Neue invasive Methoden der Schmerztherapie

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Conflict of Interest:

Vortragshonorare und Advisory Boards
Wissenschaftsunterstützungen

Grünenthal, Gerot Lannacher, Gebro-Pharma, CSC-Pharma, Böhringer Ingelheim, Sintetico, Reckitt Benkiser, Indivior, Fresenius

H.-N. M., geboren 1979/Januar 2021

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Ambulanzbesuch: 28.01.2021

Anamnese:

Die Patientin ist im Jahr 2011 auf einen Nagel getreten und hat sich dabei eine Infektion und eine Nervenverletzung im Bereich der linken Fußsohle zugezogen. In der Folge wurden mehrere Operationen und Revisionsoperationen und letztendlich ein Axogen Nerveninterponat erforderlich, Z.n. Neurolyse und Rekonstruktion des N. plant. med. li.

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Verlauf:

Die Patientin gibt derzeit VAS 7 an. Schmerzqualität: stechend und brennend und zwar im Bereich des linken Oberschenkels medial vor allem aber links am medialen Fußrand. Hier zeigt sich medial an der Fußsohle eine starke Vernarbung, lateral davon bestehen keine wesentlichen Schmerzen, medial davon heftigste Schmerzen und eine Berührungsempfindlichkeit eher dem Nervus tibialis(saphenus) entsprechend. Die Schmerzen erstrecken sich bis in Höhe des Innenknöchels. Im Bereich der Zehen und der Fußballen gibt die Patientin ein bamstiges Gefühl an.

15.02.2021 Neurochirurgie

Diagnosen:

Chronisches Schmerzsyndrom mit liegendem Impulsgeber disloziert im linken Oberschenkel medialseitig
Status post Nervus plantaris Freilegung 2012
Status post Nerventransfer in Graz im Bereich des Nervus plantaris 2014
Status post Implantation von zwei 8 poligen Sonden im Bereich des Nervus ischiadicus dorsalseitig Oberschenkel links mit Impulsgeberimplantationen links gluteal und im Weiteren links präabdominell und im Weiteren links Oberschenkel medialseitig

Letztendlich wurde der Patientin ein peripherer Nervenstimulator am Nervus ischiadicus links implantiert. Der Impulsgeber war ursprünglich am Bauch, dann am Gesäß, mittlerweile ist er medial am Oberschenkel links implantiert, wo er jedoch nach distal wandert. Anfangs hatte ihr dieser Nervenstimulator eine gewisse Verbesserung gebracht, sie war aber nie richtig zufrieden von Seiten der Schmerzsituation, mit jeder Revisionsoperation des Impulsgebers wurde die Schmerzsituation schlechter.

Eine Nervenleitfähigkeitsmessung von Jänner 2014 ergab eine **neuropathische Schmerzsymptomatik**, der neurophysiologische Befund war unauffällig.

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Derzeitige Therapie:

Lyrica 150-150-225 mg.
Trittico 75 mg 0-0-0-2/3.
Cymbalta 60 mg 1-0-0.
Sowie als Schilddrüsenmedikation Thyrex und Novothyral.

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Therapievorschlag:

Dronabinol Tropfen 3 x 3. Bei unzureichender Wirkung und guter Verträglichkeit Steigerung auf 3 x 3 Tropfen, dann max. 3 x 12 Tropfen.

Weitere Therapiemöglichkeiten???

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Ambulanzbericht 03.02.2021

Bei der Patientin wird heute eine N.tibialis Blockade links durchgeführt.
Es wird 10 ml Naropin 0,2 %ig injiziert. Es wird mit Nervenstimulator genau eine Plantarflexion ausgelöst. Die Patientin hat im Bereich des Schmerzareals im Plantarbereich dann keine Schmerzen, ist schmerzfrei.
Das heißt das ist eine Indikation für eine Implantation einer Bioness-Sonde ultraschallgezielt am tibialen Anteil des distalen N. ischiadicus.

