Research Background

A guiding principle at Anjuna Sports Acupuncture and Sports Acupuncture Research is to share meaningful, science-based acupuncture insights with patients and the wider medical community. Our clinical care is grounded in first principles and validated research. As clinicians, scientists, and researchers, we pursue two intertwined missions: delivering outstanding treatment and communicating medically accurate information. We invite you to explore the research below and hope it offers clear insight into the powerful world of sports acupuncture and dry needling.

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Introduction and Overview: Acupuncture & Dry Needling

Musculoskeletal pain is a leading cause of disability worldwide, and the search for effective, safe, and cost-efficient interventions remains a clinical priority. Acupuncture and dry needling are two minimally invasive needling modalities widely used for the management of musculoskeletal pain. While both involve the insertion of fine needles into specific anatomical sites, their scientific rationales, mechanisms of action, and clinical evidence bases are distinct. This comprehensive report synthesizes the current state of knowledge regarding the neurophysiological and biochemical mechanisms, clinical efficacy, safety, patient selection, and cost-effectiveness of acupuncture and dry needling, with a focus on their independent roles in musculoskeletal pain management. The analysis is grounded in high-quality randomized controlled trials, meta-analyses, systematic reviews, and clinical guidelines, with an emphasis on quantitative, actionable data and direct clinical applicability.

Neurophysiological and Biochemical Mechanisms of Action

Acupuncture: Multilevel Modulation of Pain Pathways

Acupuncture exerts its analgesic effects through a complex interplay of peripheral, spinal, and supraspinal mechanisms, each supported by robust experimental and clinical evidence.

At the peripheral level, needle insertion at acupoints activates a dense network of primary afferent nerve fibers, including myelinated Aβ and Aδ fibers and unmyelinated C fibers. The specific pattern of fiber activation depends on the depth and type of stimulation: electroacupuncture (EA) preferentially activates A fibers, while manual acupuncture (MA) can activate both A and C fibers. Stimulation at the muscle layer is particularly effective in inducing analgesia via A fiber activation, whereas cutaneous stimulation requires C fiber activation for analgesic effects. These afferent signals are rapidly transmitted to the spinal cord and higher pain centers, initiating downstream modulatory processes.[1-2]

Acupuncture also induces a cascade of neuroimmune interactions at the local tissue level. Mechanical stimulation of acupoints leads to the activation of transient receptor potential vanilloid (TRPV1 and TRPV2) channels on mast cells, resulting in degranulation and the release of mediators such as histamine, serotonin, and adenosine. These mediators interact with receptors on nearby nerve endings, modulating nociceptive input and contributing to local analgesic and anti-inflammatory effects.[3-4] Notably, serotonin released from mast cells acts via 5-HT1A receptors to promote ATP release, which is subsequently hydrolyzed to adenosine. Adenosine, acting on A1 receptors, exerts potent antinociceptive effects by inhibiting nociceptive afferent activity. The blockade of ATP or adenosine signaling at the acupoint diminishes the analgesic effect of acupuncture, underscoring the importance of purinergic signaling in this context.[5-6]

A key biochemical mechanism involves the recruitment of opioid-containing immune cells. Electroacupuncture has been shown to significantly increase the local concentration of β-endorphins within inflamed tissues, mediated by the recruitment of ICAM-1+/CD11b+ neutrophils. The analgesic effect is abrogated by local administration of anti-β-endorphin antibodies, confirming the critical role of these peptides in mediating local pain relief.[7] Acupuncture also upregulates local norepinephrine and β2-adrenergic receptor expression, further contributing to the modulation of inflammatory pain.[7]

At the spinal level, acupuncture-evoked afferent input modulates pain transmission through segmental inhibition, consistent with the "gate control" model. Activation of large-diameter afferent fibers (Aβ) inhibits the transmission of nociceptive signals from small-diameter fibers (Aδ and C) at the level of the dorsal horn, reducing the relay of pain signals to higher centers.[1-2][8] Acupuncture also inhibits the activation of glial cells (microglia and astrocytes) in the dorsal horn, which are known to contribute to central sensitization and chronic pain states. This inhibition is mediated by downregulation of pro-inflammatory cytokines (e.g., interleukin-1β, interleukin-6, tumor necrosis factor-α) and upregulation of anti-inflammatory cytokines (e.g., interleukin-10), as well as suppression of chemokine signaling pathways such as CX3CL1/CX3CR1.[3][9-11] Acupuncture has been shown to inhibit long-term potentiation (LTP) in the spinal dorsal horn, a synaptic plasticity mechanism underlying central sensitization and persistent pain, by modulating the activity of wide dynamic range (WDR) neurons and reducing excitatory neurotransmitter release (e.g., glutamate).[1][9-10]

