International Journal of Science and Research Archive
eISSN: 2582-8185
Cross Ref DOI: 10.30574/ijsra
Journal homepage: https://ijsra.net/

(REVIEW ARTICLE)

Check for updates

Physiotherapy instruments for the treatment of sciatic pain

Sanidhya S. Amrutkar * and Megha Patil

School of Mechatronics Engineering, Symbiosis Skills and Professional University, Maharashtra, India.

International Journal of Science and Research Archive, 2025, 15(02), 1547–1556

Publication history: Received on 15 April 2025; revised on 25 May 2025; accepted on 27 May 2025

Article DOI: https://doi.org/10.30574/ijsra.2025.15.2.1596

Abstract

Sciatica is a pain which sharply radiates along the sciatic nerve, its often caused after nerve getting compressed and can significantly disrupt day to day life. Symptoms like pain, numbness, and weakness in the legs can be loss of strength or energy. Physiotherapy emerges as a highly effective less invasive treatment option for handling sciatic pain. This review paper analyzes the ability of physiotherapy instruments to cure the pain. The instruments which are mentioned in this paper are Transcutaneous Electrical Nerve Stimulation (TENS) to Ultrasound Therapy, Interferential Current Therapy (IFC), Shockwave Therapy, and Low-Level Laser Therapy (LLLT). By reviewing certain clinical trials and evidence, this paper aims to help healthcare professionals in deciding which is the most perfect approach for treating sciatic pain based on each persons need.

Keywords: Pain; Laser Theory; Medical Treatment; Plasmas; Blood; Semiconductor Lasers; Laser Acupuncture (LA); Soft Cupping; Cortisol; Visual Analog Scale

1. Introduction

Sciatica is a popular condition that can substantially impact an individual's mobility and good quality of life. Its global commonness is analyzed to affect between 1 percent and 10 percent of the population, with some studies suggesting higher rates among old peoples and individuals with pre-existing spinal conditions. The pain flows along the sciatic nerve, often resulting from a herniated disc, spinal stenosis, or muscle spasms. This condition of sciatica can drastically reduce a person's ability to perform daily activities, leading to chronic discomfort in life. While pharmaceutical interventions and surgery are good and long-lasting treatment options but physiotherapy presents a painless and effective alternate option. Various modalities, such as TENS, Ultrasound Therapy, and Shockwave Therapy, have proven to be beneficial in alleviating pain, reducing inflammation, and improving patient outcomes. Low back pain (LBP) and sciatica should be clinically diagnosed with imaging only in specialist care if it influences treatment. Risk stratification guides treatment intensity, with simpler support for low-risk patients and more intensive options for high-risk ones. Routine imaging is not recommended in non-specialist settings (Bernstein et al., 2017) [38].

One common cause for Sciatic pain is herniated or protuding discs, where spinal discs press against the sciatic nerve, triggering some pain. Spinal stenosis, a constriction of the spinal canal, can also exert pressure on the sciatic nerve, resulting in pain and limited mobility. In some cases, piriformis syndrome occurs when the piriformis muscle gets tightened and compresses the sciatic nerve. Additionally, there are few conditions like spondylolisthesis, where a vertebra shifts out of its regular place, or some trauma from accidents, can contribute to sciatic pain in back.

Non-surgical physiotherapy treatments play a significant role in coping with sciatic pain, offering patients reliable pain control without the need for surgery or long-term medications. Several individuals choose these treatments as they help eliminate surgical necessity, which often come with risks and prolonged healing time. Physiotherapy also provides a traditional remedy to pain management, reducing dependency on painkillers that may cause unwanted side effects.

* Corresponding author: Sanidhya S. Amrutkar.

Beyond pain relief, these treatments focus on revitalizing operation, boosting motion, and developing muscle tone to prevent further complications. Unlike medications, which often provides temporary relief from the pain, physiotherapy targets the root cause of sciatica, ensuring long-term benefits and a reduced likelihood of recurrence.

1.1. Anatomy of the Sciatic Nerve

The Sciatic Nerve is the largest and longest nerve in the human body acting as a key factor in lower limb function. It emerges from the lumbar and sacral spine (L4-S3) and prolongs through the pelvis, buttocks, back of the thighs, and downwards to the lower legs. The sciatic nerve has two main roles: it offers motor control to the leg muscles, enhancing locomotion, and carries sensory signals from the lower extremities to the brain, allowing for sensation and reflexes. Any irritation or compression along its route can result in sciatica.

1.2. Signs and Effects on Everyday Activities

Sciatica presents with variety of symptoms, that fluctuate in strength and duration

- Intense or burning pain spreading from the lower back down to the legs.
- Tingling or numbness in the legs and feet, sometimes affecting both sides.
- Fatigue in the impacted leg, making walking or standing hard.

The impact of sciatica expands beyond physical discomfort

- Decreased flexibility makes everyday activities like walking, climbing stairs, or bending over challenging.
- Decrease in work efficiency affects individuals who sit for extended periods, particularly office workers.
- Emotional turmoil, including stress, anxiety, and depression, can develop due to chronic pain and restricted lifestyle.

The image below illustrates about the main points affected due to sciatic pain and also shows about the discomfort a person can feel due to the pain.

