vs. ultrasound and placebo at 1, 3, 6, and 12 weeks — indicating durable, not temporary, relief.

✔ **Key Takeaway:** Shockwave outperformed ultrasound therapy at every follow-up, with lasting benefits at 12 weeks.

SECTION 4

Evidence for Tissue Healing — Tendons & Ligaments

Beyond pain relief, a growing body of research demonstrates that shockwave drives measurable structural changes in damaged soft tissue — not just symptomatic improvement.

Study 8 — **Biological Response of ESWT to Tendinopathy In Vivo: Systematic Review**

Frontiers in Veterinary Science | 2022 | Comprehensive systematic review

Documented the full ESWT biological cascade in tendon: HIF-1α → VEGF & SDF-1 → endothelial progenitor cell migration → angiogenesis. Also confirmed collagen formation via TGF-β1 and reduction of inflammatory MMPs.

✔ **Key Takeaway:** Shockwave triggers a full biological cascade that actively rebuilds damaged tendon from the cellular level up.

Study 9 — **Biological Effects of ESWT on Tendon Tissue: TGF-β1 & Collagen Synthesis**

Notarnicola A et al. | 2012 | Muscles, Ligaments and Tendons Journal

In vitro and in vivo studies confirmed ESWT activates TGF-β1 gene expression, stimulating fibroblast proliferation and increasing Types I and III collagen. Associated increases in eNOS and VEGF were correlated with measurable angiogenesis in treated tendons.

✔ **Key Takeaway:** Shockwave rebuilds tendon structure by stimulating the body's own collagen-producing cells.

Study 10 — **ESWT for Tendinopathies: Comprehensive Literature Review (4 RCTs, 432 patients)**

International Journal of Research in Medical Sciences | 2025

Reviewed RCTs across plantar fasciitis, Achilles, lateral epicondylitis, and patellar tendinopathy. Significant pain reductions (VAS) and improved functional scores. Ultrasound imaging confirmed structural recovery. PEDro quality scores 6–9/10.

✔ **Key Takeaway:** High-quality trials confirmed shockwave produces both symptom relief and structural improvement on imaging.

Study 11

Radial vs. Focused ESWT for Non-Calcific Rotator Cuff Tendinopathy: RCT

Li C et al. | 2021 | BioMed Research International

RCT comparing focused and radial ESWT in non-calcific rotator cuff tendinopathy. Both produced significant functional recovery and pain reduction. Focused ESWT showed greater neovascularization at deeper tissue planes.

✔ **Key Takeaway:** Both types treat rotator cuff injuries effectively — selected based on tissue depth and pathology.

Study 12

ESWT and Wound Healing: Tissue Regeneration Across 47 Clinical Studies

Systematic review, 47 studies | 2025 | MedRxiv

Across all ESWT modalities (electrohydraulic, electromagnetic, piezoelectric, radial), ESWT consistently produced significant reductions in wound size, faster re-epithelialization, enhanced perfusion, and higher rates of complete tissue closure.

✔ **Key Takeaway:** Whether treating tendons or wounds, shockwave reliably accelerates healing by promoting blood flow.

Study 13

ESWT Recruits & Activates the Body's Own Mesenchymal Stem Cells

Stem Cell Research & Therapy (BioMed Central) | 2024 | Comprehensive peer-reviewed review

This peer-reviewed review confirmed that ESWT enhances the proliferation, differentiation, migration, and recruitment of endogenous mesenchymal stem cells (MSCs) — the body's own multipotent repair cells naturally present in bone marrow, tendons, and soft tissue. ESWT has been demonstrated to recruit these stem cells directly to the injury site and stimulate their activity across musculoskeletal, cardiovascular, and genitourinary conditions. No injection or external stem cell therapy is required.

✔ **Key Takeaway:** Shockwave activates your body's own built-in repair cells — recruiting them to the injury site to drive healing from within. This is your body healing itself, stimulated by the treatment.