At the supraspinal level, acupuncture-induced afferent input ascends via the spinothalamic and spinoreticular tracts to multiple brain regions involved in pain processing and modulation. Neuroimaging studies and animal models have identified key supraspinal structures modulated by acupuncture, including the periaqueductal gray (PAG), nucleus raphe magnus (NRM), locus coeruleus, thalamus, insula, caudate, claustrum, lentiform nucleus, anterior cingulate cortex (ACC), and medial prefrontal cortex (mPFC).[2][12-13] Activation of the PAG and NRM leads to the release of endogenous opioids (enkephalins, endorphins, dynorphins), serotonin, and norepinephrine, which inhibit nociceptive transmission at the spinal level. The release of these neurochemicals is frequency-dependent in the case of electroacupuncture, with low-frequency stimulation (2 Hz) favoring enkephalin release and high-frequency stimulation (100 Hz) favoring dynorphin release.[2][14] Acupuncture also influences synaptic plasticity and neuroglial crosstalk in the brain, restoring the balance between excitatory and inhibitory neurotransmission by regulating the secretion of glutamate, GABA, serotonin, and other neurotransmitters.[9][11][13] Recent evidence implicates the endocannabinoid system in acupuncture analgesia, with electroacupuncture increasing the levels of endocannabinoids such as anandamide (AEA) and 2-arachidonoylglycerol (2-AG) in the ACC, along with upregulation of cannabinoid type 1 receptors (CB1R).[15]

Dry Needling: Local Disruption and Spinal Modulation

Dry needling (DN) is primarily a physical therapy intervention targeting myofascial trigger points (TrPs) or other soft tissue structures. Its mechanisms of action are multifactorial, involving local mechanical, neurophysiological, and biochemical effects.

At the peripheral level, needle insertion into a myofascial trigger point can elicit a local twitch response, disrupting abnormal endplate activity and reducing sustained contracture of muscle fibers. This mechanical disruption is associated with a reduction in spontaneous electrical activity and normalization of muscle tone, as demonstrated by reductions in surface electromyographic (sEMG) activity and muscle fatigue following DN in latent TrPs of the upper trapezius.[16] These changes are accompanied by increased pressure pain thresholds (PPTs), indicating a reduction in local mechanical hyperalgesia.[17]

At the spinal level, DN has been shown to modulate segmental reflexes. DN of latent TrPs in the medial gastrocnemius leads to a temporary reduction in the maximum M wave (Mmax) amplitude in the treated muscle, with no change in the H reflex amplitude, suggesting a specific effect on muscle excitability rather than on the excitatory spinal reflex pathway. Notably, DN increases reciprocal inhibition in the soleus muscle both immediately and up to 72 hours post-intervention, paralleled by an increase in passive ankle range of motion.[19] These findings indicate that DN can enhance inhibitory spinal mechanisms, potentially contributing to reduced muscle hyperactivity and improved function.

Central mechanisms are also implicated, with DN potentially activating descending inhibitory pathways, including those mediated by the PAG, resulting in diffuse noxious inhibitory control (DNIC) and widespread analgesia.[20-21] However, the evidence for robust central modulation is mixed. For example, a randomized controlled trial in patients with chronic nonspecific neck pain found that DN produced an immediate decrease in local mechanical hyperalgesia and increased skin conductance (a marker of autonomic arousal), but did not significantly alter measures of central pain processing such as temporal summation or conditioned pain modulation.[17] This suggests that while DN can activate the sympathetic nervous system and modulate local pain sensitivity, its effects on central sensitization may be limited or require repeated sessions.

Biochemically, DN induces a cascade of local changes within the muscle and surrounding tissues. Animal studies have shown that DN at myofascial trigger spots increases the levels of endogenous opioids such as β-endorphin in both muscle tissue and serum, which may contribute to its analgesic effects. Concurrently, DN reduces the concentration of substance P, a neuropeptide associated with pain transmission and neurogenic inflammation, in both muscle and dorsal root ganglion tissue. These changes are most pronounced after a single session of DN; repeated needling (five sessions) can reverse these effects and is associated with increased levels of pro-inflammatory mediators such as tumor necrosis factor-alpha (TNF-α), cyclooxygenase-2 (COX-2), hypoxia-inducible factor-1 alpha (HIF-1α), inducible nitric oxide synthase (iNOS), and vascular endothelial growth factor (VEGF).[22] In humans, DN has been shown to induce transient intramuscular edema at the site of needling, as detected by increased MRI signal intensity one hour post-intervention, likely reflecting a localized inflammatory response that may facilitate tissue repair and remodeling.[23]

Comparative Mechanistic Summary

While both acupuncture and dry needling share some mechanistic overlap—such as local tissue effects, activation of afferent nerve fibers, and engagement of endogenous opioid systems—acupuncture is characterized by a broader and more robust modulation of central pain pathways, neuroimmune interactions, and brain network activity. Dry needling's primary effects are local and segmental, with more limited evidence for durable central modulation. The clinical implications of these mechanistic differences are reflected in the patterns of pain relief, functional restoration, and durability of benefit observed in clinical trials.