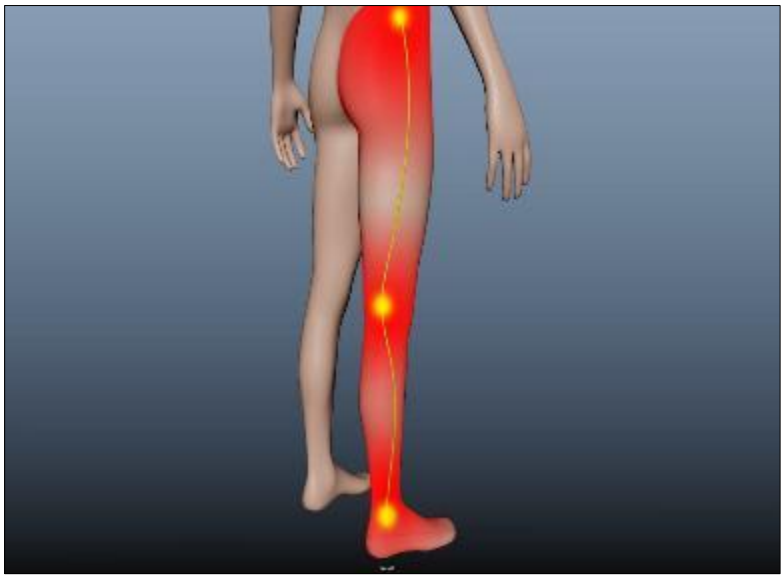

Figure 1 Pathway of Sciatic nerve and Painful regions

2. Traditional Physiotherapy Approaches

2.1. Manual Therapy Techniques

Manual therapy is a practical method used to reduce pain, reduce muscle tension, and enhance locomotion in sciatica patients.

2.1.1. Massage Therapy

- Helps loosen muscle tension and improve blood circulation.
- Minimizes inflammation and minimizes pressure on the sciatic nerve.
- Deep tissue massage specifically addresses tight muscles in the lower back.

2.1.2. Stretching Techniques:

- Increases range of motion and mobility, reducing sciatic nerve discomfort.
- There are almost 3 common stretching exercises which are:
  - Piriformis stretch – Eases tension in the piriformis muscle, which can compress the sciatic nerve.
  - Hamstring stretch – Decreases tightness in the back of the thighs, softening pressure on the lower back.
  - Cat-cow stretch – Strengthens spinal mobility, reduces stiffness.

2.1.3. Mobilization Techniques:

- Involves gentle joint mobilization to minimize stiffness in the lower part of spine and hips.
- Helps regain normal movement patterns and enhance spinal flexibility.

2.1.4. Heat and Cold Therapy

Temperature-based therapy is a highly effective method for pain relief and inflammation control.

Heat Therapy

- Increases the blood flow and promotes healing in all the affected tissues.
- Relaxes the tight muscles of back and reduces all the stiffness.
- Common methods: Heating pads or warm compresses.

Cold Therapy

- Reduces inflammation and numbness, provides instant relief.
- Slows down nerve conduction, decreasing discomfort.

3. Advancements in Physiotherapy Instruments for Sciatica Pain Management

3.1. Transcutaneous Electrical Nerve Stimulation (TENS)

Transcutaneous Electrical Nerve Stimulation (TENS) is a well stable method for pain relief, especially in managing chronic conditions like sciatica. Dohnert et al. (2020) [1] conducted a randomized controlled trial highlighting TENS' ability in reducing sciatic pain through the application of low-voltage electrical impulses. By stimulating sensory nerves, TENS disrupts pain signals before they reach the brain, utilizing the Gate Control Theory to reduce suffering . Patients in this trial showed significant improvement in both pain levels and mobility after continuous use. TENS mode uses slightly lower frequency simulations , the range varies from 2-5 hertz and a longer pulse width of around 200-250us. Wong et al. (2019)[2] also conducted a systematic review evaluating the efficiency and safety of using TEN's method for controlling the lower back pain. This research gave some mixed results for both chronic and acute lower back pain and concluded that using tens method can cure the pain for only a short period of time . Silitonga et al. (2024) [3] summarized a pre and post test measurements of 30 patients form a physio clinic. It proved that tens method is a non surgical method for pain management in lower back pain cases.The Gate Control Theory, first introduced by Melzack and Wall (1965), suggests that stimulating non-painful inputs such as electrical impulses can 'close the gates' to pain signals, preventing their communication to the brain. Over the years, TENS has evolved, becoming more accessible and easier to use for both clinical and home settings. However, its effectiveness varies depending on factors like electrode placement, intensity, and patient compliance. Recent studies also explore its capacity to influence neuroplasticity, where uniform usage of TENS may lead to long-term changes in pain pathways.Pivec et al. (2013)[4] further mentioned about the difference in the patients who used to visit regularly for lower back pain vs patients who used to visit clinics rarely. It concluded that those who used to do tens treatment had to ignore the surgery.