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Ambulanzbericht 07.04.2021:

Bei der Patientin wird heute im Bereich des linken Fußes, im Bereich der Nervus tibialis, eine Bioness-Sonde eingebaut. Es wird der Nerv aufgesucht, ultraschallgezielt markiert, dann die Bioness-Sonde praktisch positioniert und diese dann im linken Fußbereich dann stimuliert.

Die Patientin kommt dann postoperativ zur Überwachung auf die Tagesklinik und das weitere Procedere ist dann vom Erfolg abhängig.

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Ambulanzbericht 21.04.2021:

Die Patientin kommt zur Kontrolle nach Implantation eines peripheren Nervenstimulators am linken Unterschenkel, Nervus tibialis.
Sie berichtet, dass es zu einer guten Schmerzreduktion gekommen ist und ist ausgesprochen zufrieden mit der Situation. 1 Naht wird am linken Unterschenkel entfernt, blande Wundverhältnisse. **NRS 1-2**
Beeinträchtigt ist die Patientin massiv durch den Impulsgeber am linken Oberschenkel, der mittlerweile ans mittlere Drittel medialseitig verrutscht ist und hier beim Gehen ständig reibt und sehr schmerzhaft ist. Diesbezüglich wird sofort NCH Kontakt aufgenommen und die Verlagerung des Impulsgeber geplant.
Kontrolle mit der Bioness Sonde in 3 Monaten terminsiert.

Am 19.5 Revision des Impulsgeber und plastische Straffung

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Ambulanzbericht vom 21.07.2021

Die Patientin ist ausgesprochen zufrieden, die Schmerzen im Bereich der linken unteren Extremität treten nur noch etwa alle 2 Wochen auf in einer Intensität von VAS 3-4. Sie bemerkt eine massive Steigerung ihrer Lebensqualität. Das alte System am linken Oberschenkel wurde ausgebaut. Die Patientin hat insgesamt 4 Operationen, auch aufgrund einer Infektion, benötigt. Heute noch Gespräch mit dem Techniker.

08/2022

Patientin VAS 0-1,gut mobil,kann längere Spaziergänge machen

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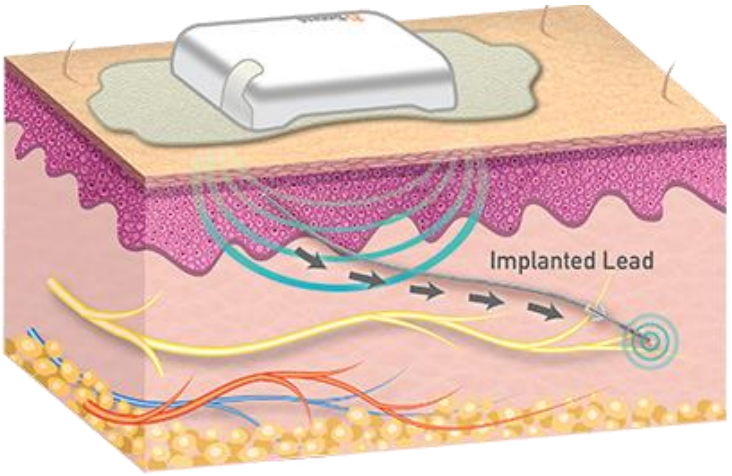
StimRouter Neuromodulation System



Minimally-invasive implant designed to treat **chronic pain of peripheral nerve origin,** below the cranial facial region. The minimally-invasive lead implant procedure is performed **under local anesthesia** through a small incision.

Powered externally through the skin to stimulate the target peripheral nerve with a small, focal electrical field - interrupting the pain signal to alleviate pain.

Puts **patients in control** of their pain with a handheld, wireless Patient Programmer.