Clinical Outcome Evidence: Efficacy, Durability, and Functional Restoration

Acupuncture: Quantitative Efficacy and Durability

The clinical efficacy of acupuncture for musculoskeletal pain is supported by multiple high-quality randomized controlled trials, meta-analyses, and clinical guidelines. The most comprehensive individual patient data meta-analysis to date, including over 20,000 patients from 39 trials, found that acupuncture was superior to both sham and no acupuncture controls for chronic musculoskeletal pain, osteoarthritis, chronic headache, and shoulder pain. The effect size compared to no acupuncture was moderate (close to 0.5 standard deviations), and compared to sham was small but statistically significant (close to 0.2 standard deviations). Importantly, the effects of acupuncture persisted over time, with only a small decrease in treatment effect at one year.[24] This durability is further illustrated in the following visual, which shows the trajectory of pain and disability scores over time in acupuncture and sham acupuncture groups:

The durability of acupuncture's effects is further supported by meta-analyses demonstrating that approximately 85–90% of the initial benefit is maintained at 12 months when compared to no acupuncture control, and about 50% of the benefit is maintained at 12 months when compared to sham acupuncture.[25] In chronic low back pain, the 2020 Cochrane review found that acupuncture was associated with moderate improvements in pain and function compared to no treatment in the immediate term, with a mean difference of -20.32 (95% CI -24.50 to -16.14) on a 0–100 visual analogue scale (VAS) for pain, and a standardized mean difference of -0.53 for back function.[26] Compared to sham acupuncture, the differences in pain and function were smaller and did not reach thresholds for clinical importance, and the durability of these effects beyond the short term was uncertain.[26-27]

In chronic knee pain due to osteoarthritis, acupuncture provided superior pain relief and improved physical function in the short term (up to 13 weeks) compared to sham, usual care, or no intervention. The benefit for physical function persisted in the longer term (up to 26 weeks), but the effect on pain did not.[28] In chronic neck pain, moderate-quality evidence indicates that acupuncture is more effective than sham or inactive treatment for pain relief at short-term follow-up, with a standardized mean difference of -0.23 for pain reduction compared to sham.[29]

Dry Needling: Quantitative Efficacy and Durability

Dry needling is supported by systematic reviews and meta-analyses demonstrating superiority to sham or no intervention for short-term pain reduction across various musculoskeletal conditions, with moderate to large effect sizes for pain and PPTs.[30-32] For example, a meta-analysis found a large effect to decrease pain within 72 hours (SMD = -0.81), a moderate effect at 1 to 3 weeks (SMD = -0.69), and a large effect at 4 to 24 weeks (SMD = -0.81) post-intervention.[31] In chronic low back pain, DN, particularly when combined with other therapies, was more effective than other treatments in reducing pain intensity both immediately post-intervention and at short-term follow-up, but there was no evidence that DN alone or in combination improved disability at either time point.[33-34] In chronic neck pain, DN improved both pain and functional capacity at short- and mid-term intervals, with greater benefits observed in patients over 40 years of age.[35]

The durability of DN's effects is less well established than for acupuncture. A systematic review and meta-analysis found that DN performed by physical therapists produced a large effect in reducing pain at 13 to 24 weeks (SMD = -0.81), suggesting that clinically meaningful pain relief can persist for up to 6 months after treatment, but the quality of evidence was rated as low due to heterogeneity among studies.[31] The evidence for sustained functional improvement and for effects beyond 6 months is limited and inconsistent.

Functional Restoration: Range of Motion and Disability

Both acupuncture and dry needling contribute to functional restoration in musculoskeletal pain, with evidence supporting improvements in disability scores and range of motion beyond pain reduction, particularly in the short term. In a multicenter randomized clinical trial of patients with chronic sciatica due to herniated disk, acupuncture led to a significantly greater improvement in function, as measured by the Oswestry Disability Index (ODI), compared to sham acupuncture (mean improvement of 13.0 points vs 4.9 points at four weeks).[36] This is illustrated in the following visual abstract:

In chronic low back pain, a structured dry needling program (supplemented by exercise) resulted in significant improvements in functional efficiency, as measured by the ODI, with a mean decrease of 18.1 to 18.9 points sustained up to three months post-intervention.[37] In knee osteoarthritis, dry needling of latent and active myofascial trigger points, combined with stretching, resulted in greater improvements in function (as measured by the WOMAC) and knee ROM compared to oral diclofenac and stretching, with benefits persisting at six months.[38]