TENS is widely used for conditions like post-operative body pain, lower back pain, osteoarthritis, and diabetic neuropathy, demonstrating multipurpose functionality in managing acute and chronic pain. Core approaches include intense TENS, acupuncture-like TENS, and conventional TENS, each aiming at unique nerve routes and discomfort classifications. While evidence supports its efficacy in various conditions, advanced studies remain limited for specific

cases like chronic pelvic pain, dysmenorrhea, and neck pain (Teoli et al., (2024)[25]).Persistent neck pain impacts 10% to 24% of individuals and greatly restricts routine tasks, causing employment absences and financial difficulties. (Martimbianco et al., 2019)[26]. Defined as pain persisting for over 12 weeks with reduced neck mobility, its causes are often unclear, and therapy focuses on managing symptoms and preventing incapacity. While most cases resolve spontaneously, some patients require ongoing management strategies to address chronic symptoms. Buchmuller et al., 92012) [34] evaluated the efficacy of transcutaneous electrical neurostimulation (TENS) in patients with chronic low back pain (LBP). Two hundred thirty-six patients were randomly assigned to receive either active or sham TENS over three months. While pain relief improved with active TENS, no significant functional benefit was observed. The study found that TENS did not provide a clear advantage in terms of functional status or long-term pain relief. While TENS is effective for many, it is not without limitations. Some patients may not respond as efficiently, and the benefits can be transient, requiring ongoing usage. Additionally, patients with implanted devices such as pacemakers may face restrictions when using TENS due to potential electrical interference.

3.2. Ultrasound Therapy

Robertson, Baker, and Duck et al. (2017) [5] conducted a randomized controlled trial to assess the impact of therapeutic ultrasound in managing sciatic pain. Sciatic pain, typically caused by irritation or compression of the sciatic nerve, can result in extreme discomfort radiating from the lower back down to the legs. Common treatments include medication, physical therapy, and exercise, but the study explored therapeutic ultrasound—a less conventional approach.Ebadi et al. (2011)[6] highlighted about the therapeutic ultrasound therapy for chronic back pain . It stated that performing ultrasound therapy and exercises resulted in reducing pain and improving mobility of back as compared to other treatment and Van der Windt et al. (1999)[7] investigated that this method is used to improve local circulation, tissue regeneration and pain relief. Fiore et al. (2011) [8]compared the HILT (high intensity laser therapy) and ultrasound method for ultrasound therapy and concluded that ultrasound therapy is more effective and gives fast result as compared to other method .The results were convincing. Patients treated with ultrasound experienced noticeable pain relief and improved mobility compared to those receiving average care. Therapeutic ultrasound works by sending high-frequency sound waves deep inside tissues, promoting increase in blood flow, reducing inflammation, and facilitating tissue repair. This painless modality shows promise in accelerating the healing process while minimizing discomfort.However, not all patients achieved the same level of success. The study noted variations in outcomes, with some individuals responding better than others. Factors such as the severity of sciatic nerve irritation, treatment consistency, and the patient's overall health played significant roles in determining effectiveness. Despite these variances, many participants reported significant improvements in quality of life and day-to-day functionality.

The authors also acknowledged the need for more extensive research to better understand the long-term effects of ultrasound therapy on sciatica. While the trial offered valuable insights, larger studies with diverse populations are necessary to further refine treatment protocols and assess sustained outcomes.In conclusion, Robertson and colleagues highlighted therapeutic ultrasound as a promising painless intervention for sciatic pain. Though results may not be uniform for all patients, the treatment offers significant benefits for many, marking it as a potential cornerstone in managing sciatic pain when used alongside traditional therapies.San-Emeterio-Iglesias et al. (2021)[21] suggested that using ultrasound therapy with percutaneous neuromodulation (PNM) will give patients more relief as this method directly targets peripheral nerves including sciatic nerves .

3.3. Interferential Current Therapy (IFC)

Fuentes et al. (2018)[9] evaluated the ability of interferential current (IFC) therapy in controlling musculoskeletal pain. Musculoskeletal pain, which can occur in large range of conditions—such as arthritis, muscle strain, or injury, which affects millions of people globally. IFC therapy is a form of electrotherapy which delivers low frequency electric currents to stimulate nerves and relieve pain. The review combined data from numerous clinical trials, revealing mixed yet promising outcomes. Patients receiving IFC therapy reported notable reductions in pain levels, especially in the short term. The mechanism? IFC therapy stimulates deeper tissues through intersecting electrical currents, enhancing blood flow, reducing inflammation, and modulating pain signals—an approach that hypothetically accelerates the body's natural healing process.While the therapy offers various advantages, including being painless and easy to control, the study underscored varying degrees of success. Not every patient experienced substantial relief, and the long-term benefits of IFC therapy remained unclear. The outcomes of this treatment largely depended on factors like treatment duration, frequency, and the specific condition being treated.The authors also noted the limitations in the existing research. Some trials lacked consistency in methodology, which could have influenced the results. They reinforced the need for further high-quality studies to fully establish IFC treatment's place in pain management.Ultimately, Fuentes and colleagues concluded that IFC therapy shows potential as a temporary solution for musculoskeletal pain, but its long-lasting ability remains uncertain. While promising, more sturdy evidence is needed to define its role in clinical practice and to understand which patient populations might benefit most.Dohnert et al. (2015)[10] differentiated two

techniques which are TEN'S and IFC. It concluded that both methods are good and has no significant difference in managing chronic lower back pain. Corrêa et al. (2013) [11] discovered and studied different IFC frequencies like 1khz to 4khz to understand their pain modulating effects on reducing pain.Yaşar et.al (2022) [23] indicated that IFC therapy simply works by delivering some medium frequency currents which penetrates into tissues , this offers more effective pain relief compared to other different electrical simulation methods .TENS and IFC significantly reduced pain intensity, improved disability, and decreased medication use in chronic low back pain patients, while control groups showed no such benefits (Facci et al., 2011)[28]. Despite differences in methodologies, these findings align with prior studies but mentions the need for unified parameters and detailed cost forecasting. Future research should focus on optimizing electrotherapy protocols for sustained pain relief.