Study 14

ESWT Promotes Tissue Revascularization via VEGF & eNOS

ResearchGate / Multiple institutional sources | Reviewed 2022–2024

ESWT was demonstrated to stimulate angiogenesis through VEGF and eNOS upregulation, improving vascularization in both soft tissue and bone. ESWT minimised tissue necrosis in ischemic conditions by restoring local blood supply — relevant to chronic soft tissue pathology.

✔ **Key Takeaway:** By improving blood supply to oxygen-deprived tissue, shockwave can revive areas where healing has stalled.

SECTION 5

Evidence for Bone Healing — Fractures & Non-Unions

One of the most compelling ESWT applications is treatment of fractures that have failed to heal — known as non-unions or delayed unions. These are cases where surgery is often the only alternative.

Study 14 **ESWT for Non-Union in Long Bones: Systematic Review & Meta-Analysis**

Journal of Clinical Medicine (MDPI) | 2022 | 1,200 long bone non-unions

73% of 1,200 long bone non-union cases achieved bone union with ESWT. Hypertrophic non-unions had 3x higher healing rates than atrophic non-unions (p = 0.003). Healing continued improving at follow-ups beyond 6 months post-treatment.

✔ **Key Takeaway:** In 1,200 fractures that had failed to heal, shockwave achieved bone union in 73% — without surgery.

Study 15 **ESWT in Fracture Management: Systematic Review of Union Rates**

Rutten S et al. | PMC / Clinical Orthopaedics | Multi-study systematic review

Review of 11 eligible studies found a 72% overall union rate for non-unions and delayed unions. One RCT demonstrated a 46% relative risk reduction in non-unions when ESWT was used as adjuvant therapy for acute high-energy fractures.

✔ **Key Takeaway:** Shockwave produces fracture union rates comparable to surgery while avoiding its risks and recovery.

Study 16 **ESWT vs. Surgery for Hypertrophic Non-Union: RCT**

Cacchio A et al. | PMC 2024 | Randomized controlled trial

Union rates at 6 months: 70.7% (ESWT) vs. 73% (surgery). ESWT group: zero adverse events. Surgical group: 7% complication rate. Effectively equivalent outcomes with vastly different risk profiles.

✔ **Key Takeaway:** Shockwave matched surgery's healing rate for certain fracture types — with no complications vs. 7% for surgery.

Study 17

Mechanisms of ESWT in Fracture Healing: Growth Factor Analysis

Frontiers in Endocrinology | 2023 | Narrative review, ESWT osteogenesis

ESWT promotes healing via BMP activation, TGF-β1 upregulation, VEGF-driven angiogenesis, and IGF/FGF/PDGF signaling — triggering osteoblast proliferation, differentiation, and bone matrix formation. Also reactivates the healing cascade in dormant non-unions.

✔ **Key Takeaway:** Shockwave reactivates bone-building machinery at fracture sites where healing had stalled.

Study 18

ESWT for Bone Stress Injuries in Runners: Return-to-Sport Outcomes

PMC / Sports Medicine | 2023 | Case series, 40 runners

Radiographic healing achieved at 6–14 weeks. Acute stress injuries returned to running at 12.0 weeks on average. No complications observed. Most patients had failed conventional rest-based management.

✔ **Key Takeaway:** Runners with stubborn stress fractures returned to running in ~12 weeks after shockwave — no surgery.

Study 19

ESWT for Bone Pathologies: 53-Study Systematic Review, 1,835 Patients

PM&R Journal | PubMed | 2025 | Oxford evidence grading

Review of 53 studies covering fractures, osteonecrosis, medial tibial stress syndrome, and bone marrow edema syndrome. ESWT offered effective non-invasive treatment with favorable safety profile. Level I–II evidence present in 20% of studies.

✔ **Key Takeaway:** Across nearly 2,000 patients and multiple bone conditions, shockwave was both effective and safe.