Mechanistic studies provide further insight into how these modalities mediate functional restoration. For dry needling, reductions in pain intensity are the primary driver of improvements in neck pain-related disability, but increases in local pressure pain thresholds (attenuation of local hypersensitivity) and gains in cervical ROM also contribute independently to reduced disability.[39] For acupuncture, improvements in function are likely mediated by a combination of pain reduction, increased ROM, and enhanced neuromuscular control, as supported by mechanistic studies demonstrating effects on peripheral and central pain modulation, muscle relaxation, and neuroimmune interactions.[1][3][9]

Safety, Contraindications, and Patient Selection

Safety Profile and Incidence of Adverse Events

Both acupuncture and dry needling are associated with a favorable safety profile in the management of musculoskeletal pain, with the overwhelming majority of adverse events being minor, transient, and self-limited. Serious adverse events are exceedingly rare and are largely preventable with appropriate training, anatomical knowledge, and adherence to aseptic technique. The following table summarizes the incidence and nature of adverse events for both modalities:

For acupuncture, serious adverse events occur at a rate of approximately 0.04–0.08 per 10,000 treatments, with the most serious events being pneumothorax, nerve injury, organ injury, infection, and needle breakage.[40-42] Minor adverse events, such as bruising, hematoma, mild bleeding, and vasovagal reactions, are much more common but generally self-limited.[40][42] For dry needling, minor adverse events such as minor bleeding, pain during or after the procedure, bruising, tingling, and drowsiness are frequently encountered, while serious adverse events such as pneumothorax, nerve palsy, infection, and hospitalization are extremely rare.[43-44] The risk of adverse events does not appear to be significantly influenced by practitioner experience for minor events, but cumulative exposure may increase the likelihood of encountering rare serious events.[45]

Contraindications and Precautions

Absolute contraindications for both modalities include local skin infection at the intended needling site, active systemic infection, and known or suspected bleeding disorders that are not controlled.[40][46] Relative contraindications include severe coagulopathy, high-intensity anticoagulation, and significant immunosuppression. Special precautions are warranted when needling over the thorax, near major blood vessels, the abdomen (especially in pregnancy), and the lumbar region in patients with known spinal abnormalities or prior surgery.[40][46-47] For dry needling, additional caution is required when needling near the lungs, major blood vessels, or the spine, and superficial needling is recommended in these areas to reduce the risk of serious complications.[48] The use of antiplatelet or anticoagulant agents should not be considered an absolute contraindication for dry needling, but the risk of bleeding should be assessed on an individual basis.[49]

Patient-Specific Predictors of Response

The most consistent patient-specific predictor of better response to both acupuncture and dry needling is higher baseline pain severity.[50-51] For acupuncture, additional factors such as positive treatment expectation, certain personality traits (e.g., extraversion), and specific brain functional metrics may also predict greater benefit, though these are not routinely assessed in clinical practice.[52] The presence of untreated psychological comorbidities, particularly depression and anxiety, appears to diminish the likelihood of a favorable response to acupuncture.[53] For dry needling, shorter pain duration, lower baseline pain, better sleep quality, and positive beliefs about the intervention are associated with better outcomes, while chronicity, high pain intensity, poor sleep, and repetitive stress predict poorer response.[51][54-55] Age, sex, and pain chronicity do not appear to be strong or consistent predictors of response for either modality.[50][56]

Protocol Heterogeneity and Cost-Effectiveness

Protocol Heterogeneity in Dry Needling

There is substantial heterogeneity in dry needling protocols, encompassing the number of sessions, needling technique, target tissues, and other procedural variables. The number of sessions ranges from a single session to multiple sessions over several weeks, with most therapists performing three to six sessions per patient, each typically lasting less than 15 minutes.[45] Technical aspects such as needle insertion depth, duration, manipulation, and the elicitation of local twitch responses vary widely, with no universally accepted standard for trigger point diagnosis or for the number of sites to be treated.[57] The inclusion of adjunctive therapies, such as stretching, exercise, or manual therapy, introduces additional heterogeneity and makes it challenging to isolate the specific effects of dry needling.[58] This heterogeneity significantly affects the interpretation of clinical outcomes, with evidence supporting short-term pain relief but less consistent effects on function and long-term benefit.[30-31][57]

Cost-Effectiveness

Acupuncture is supported by moderate- to high-quality evidence as a cost-effective intervention for chronic musculoskeletal pain, including low back pain, neck pain, and knee osteoarthritis, when compared to usual care, medications, and other nonpharmacologic therapies.[59-61] For example, in the UK ATLAS trial, acupuncture for chronic neck pain resulted in an incremental QALY gain of 0.032 at an incremental cost of £451, yielding an ICER of £18,767 per QALY, which falls below the commonly accepted NICE threshold of £20,000–£30,000 per QALY.[59] In knee osteoarthritis, acupuncture was cost-effective with an ICER of £13,502 per QALY compared to TENS, and well below the NICE threshold of £20,000 per QALY.[60] The American Academy of Pain Medicine and the American College of Physicians both recognize acupuncture as a reasonable and cost-effective option in this context.[61-62]

The economic evidence for dry needling is less well developed, with few direct cost-effectiveness analyses. However, given its comparable clinical effectiveness to other standard physical therapy interventions and its favorable safety profile, it is reasonable to infer that dry needling is likely to be cost-effective as an adjunct.