Olawale .et.al (2014)[37] evaluated the efficacy of interferential therapy (IFT) and exercise therapy in treating low back pain (LBP), showing significant pain relief and increased spine flexion and extension after eight weeks. No control group was used, limiting the strength of conclusions. Both therapies were effective in reducing pain and improving function in individuals with chronic LBP .

3.4. Shockwave Therapy

Notarnicola, Maccagnano, Tafuri, and Moretti et al. (2019)[12] conducted a randomized controlled trial investigating the effectiveness of shockwave therapy in treating piriformis syndrome, a condition often answerable for chronic pain in the lower back, hips, and legs. Piriformis syndrome occurs when the piriformis muscle, located near the sciatic nerve, becomes tighten or inflamed, leading to nerve getting compressed and, in many cases, sciatica-like symptoms. Traditional treatments include physical therapy, stretching, and injections, but the study explored a more unconventional approach known as shockwave therapy.The trial's results were captivating. Patients receiving shockwave therapy illustrated significant pain reduction and improved functionality comparing to those undergoing standard treatments. Shockwave therapy, which sends high-energy sound waves into affected tissues, promotes healing by increasing the blood flow and reducing inflammation in that area. This technique offers a painless alternative for patients struggling with piriformis syndrome's often stubborn symptoms.The authors highlighted the benefits of shockwave therapy—its painlessness and less side effects. Patients in the trial not only reported decrease in pain but also increased range of motion and enhanced overall quality of day to day life. For many, this meant regaining normal movement patterns without turning to more harsh treatments.(Lee et al., 2014[29]. studied around 28 patients with chronic low back pain, divided into an extracorporeal shockwave therapy (ESWT) group and a conservative physical therapy (CPT) group. Over six – seven weeks, both groups participated in therapy sessions and lumbar-strengthening exercises. ESWT showed significant improvements in pain reduction and dynamic balance compared to CPT .

However, the study also recognized limitations. While many patients responded well, not all saw the same degree of improvement after the treatment. Factors like the intensity of the syndrome, individual patient conditions, and treatment loyalty played significant roles in outcomes. More extensive trials were recommended to fully understand the therapy's long-term effects and streamline protocols.In conclusion, Notarnicola et.al (2019)[12] presented shockwave therapy as a promising, painless treatment for piriformis syndrome. Though not universally effective, it shows substantial potential in reducing symptoms and enhancing mobility, marking it as a valuable tool in administering musculoskeletal conditions.Lange et al. (2021)[13] specifically studied about extracorporeal shockwave therapy which concluded that this method improves pai life and quality of life. It suggested that this method can be a valuable alternative treatment for CBLP.Ahas et al. (2018)[14] concluded that combining shock wave therapy with abdominal strengthening and postural correction reported that this helped to reduce pain compared to exercise alone. Walewicz et al.(2019)[30] evaluated about the long-term effectiveness of radial extracorporeal shock wave therapy (rESWT) in conjunction with stability training for patients with chronic low back pain (LBP). While the control group showed initial pain relief, the rESWT group demonstrated significant extended pain alleviation and functional improvements

(Rajfur et al., 2022) [31] found that radial extracorporeal shock wave therapy (rESWT) combined with stabilization training significantly reduced pain and improved function in chronic low back pain patients over the long term, with better results observed at follow-up compared to the control group .Yue et al., (2021)[39] stated that extracorporeal shockwave therapy (ESWT) effectively reduces pain intensity and disability in patients with chronic low back pain (CLBP) in the short term, with no serious adverse events reported. However, further high-quality RCTs are needed to strengthen evidence for clinical use.

3.5. Spinal Decompression Devices

Helm, Gazelka, and Huntoon (2015) et al. [15] precisely evaluated the ability of non-surgical spinal decompression (NSSD) for lumbar disc herniation, a prevalent cause of debilitating lower back pain and sciatica. Lumbar disc herniation