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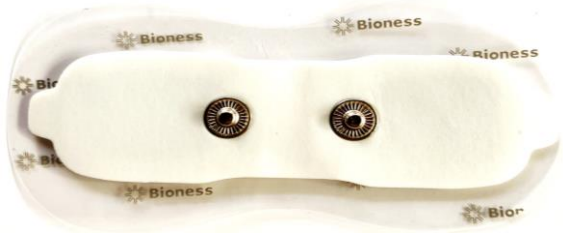
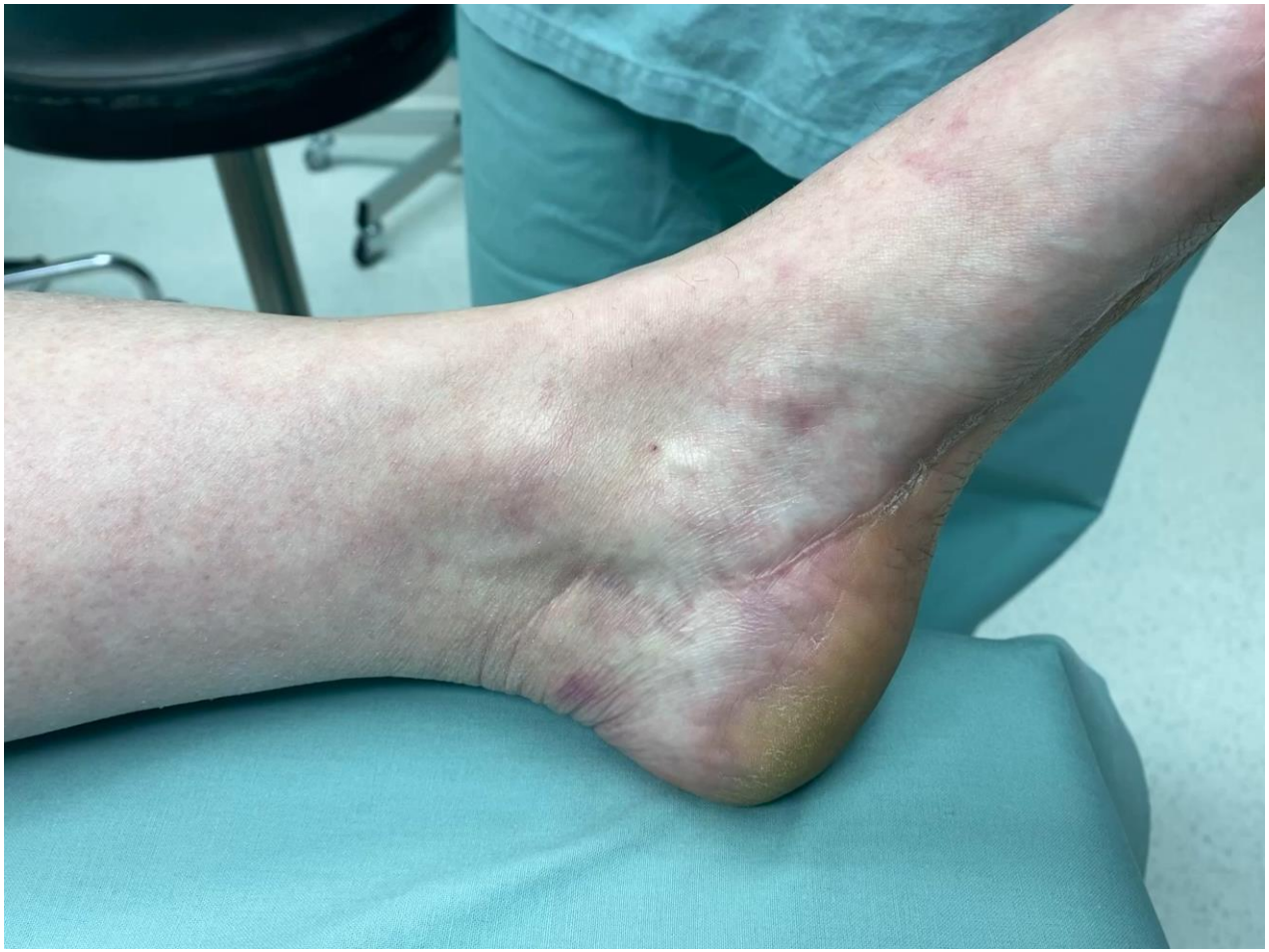
StimRouter-System
Komponenten