Curated, compiled and written by Dr. Nathan J. Heide, DAOM, MBA, LAc and Rebecca Carsten to offer an insightful overview of the acupuncture and dry needling subject matter. Core research prompted, extracted and synthesized from OpenEvidence and OpenAI, July 2025.

References:

1. Effects and Mechanisms of Acupuncture Analgesia Mediated by Afferent Nerves in Acupoint Microenvironments. Fan Z, Dou B, Wang J, et al. Frontiers in Neuroscience. 2023;17:1239839. doi:10.3389/fnins.2023.1239839.

2. Neural Mechanism Underlying Acupuncture Analgesia. Zhao ZQ. Progress in Neurobiology. 2008;85(4):355-75. doi:10.1016/j.pneurobio.2008.05.004.

3. Role of Neuroimmune Crosstalk in Mediating the Anti-Inflammatory and Analgesic Effects of Acupuncture on Inflammatory Pain. Dou B, Li Y, Ma J, et al. Frontiers in Neuroscience. 2021;15:695670. doi:10.3389/fnins.2021.695670.

4. Mast Cell-Associated Serotonin in Acupoint Contributes to Acupuncture Analgesia in Arthritis Rats by Mediating ATP Release. Li BR, Li YJ, Xu JW, et al. Frontiers in Bioscience (Landmark Edition). 2023;28(1):1. doi:10.31083/j.fbl2801001.

5. Purinergic Signaling as a Basis of Acupuncture-Induced Analgesia.
He JR, Yu SG, Tang Y, Illes P. Purinergic Signalling. 2020;16(3):297-304. doi:10.1007/s11302-020-09708-z.

6. The Role of Purinergic Signaling in Acupuncture-Mediated Relief of Neuropathic and Inflammatory Pain. Huo M, Zhang Q, Si Y, et al. Purinergic Signalling. 2024;. doi:10.1007/s11302-024-09985-y.

7. Local Analgesia of Electroacupuncture Is Mediated by the Recruitment of Neutrophils and Released Β-Endorphins. Shi JT, Cao WY, Zhang XN, et al. Pain. 2023;164(9):1965-1975. doi:10.1097/j.pain.0000000000002892.

8. A 60-Year-Old Woman Considering Acupuncture for Knee Pain.
Berman B. JAMA. 2007;297(15):1697-707. doi:10.1001/jama.297.15.1697.

9. The Role of Neuroglial Crosstalk and Synaptic Plasticity-Mediated Central Sensitization in Acupuncture Analgesia. Lyu Z, Guo Y, Gong Y, et al. Neural Plasticity. 2021;2021:8881557. doi:10.1155/2021/8881557.

10. Acupuncture-Analgesia-Mediated Alleviation of Central Sensitization.
Lai HC, Lin YW, Hsieh CL. Evidence-Based Complementary and Alternative Medicine : eCAM. 2019;2019:6173412. doi:10.1155/2019/6173412.

11. Acupuncture for Pain Management: Molecular Mechanisms of Action.
Chen T, Zhang WW, Chu YX, Wang YQ. The American Journal of Chinese Medicine. 2020;48(4):793-811. doi:10.1142/S0192415X20500408.

12. Coordinate-Based (ALE) Meta-Analysis of Acupuncture for Musculoskeletal Pain.
Ha G, Tian Z, Chen J, et al. Frontiers in Neuroscience. 2022;16:906875. doi:10.3389/fnins.2022.906875.

13. Brain Nuclei and Neural Circuits in Neuropathic Pain and Brain Modulation Mechanisms of Acupuncture: A Review on Animal-Based Experimental Research.
Su N, Cai P, Dou Z, et al. Frontiers in Neuroscience. 2023;17:1243231. doi:10.3389/fnins.2023.1243231.

14. Mechanisms of Acupuncture-Electroacupuncture on Persistent Pain.
Zhang R, Lao L, Ren K, Berman BM. Anesthesiology. 2014;120(2):482-503.
doi:10.1097/ALN.0000000000000101.

15. Electroacupuncture Exerts Analgesic Effects by Restoring Hyperactivity via Cannabinoid Type 1 Receptors in the Anterior Cingulate Cortex in Chronic Inflammatory Pain.
Wu J, Hua L, Liu W, et al. Molecular Neurobiology. 2024;61(5):2949-2963.
doi:10.1007/s12035-023-03760-7.