arises when displaced disc material impinges on surrounding nerves, often resulting in sharp pain, numbness, or even significant movement loss. NSSD, a treatment involving mechanical traction, aims to reduce this pressure without surgical intervention—offering hope for relief from pain.The study's findings were remarkable. Patients undergoing NSSD displayed outstanding improvements, experiencing not only reduction in pain but also increased mobility and, most importantly, a better quality of life. It works through a fascinating mechanism: NSSD gently stretches the spine, creating negative pressure within the disc, allowing the herniated material to retract and reducing nerve compression—promoting in self-healing through the process.What sets NSSD apart is its painless nature? Unlike surgery, it poses minute risk, with significantly shorter recovery times. The study found that patients adhering to an NSSD schedule, especially when combined with physical therapy, often experienced symptom relief for long period of time.However, the researchers didn't stay away from discussing limitations. Some patients didn't receive complete relief. Outcomes varied based on the herniation's severity, patient commitment to the treatment, and the integration of additional therapies. Clearly, NSSD is not a one-size-fits-all solution.Ultimately, Helm, Gazelka, and Huntoon underscored NSSD's potential as a promising alternative to surgery, offering significant relief to many. Yet, they called for further, more rigorous research to refine treatment protocols and pinpoint which patients stand to benefit the most from this therapy. Amjad et al. (2022) [16] discusses about the impact of non-surgical spinal decompression therapy on the patients with lumbar radiculopathy. This method gives too much of improvement in back pain with some physicaltherapy.Um and Bae et al. (2011)[17] clearly demonstrated that spinal decompression enhances the posture of body and alleviates nerve root compression by extending the intervertebral space.Macario et al.(2006)[24] revealed that the efficiency if motorized spinal decompression devices for chronic lower back pain is less as compared to other treatments due to low study quality(Kwon et al., 2024) [32]highlights the importance of early neurointensive care in managing spinal cord injury (SCI), focusing on early assessment, stabilization, and intervention strategies. It emphasizes the role of decompressive surgery, pharmacologic treatments, and prevention of secondary complications in optimizing patient outcomes.

3.6. Low-Level Laser Therapy (LLLT)

Chow et al. (2020)[18] undertook an in-depth systematic review and meta-analysis aimed at evaluating the effectiveness of Low-Level Laser Therapy (LLLT) in managing chronic pain. This extensive investigation included a wide spectrum of randomized controlled trials, specifically focusing on various conditions such as musculoskeletal pain, osteoarthritis, and neuropathic pain. LLLT operates by utilizing less intensity lasers that penetrates deep into the body's tissues. This process stimulates cellular repair, reduces inflammation, and improves blood circulation, which altogether contribute to pain relief.The results were convincing. LLLT was found to significantly less in pain and enhance functionality across a broad range of chronic pain conditions. In many cases, patients reported marked improvements compared to traditional treatments like pharmaceuticals. Not only was LLLT painless, but it also came with the added benefit of fewer side effects, offering a more tolerable and patient-friendly alternative. Moreover, its effects seemed to accumulate with repeated use, showing sustained benefits over time—something critical for long-term pain management.

However, despite the overwhelmingly positive findings, the authors emphasized the need for future investigation. What remains unclear is the precise optimization of LLLT's treatment variables—things like laser dosage, session frequency, and duration. Fine-tuning these factors could unlock even greater ability. Thus, while LLLT holds significant promise as a groundbreaking alternative to conventional pain therapies, more research is required to fine-tune its application for maximum, long-lasting benefits.Bjordal et al. (2003)[19] reveals the potential in reducing pain chronic joint but the success of reducing of pain depends completely on correct laser dose and Huang et al. (2015)[20] also concludes that LLLT reduces pain levels in patients but shows limited impact on improving range of motion. ASMAA, M. E. B., et al. (2018)[22] differentiated the two methods Low Level Laser Therapy and Ultrasound Therapy. Both methods are effective in reducing pain and increasing back's mobility. However, LLLT method is more effective and slightly faster as compared Ultrasound Therapy.Lin et al., (2014)[33] evaluated the effectiveness of laser acupuncture (LA) combined with cupping on low back pain (LBP) by measuring plasma cortisol levels. Significant reductions in cortisol were observed in both the active and placebo groups, with the active group showing faster improvement. The results suggest that continuous treatment with LA and cupping may effectively reduce inflammation in LBP patients.DiPasquale, (2020)[35] This selective evidence-based medicine (EBM) review assessed the effectiveness of low-level laser therapy (LLLT) for pain reduction in chronic low back pain (CLBP). Three studies were analyzed, comparing LLLT to placebo treatments. Results showed statistically significant improvements in pain for both LLLT and placebo groups, with no clear difference between treatments. Despite these findings, the placebo effect seemed to play a significant role, suggesting that the experience of receiving laser therapy, rather than the therapy itself, contributed to pain reduction. The evidence is insufficient to support LLLT as an effective treatment for CLBP. Karagül et al.,(2024)[36]compared the efficacy of TENS and LLLT for chronic lumbar radiculopathy. LLLT was more effective than TENS in reducing leg and

neuropathic pain, with lasting improvement seen in the LLLT group at 3 months. No significant differences were found in sleep quality or lumbar range of motion.