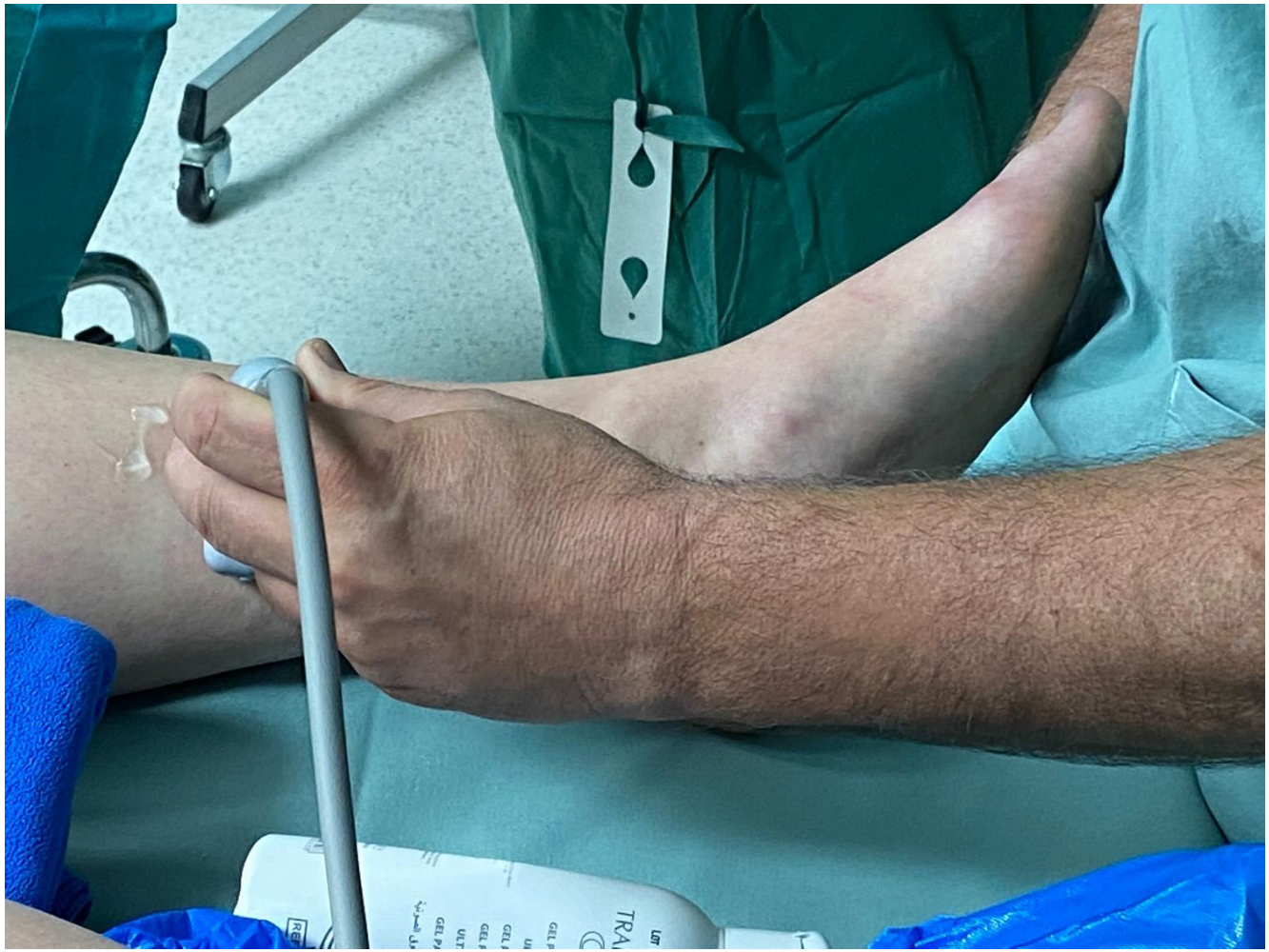
Externer Pulse Transmitter (EPT) überträgt E-Feld Stimulation