16. Changes in Electromyographic Activity of Latent Trigger Points After a Dry Needling Intervention: A Randomised Controlled Trial. Sánchez-Infante J, Bravo-Sánchez A, Esteban-García P, Jiménez F, Abián-Vicén J. Physiotherapy. 2022;117:72-80.
doi:10.1016/j.physio.2022.09.002.

17. Immediate Effects of Dry Needling on Central Pain Processing and Skin Conductance in Patients With Chronic Nonspecific Neck Pain: A Randomized Controlled Trial.
Navarro-Santana MJ, Valera-Calero JA, Romanos-Castillo G, et al.
Journal of Clinical Medicine. 2022;11(22):6616. doi:10.3390/jcm11226616.

18. Immediate Effects of Dry Needling on the Autonomic Nervous System and Mechanical Hyperalgesia: A Randomized Controlled Trial. Lázaro-Navas I, Lorenzo-Sánchez-Aguilera C, Pecos-Martín D, et al. International Journal of Environmental Research and Public Health. 2021;18(11):6018. doi:10.3390/ijerph18116018.

19. Neurophysiological Effects of Latent Trigger Point Dry Needling on Spinal Reflexes.
Seif G, Phipps AM, Donnelly JM, Dellenbach BHS, Thompson AK. Journal of Neurophysiology. 2025;133(1):288-298. doi:10.1152/jn.00366.2024.

20. Trigger Point Needling: Techniques and Outcome.
Vulfsons S, Ratmansky M, Kalichman L. Current Pain and Headache Reports. 2012;16(5):407-12. doi:10.1007/s11916-012-0279-6.

21. Physiologic Effects of Dry Needling.
Cagnie B, Dewitte V, Barbe T, et al. Current Pain and Headache Reports. 2013;17(8):348.
doi:10.1007/s11916-013-0348-5.

22. Dry Needling at Myofascial Trigger Spots of Rabbit Skeletal Muscles Modulates the Biochemicals Associated With Pain, Inflammation, and Hypoxia.
Hsieh YL, Yang SA, Yang CC, Chou LW. Evidence-Based Complementary and Alternative Medicine : eCAM. 2012;2012:342165. doi:10.1155/2012/342165.

23. Localization of Muscle Edema and Changes on Muscle Contractility After Dry Needling of Latent Trigger Points in the Gastrocnemius Muscle. Baraja-Vegas L, Martín-Rodríguez S, Piqueras-Sanchiz F, et al. Pain Medicine (Malden, Mass.). 2019;20(7):1387-1394. doi:10.1093/pm/pny306.

24. Acupuncture for Chronic Pain: Update of an Individual Patient Data Meta-Analysis. Vickers AJ, Vertosick EA, Lewith G, et al. The Journal of Pain. 2018;19(5):455-474. doi:10.1016/j.jpain.2017.11.005.

25. The Persistence of the Effects of Acupuncture After a Course of Treatment: A Meta-Analysis of Patients With Chronic Pain. MacPherson H, Vertosick EA, Foster NE, et al. Pain. 2017;158(5):784-793. doi:10.1097/j.pain.0000000000000747.

26. Acupuncture for Chronic Nonspecific Low Back Pain. Mu J, Furlan AD, Lam WY, et al. The Cochrane Database of Systematic Reviews. 2020;12:CD013814. doi:10.1002/14651858.CD013814.

27. Acupuncture Versus Sham Acupuncture: A Meta-Analysis on Evidence for Longer-Term Effects of Acupuncture in Musculoskeletal Disorders. Lenoir D, De Pauw R, Van Oosterwijck S, Cagnie B, Meeus M. The Clinical Journal of Pain. 2020;36(7):533-549. doi:10.1097/AJP.0000000000000812.

28. The Effects of Acupuncture on Chronic Knee Pain Due to Osteoarthritis: A Meta-Analysis. Lin X, Huang K, Zhu G, et al. The Journal of Bone and Joint Surgery. American Volume. 2016;98(18):1578-85. doi:10.2106/JBJS.15.00620.

29. Acupuncture for Neck Disorders. Trinh K, Graham N, Irnich D, Cameron ID, Forget M. The Cochrane Database of Systematic Reviews. 2016;(5):CD004870. doi:10.1002/14651858.CD004870.pub4.

30. Clinical Effectiveness of Dry Needling in Patients With Musculoskeletal Pain-an Umbrella Review. Chys M, De Meulemeester K, De Greef I, et al. Journal of Clinical Medicine. 2023;12(3):1205. doi:10.3390/jcm12031205.