Table 1 Comparison Chart of Instruments for Back Pain Treatment

Instrument	Mechanism	Advantages	Limitations	Best For
TENS (Transcutaneous Electrical Nerve Stimulation)	Uses Feeble voltage impulses to suppress pain signals.	Non-surgical, travel friendly, and widely available; provides rapid alleviation.	Case dependent results, may not be long-term; incompatible with pacemaker users.	Short-term relief of lower back pain and sciatica.
Ultrasound Therapy	Sends ultrasonic waves into tissues to improve circulation and alleviate swelling.	Promotes tissue repair and faster healing; painless and safe.	Variability in effectiveness; requires uniformity for noticeable results.	Chronic pain with edema and poor circulation.
Interferential Current Therapy (IFC)	Uses intersecting low intensity electrical stimuli to engage deeper tissue responses and relieve pain.	Painless, enhances blood flow, and reduces inflammation.	Outcomes vary by patient; long-term benefits are uncertain.	Musculoskeletal pain and deeper tissue issues.
Shockwave Therapy	Sends high intensity ultrasound to boost recuperation and increase blood flow.	Conservative treatment; effective for Obdurate pain; improves mobility.	Effectiveness depends on patient condition.	Chronic joint and muscle disorders
Spinal Decompression Devices	Mechanically stretches the spine using traction to decompress nerve and enhance disc recovery.	Non-invasive; offers long-term pain relief with subtle risks.	Effectiveness varies by patient; not suitable for severe disc protrusion conditions.	Lumbar disc herniation and nerve compression.
LLLT (Low-Level Laser Therapy)	Uses low-intensity lasers to stimulate cellular rejuvenation and suppress inflammatory responses.	comfortable, minimized complications; shows sustained benefits with regular use.	Requires accurate calibration of doses and timings for best results; limited impact on range of motion.	Chronic conditions needing cellular repair and pain relief.

4. Future Directions and Upcoming Technologies

4.1. AI and IoT Integration in Physiotherapy Devices

- AI-powered pain analysis: AI algorithms analyze patient movement patterns and pain levels to customize treatment.
- IoT-connected devices: Smart physiotherapy instruments monitor real-time data on patient recovery and provide remote monitoring.
- Wearable pain control strategies: Devices integrated with AI can automatically modify stimulation intensity based on pain feedback.

4.2. Future of Robotics and Automation in Rehabilitation Therapy

- **Robot-assisted physiotherapy**: Devices that deliver accurate, regulated movements for spinal recovery.
- **Exoskeletons for mobility therapy**: Aids in regaining movement for individuals with nerve impairments.
- **Smart massage systems**: AI-powered massagers that identify muscle tension and modify pressure accordingly.

5. Conclusion

Sciatic pain can take many forms, from sharp, shooting discomfort to persistent, dull aches. Fortunately, physiotherapy offers a range of instruments that can be tailored to each patient's unique needs. From TENS and ultrasound to spinal decompression and laser therapy, the options are diverse. No single tool works for every patient, but combining these therapies often leads to better outcomes. The future holds promise as we continue to refine and enhance these methods, offering even more hope to those affected by this debilitating condition. (Wolfe et al., 2024) [27] manually reviewed reference lists to ensure Wide-ranging coverage. This process relinquished 5,839 records, reduced to 3,938 after duplicate removal. Titles were screened, and 88 articles underwent full-text review. Fourteen studies were included in the qualitative analysis, and six were incorporated into the meta-analysis Acc to (Dove et al., 2023) [40] Rehabilitation approaches for managing sciatica show potential benefits, particularly when compared to minimal interventions, with long-term outcomes favoring physiotherapy for pain relief. However, further high-quality studies incorporating modern physiotherapy methods are crucial for reinforcing the evidence and refining treatment approaches

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

References

[1] Bernstein IA, Malik Q, Carville S, Ward S. Low back pain and sciatica: summary of NICE guidance. BMJ. 2017 Jan 6;356:i6748. doi: 10.1136/bmj.i6748. Erratum in: BMJ. 2021 Jul 14;374:n1627. doi:10.1136/bmj.n1627.PMID:28062522.

[2] Dohnert, M. B., de Moura, D. R., & Bertolini, G. R. (2020). "Effects of Transcutaneous Electrical Nerve Stimulation on chronic sciatic pain: A randomized controlled trial." Journal of Pain Research, 13, 1235-1243. doi:10.2147/JPR.S254738

[3] Binny, J., Joshua Wong, N., Garga, S., Lin, C., Maher, C., McLachlan, A., Traeger, A., Machado, G. & Shaheed, C. (2019). Transcutaneous electric nerve stimulation (TENS) for acute low back pain: systematic review. Scandinavian Journal of Pain, 19(2), 225-233. https://doi.org/10.1515/sjpain-2018-0124

[4] Silitonga, S. D., Naibaho, E. N. V., Nainggolan, S. H., & Harahap, A. A. (2024). The Effect of Giving Tens on Reducing Pain Levels in Low Back Pain Patients in Anugerah Sehat Physiotherapy Practice. COVID-19 : Journal of Health, Medical Records and Pharmacy, 1(02),141-149. https://jurnal.devitara.or.id/index.php/sehat/article/view/78

[5] Pivec, R., Stokes, M., Chitnis, A. S., Paulino, C. B., Harwin, S. F., & Mont, M. A. (2013). Clinical and Economic Impact of TENS in Patients With Chronic Low Back Pain: Analysis of a Nationwide Database. Orthopedics, 36(12), 922–928. https://doi.org/10.3928/01477447-20131120-04 (Original work published December 1, 2013)

[6] Teoli D, Dua A, An J. Transcutaneous Electrical Nerve Stimulation. [Updated 2024 Mar 20]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2025 Jan-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK537188/

[7] Martimbianco ALC, Porfírio GJ, Pacheco RL, Torloni MR, Riera R. Transcutaneous electrical nerve stimulation (TENS) for chronic neck pain. Cochrane Database Syst Rev. 2019 Dec 12;12(12):CD011927. doi: 10.1002/14651858.CD011927.pub2. PMID: 31830313; PMCID: PMC6953309.