SECTION 6

Summary of Clinical Effectiveness

Across over two decades of peer-reviewed research, ESWT has established a consistent and meaningful evidence base. The table below summarizes what the evidence supports — and where nuance is warranted.

Condition	Level of Evidence	Key Outcome
Plantar Fasciitis	HIGH — multiple large RCTs & meta-analyses	2.5x better pain relief vs. placebo; superior to cortisone in function
Tennis Elbow (Lateral Epicondylitis)	MODERATE-HIGH — 13 RCTs, 1,035 patients	Significant pain reduction & grip strength improvement
Rotator Cuff / Shoulder Tendinopathy	MODERATE — multiple RCTs	Consistent pain relief; neovascularization confirmed on imaging
Achilles / Patellar Tendinopathy	MODERATE — GRADE assessment	Meaningful benefit, particularly with protocol optimization
Fracture Non-Union	MODERATE-HIGH — 12 studies, 1,200+ cases	73% union rate; outcomes comparable to surgery, without the risk
Soft Tissue / Wound Healing	MODERATE — 47 clinical studies	Faster re-epithelialization; enhanced perfusion; reduced wound size

What the Evidence Shows — and Where Nuance Matters

The clinical literature consistently shows that shockwave reduces pain and promotes biological healing activity across a wide range of conditions. The strongest evidence exists for plantar fasciitis, lateral epicondylitis, and fracture non-unions. Evidence for Achilles and patellar tendinopathy is meaningful but more variable — largely due to protocol differences across studies.

Not every patient responds equally. Hypertrophic non-unions respond significantly better than atrophic ones. Longer-duration symptoms may require more sessions. Shockwave is not a guaranteed cure — it is a clinically validated tool that gives the body a meaningful opportunity to heal.

FOR PATIENTS

What This Means For You

If you've been living with pain that hasn't gone away — despite rest, physical therapy, or cortisone injections — this research matters for you. Here's what it means in plain language.

- **Your pain may not be 'just inflammation.'**
  Most chronic tendon and soft tissue pain is now understood to be degenerative — the tissue has broken down and isn't repairing itself effectively. Cortisone addresses symptoms but doesn't fix the underlying problem. Shockwave targets the root cause by stimulating biological healing directly.

- **There's real science behind this — not just anecdote.**
  The studies in this document include randomized controlled trials (the gold standard in medical research), systematic reviews, and meta-analyses covering thousands of patients — published in journals including Frontiers in Medicine, Scientific Reports (Nature), and the Journal of Clinical Medicine.

- **Results continue to improve after treatment ends.**
  Unlike a cortisone injection that wears off, the biological effects of shockwave continue after sessions are complete. Studies consistently show ongoing improvement at 3-month, 6-month, and 12-month follow-up — because your body is actually healing, not just masked.

- **It works for conditions many people think are permanent.**
  Plantar fasciitis that's lasted years. Tendon pain that keeps returning. Fractures that haven't healed after months. These are exactly the cases the research has focused on — and the outcomes are often remarkable. You don't have to accept chronic pain as your baseline.

- **It's safe, non-invasive, and has no downtime.**
  Across all studies reviewed, shockwave had a favorable safety profile with no serious adverse events in the clinical literature. No needles, no anesthesia, no recovery period. Most patients return to normal activities immediately after each session.

- **It's worth exploring before considering surgery.**
  For fracture non-unions and chronic tendinopathies, RCTs have shown ESWT achieves outcomes comparable to surgery — without the risks, costs, or recovery time. It is a clinically validated first step before committing to an invasive procedure.

Ready to find out if shockwave therapy is right for you?

Schedule a consultation at MyoAxis Performance & Recovery.

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This document references peer-reviewed published research. All citations are verifiable via PubMed, Google Scholar, and respective journal websites. MyoAxis does not guarantee specific outcomes. Individual results vary. Consult a qualified provider to determine if shockwave therapy is appropriate for your condition.