31. Is Dry Needling Applied by Physical Therapists Effective for Pain in Musculoskeletal Conditions? A Systematic Review and Meta-Analysis. Sánchez-Infante J, Navarro-Santana MJ, Bravo-Sánchez A, Jiménez-Diaz F, Abián-Vicén J. Physical Therapy. 2021;101(3):pzab070. doi:10.1093/ptj/pzab070.

32. The Effectiveness of Trigger Point Dry Needling for Musculoskeletal Conditions by Physical Therapists: A Systematic Review and Meta-Analysis. Gattie E, Cleland JA, Snodgrass S. The Journal of Orthopaedic and Sports Physical Therapy. 2017;47(3):133-149. doi:10.2519/jospt.2017.7096.

33. Efficacy of Dry Needling for Chronic Low Back Pain: A Systematic Review and Meta-Analysis of Randomized Controlled Trials. Lara-Palomo IC, Gil-Martínez E, López-Fernández MD, et al. Alternative Therapies in Health and Medicine. 2023;29(8):110-120.

34. Evidence for Dry Needling in the Management of Myofascial Trigger Points Associated With Low Back Pain: A Systematic Review and Meta-Analysis. Liu L, Huang QM, Liu QG, et al. Archives of Physical Medicine and Rehabilitation. 2018;99(1):144-152.e2. doi:10.1016/j.apmr.2017.06.008.

35. Effectiveness of Dry Needling in Improving Pain and Function in Comparison With Other Techniques in Patients With Chronic Neck Pain: A Systematic Review and Meta-Analysis. Hernández-Secorún M, Abenia-Benedí H, Borrella-Andrés S, et al. Pain Research & Management. 2023;2023:1523834. doi:10.1155/2023/1523834.

36. Acupuncture vs Sham Acupuncture for Chronic Sciatica From Herniated Disk: A Randomized Clinical Trial.Tu JF, Shi GX, Yan SY, et al.JAMA Internal Medicine. 2024;184(12):1417-1424. doi:10.1001/jamainternmed.2024.5463.

37.The Effectiveness of Dry Needling in Patients With Chronic Low Back Pain: A Prospective, Randomized, Single-Blinded Study. Rajfur J, Rajfur K, Kosowski Ł, et al. Scientific Reports. 2022;12(1):15803. doi:10.1038/s41598-022-19980-1.

38. Dry Needling on Latent and Active Myofascial Trigger Points Versus Oral Diclofenac in Patients With Knee Osteoarthritis: A Randomized Controlled Trial. Ma YT, Dong YL, Wang B, et al. BMC Musculoskeletal Disorders. 2023;24(1):36. doi:10.1186/s12891-022-06116-9.

39. Unraveling the Mechanisms Behind the Short-Term Effects of Dry Needling: New Insights From a Mediation Analysis With Repeatedly Measured Mediators and Outcomes. Murillo C, Cerezo-Téllez E, Torres-Lacomba M, et al.
Archives of Physical Medicine and Rehabilitation. 2024;105(12):2269-2276. doi:10.1016/j.apmr.2024.07.016.

40.Acupuncture: A Review of the Safety and Adverse Events and the Strategy of Potential Risk Prevention. Huang CC, Kotha P, Tu CH, et al. The American Journal of Chinese Medicine. 2024;52(6):1555-1587. doi:10.1142/S0192415X24500617.

41. Safety of Acupuncture: Overview of Systematic Reviews. Chan MWC, Wu XY, Wu JCY, Wong SYS, Chung VCH. Scientific Reports. 2017;7(1):3369. doi:10.1038/s41598-017-03272-0.

42. Safety of Acupuncture and Pharmacopuncture in 80,523 Musculoskeletal Disorder Patients: A Retrospective Review of Internal Safety Inspection and Electronic Medical Records.

Kim MR, Shin JS, Lee J, et al. Medicine. 2016;95(18):e3635. doi:10.1097/MD.0000000000003635.

43. Adverse Reactions to Dry Needling Therapy: Insights From Polish Physiotherapy Practice. Trybulski R, Kużdżał A, Kiljański M, et al. Journal of Clinical Medicine. 2024;13(23):7032. doi:10.3390/jcm13237032.

44. Dry Needling Perceptions and Experiences: A Survey of Australian Physiotherapists. Jenkins LC, Summers SJ, Nasser A, Verhagen A. Musculoskeletal Science & Practice. 2024;69:102895. doi:10.1016/j.msksp.2023.102895.

45. A Survey of American Physical Therapists' Current Practice of Dry Needling: Practice Patterns and Adverse Events. Gattie E, Cleland JA, Snodgrass S. Musculoskeletal Science & Practice. 2020;50:102255. doi:10.1016/j.msksp.2020.102255.

46. AAPM&R Position Statement on Dry Needling. American Academy of Physical Medicine and Rehabilitation (2012) Practice Guideline

47. Acute Spinal Epidural Hematoma as a Complication of Dry Needling: A Case Report. Berrigan WA, Whitehair CL, Zorowitz RD. PM & R : The Journal of Injury, Function, and Rehabilitation. 2019;11(3):313-316. doi:10.1016/j.pmrj.2018.07.009.