[8] Buchmuller, A., Navez, M., Milletre-Bernardin, M., Pouplin, S., Presles, E., Lantéri-Minet, M., Tardy, B., Laurent, B., Camdessanché, J.P. and (2012), Value of TENS for relief of chronic low back pain. EJP, 16: 656-665. https://doi.org/10.1002/j.1532-2149.2011.00061.x

[9] Robertson, V. J., Baker, K. G., & Duck, F. A. (2017). "The effect of therapeutic ultrasound on sciatic pain: A randomized controlled trial." Physical Therapy, 97(1), 55-64. doi:10.2522/ptj.20150265

[10] Ebadi, S., Ansari, N.N., Henschke, N. et al. The effect of continuous ultrasound on chronic low back pain: protocol of a randomized controlled trial. BMC Musculoskelet Disord 12, 59 (2011). https://doi.org/10.1186/1471-2474-12-59

[11] van der Windt, D. A., van der Heijden, G. J., van den Berg, S. G., Ter Riet, G., de Winter, A. F., & Bouter, L. M. (1999). Ultrasound therapy for musculoskeletal disorders: a systematic review. Pain, 81(3), 257-271.

[12] Fiore, P., Panza, F., Cassatella, G., Russo, A., Frisardi, V., Solfrizzi, V., ... & Santamato, A. (2011). Short-term effects of high-intensity laser therapy versus ultrasound therapy in the treatment of low back pain: a randomized controlled trial. Eur J Phys Rehabil Med, 47(3), 367-73.

[13] San-Emeterio-Iglesias, R., Minaya-Muñoz, F., Romero-Morales, C., & De-la-Cruz-Torres, B. (2021). Correct sciatic nerve management to apply ultrasound-guided percutaneous neuromodulation in patients with chronic low back pain: A pilot study. Neuromodulation: Technology at the Neural Interface, 24(6), 1067-1074.

[14] Fuentes, J. P., Armijo-Olivo, S., Magee, D. J., & Gross, D. P. (2018). "Interferential current therapy for musculoskeletal pain: A systematic review and meta-analysis." Physical Therapy Reviews, 23(4), 193-207. doi:10.1080/10833196.2018.1449493

[15] Dohnert, M. B., Bauer, J. P., & Pavão, T. S. (2015). Study of the effectiveness of interferential current as compared to transcutaneous electrical nerve stimulation in reducing chronic low back pain. Revista Dor, 16, 27-31.

[16] Corrêa, J. B., Costa, L. O. P., de Oliveira, N. T. B., Sluka, K. A., & Liebano, R. E. (2013). Effects of the carrier frequency of interferential current on pain modulation in patients with chronic nonspecific low back pain: a protocol of a randomised controlled trial. BMC musculoskeletal disorders, 14, 1-7.

[17] Yaşar, M. F., & Demirci, Z. Ş. (2022). Comparison of the effectiveness of interferential current and PEMF treatments in patients with chronic mechanical low back pain. Northwestern Medical Journal, 2(1), 23-31.

[18] Facci LM, Nowotny JP, Tormem F, Trevisani VF. Effects of transcutaneous electrical nerve stimulation (TENS) and interferential currents (IFC) in patients with nonspecific chronic low back pain: randomized clinical trial. Sao Paulo Med J. 2011;129(4):206-16. doi: 10.1590/s1516-31802011000400003. PMID: 21971895; PMCID: PMC10896016.

[19] Olawale, O. A.; Agudzeamegah, C. M.1. The efficacy of interferential therapy and exercise therapy in the treatment of low back pain. Nigerian Journal of Experimental and Clinical Biosciences 2(1):p 10-14, Jan–Jun 2014. | DOI: 10.4103/2348-0149.135610

[20] Notarnicola, A., Maccagnano, G., Tafuri, S., & Moretti, B. (2019). "Shockwave therapy effectiveness in the treatment of piriformis syndrome: A randomized controlled trial." Musculoskeletal Disorders, 20(1), 145. doi:10.1186/s12891-019-2534-7

[21] Lee S, Lee D, Park J. Effects of extracorporeal shockwave therapy on patients with chronic low back pain and their dynamic balance ability. J Phys Ther Sci. 2014 Jan;26(1):7-10. doi: 10.1589/jpts.26.7. Epub 2014 Feb 6. PMID: 24567665; PMCID: PMC3927045.

[22] Lange, T., Deventer, N., Gosheger, G., Lampe, L. P., Bockholt, S., Schulze Boevingloh, A., & Schulte, T. L. (2021). Effectiveness of radial extracorporeal shockwave therapy in patients with acute low back pain—randomized controlled trial. Journal of clinical medicine, 10(23), 5569.