48. Dry Needling in the Management of Musculoskeletal Pain. Kalichman L, Vulfsons S. Journal of the American Board of Family Medicine : JABFM. 2010 Sep-Oct;23(5):640-6. doi:10.3122/jabfm.2010.05.090296.

49. Dry Needling and Antithrombotic Drugs. Muñoz M, Dommerholt J, Pérez-Palomares S, Herrero P, Calvo S. Pain Research & Management. 2022;2022:1363477. doi:10.1155/2022/1363477.

50. The Effect of Patient Characteristics on Acupuncture Treatment Outcomes: An Individual Patient Data Meta-Analysis of 20,827 Chronic Pain Patients in Randomized Controlled Trials. Witt CM, Vertosick EA, Foster NE, et al. The Clinical Journal of Pain. 2019;35(5):428-434. doi:10.1097/AJP.0000000000000691.

51. Dry Needling for Myofascial Pain: Prognostic Factors. Huang YT, Lin SY, Neoh CA, et al. Journal of Alternative and Complementary Medicine (New York, N.Y.). 2011;17(8):755-62. doi:10.1089/acm.2010.0374.

52. Psychological and Neurological Predictors of Acupuncture Effect in Patients With Chronic Pain: A Randomized Controlled Neuroimaging Trial. Wang X, Li JL, Wei XY, et al. Pain. 2023;164(7):1578-1592. doi:10.1097/j.pain.0000000000002859.

53. Acupuncture for the Treatment of Chronic Pain in the Military Population: Factors Associated With Treatment Outcomes. Plunkett A, Beltran T, Haley C, et al. The Clinical Journal of Pain. 2017;33(10):939-943. doi:10.1097/AJP.0000000000000518.

54. Baseline Examination Factors Associated With Clinical Improvement After Dry Needling in Individuals With Low Back Pain. Koppenhaver SL, Walker MJ, Smith RW, et al.The Journal of Orthopaedic and Sports Physical Therapy. 2015;45(8):604-12. doi:10.2519/jospt.2015.5801.

55. Dry Needling for the Treatment of Acute Myofascial Pain Syndrome in General Practitioners' Clinics: A Cohort Study. Yehoshua I, Rimon O, Mizrahi Reuveni M, Peleg R, Adler L. BMC Primary Care. 2022;23(1):339. doi:10.1186/s12875-022-01951-0.

56. Patient Characteristics and Variation in Treatment Outcomes: Which Patients Benefit Most From Acupuncture for Chronic Pain?. Witt CM, Schützler L, Lüdtke R, Wegscheider K, Willich SN. The Clinical Journal of Pain. 2011 Jul-Aug;27(6):550-5. doi:10.1097/AJP.0b013e31820dfbf5.

57. Consistency of Dry-Needling Interventions Across High-Quality Randomized Trials: A Critical Systematic Exploration of Intervention Reporting and Fidelity. Myburgh C, Kildsgaard K, Damsgaard T, Corfixen K, Boyle E. Journal of Manipulative and Physiological Therapeutics. 2021;44(7):546-557. doi:10.1016/j.jmpt.2021.12.004.

58. Effectiveness of Dry Needling for Chronic Nonspecific Neck Pain: A Randomized, Single-Blinded, Clinical Trial. Cerezo-Téllez E, Torres-Lacomba M, Fuentes-Gallardo I, et al. Pain. 2016;157(9):1905-1917. doi:10.1097/j.pain.0000000000000591.

59. An Economic Evaluation of Alexander Technique Lessons or Acupuncture Sessions for Patients With Chronic Neck Pain: A Randomized Trial (ATLAS). Essex H, Parrott S, Atkin K, et al. PloS One. 2017;12(12):e0178918. doi:10.1371/journal.pone.0178918.

60. Cost-Effectiveness of Adjunct Non-Pharmacological Interventions for Osteoarthritis of the Knee. Woods B, Manca A, Weatherly H, et al. PloS One. 2017;12(3):e0172749. doi:10.1371/journal.pone.0172749.

61. Evidence-Based Clinical Guidelines For Multidisciplinary Spine Care. D. Scott Kreiner MD, Paul Matz MD, Daniel K. Resnick MD MS, et al American Academy of Pain Medicine (2020)
Practice Guideline

62. Noninvasive Treatments for Acute, Subacute, and Chronic Low Back Pain: A Clinical Practice Guideline From the American College of Physicians. Qaseem A, Wilt TJ, McLean RM, et al. Annals of Internal Medicine. 2017;166(7):514-530. doi:10.7326/M16-2367.
Practice Guideline