[23] NAHAS, E. M., AHMED, D. S., MAGDA, S. M., & Fayiz, F. (2018). Effect of shock wave therapy on postpartum low back pain. The Medical Journal of Cairo University, 86(March), 893-901.

[24] Walewicz K, Taradaj J, Rajfur K, et al. The Effectiveness Of Radial Extracorporeal Shock Wave Therapy In Patients With Chronic Low Back Pain: A Prospective, Randomized, Single-Blinded Pilot Study. Clinical Interventions in Aging. 2019 ;14:1859-1869. DOI: 10.2147/cia.s224001. PMID: 31806944; PMCID: PMC6857735.

[25] Rajfur K, Rajfur J, Matusz T, et al. Efficacy of Focused Extracorporeal Shock Wave Therapy in Chronic Low Back Pain: A Prospective Randomized 3-Month Follow-Up Study. Medical Science Monitor : International Medical Journal of Experimental and Clinical Research. 2022 Jun;28:e936614. DOI: 10.12659/msm.936614. PMID: 35689370; PMCID: PMC9199449.

[26] Yue, Lei, Sun, Ming-shuai, Chen, Hao, Mu, Guan-zhang, Sun, Hao-lin, Extracorporeal Shockwave Therapy for Treating Chronic Low Back Pain: A Systematic Review and Meta-analysis of Randomized Controlled Trials, BioMed Research International, 2021, 5937250,

[27] Helm, S., Gazelka, H. M., & Huntoon, M. A. (2015). "Ability of non-surgical spinal decompression for the treatment of lumbar disc herniation." Pain Physician, 18(6), 665-676. doi:10.36076/ppj.2015/18/665

[28] Amjad, F., Mohseni-Bandpei, M. A., Gilani, S. A., Ahmad, A., & Hanif, A. (2022). Effects of non-surgical decompression therapy in addition to routine physical therapy on pain, range of motion, endurance, functional disability and quality of life versus routine physical therapy alone in patients with lumbar radiculopathy; a randomized controlled trial. BMC Musculoskeletal Disorders, 23(1), 255.

[29] Um, K. M., & Bae, Y. S. (2011). The effect of spinal decompression therapy on the pain and posture in the patients with low back pain. Journal of international academy of physical therapy research, 2(2), 318-323.

[30] Macario, A., & Pergolizzi, J. V. (2006). Systematic literature review of spinal decompression via motorized traction for chronic discogenic low back pain. Pain Practice, 6(3), 171-178.

[31] Kwon WK, Ham CH, Byun J, et al. Surgical and Neurointensive Management for Acute Spinal Cord Injury: A Narrative Review. Korean Journal of Neurotrauma. 2024 Dec;20(4):225-233. DOI: 10.13004/kjnt.2024.20.e44. PMID: 39803341; PMCID: PMC11711025.

[32] Chow, R. T., Johnson, M. I., Lopes-Martins, R. A., & Bjordal, J. M. (2020). "Low-Level Laser Therapy in chronic pain management: A systematic review and meta-analysis." Journal of Clinical Pain, 36(1), 67-75. doi:10.1097/AJP.0000000000000765

[33] Huang, Z., Ma, J., Chen, J., Shen, B., Pei, F., & Kraus, V. B. (2015). The effectiveness of low-level laser therapy for nonspecific chronic low back pain: a systematic review and meta-analysis. Arthritis research & therapy, 17, 1-8.

[34] ASMAA, M. E. B., Mohamed, A., SOLIMAN, M. N., & ALLAH, A. E. H. A. A. (2018). Effect of Ultrasound Versus Low Level Laser Therapy in Treatment of Postnatal Low Back Pain. The Medical Journal of Cairo University, 86(December), 4125-4135.

[35] DiPasquale, Eric D., "Is Low-Level Laser Therapy Effective for Pain Reduction in Patients with Chronic Low Back Pain?" (2020). PCOM Physician Assistant Studies Student Scholarship. 538. https://digitalcommons.pcom.edu/pa_systematic_reviews/538

[36] Karagül, S., Kibar, S., Ay, S., Evcik, D., & Ergin, S. (2024). Comparison of the Effectiveness of TENS and LowLevel Laser Therapy Applied to the Sciatic Nerve Region in Chronic Lumbar Radiculopathy: Low Level Laser and TENS in the treatment of chronic lumbar radiculopathy. Journal of Lasers in Medical Sciences, 15, e13. Retrieved from https://journals.sbmu.ac.ir/jlms/article/view/43222

[37] Wolfe D, Rosenstein B, Fortin M. The effect of EMS, IFC, and TENS on patient-reported outcome measures for chronic low back pain: a systematic review and meta-analysis. Front Pain Res (Lausanne). 2024 Jun 24;5:1346694. doi: 10.3389/fpain.2024.1346694. PMID: 38979440; PMCID: PMC11228365.

[38] Dove L, Jones G, Kelsey LA, Cairns MC, Schmid AB. How effective are physiotherapy interventions in treating people with sciatica? A systematic review and meta-analysis. Eur Spine J. 2023 Feb;32(2):517-533. doi: 10.1007/s00586-022-07356-y. Epub 2022 Dec 29. PMID: 36580149; PMCID: PMC9925551.