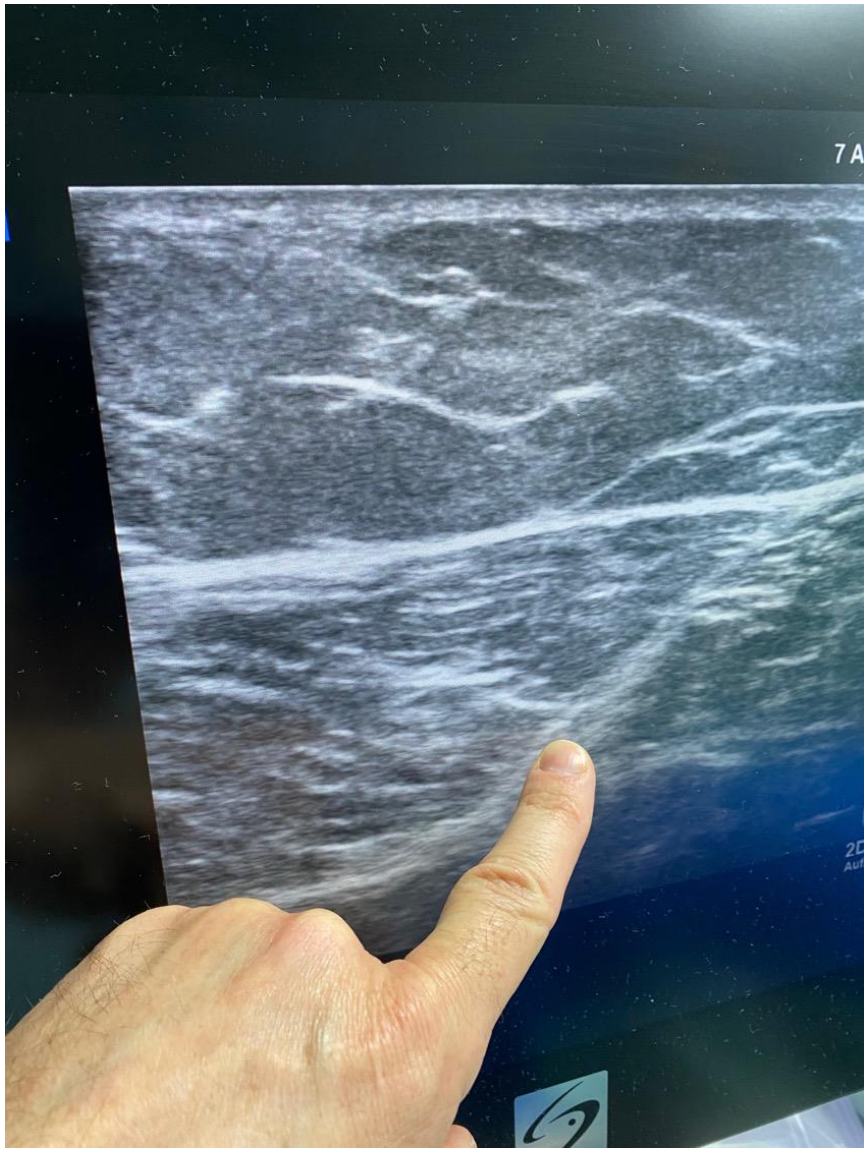
Wird nach Stimulation abgenommen und über Nacht aufgeladen



Gel Elektrode wird alle 2-5 Tage erneuert



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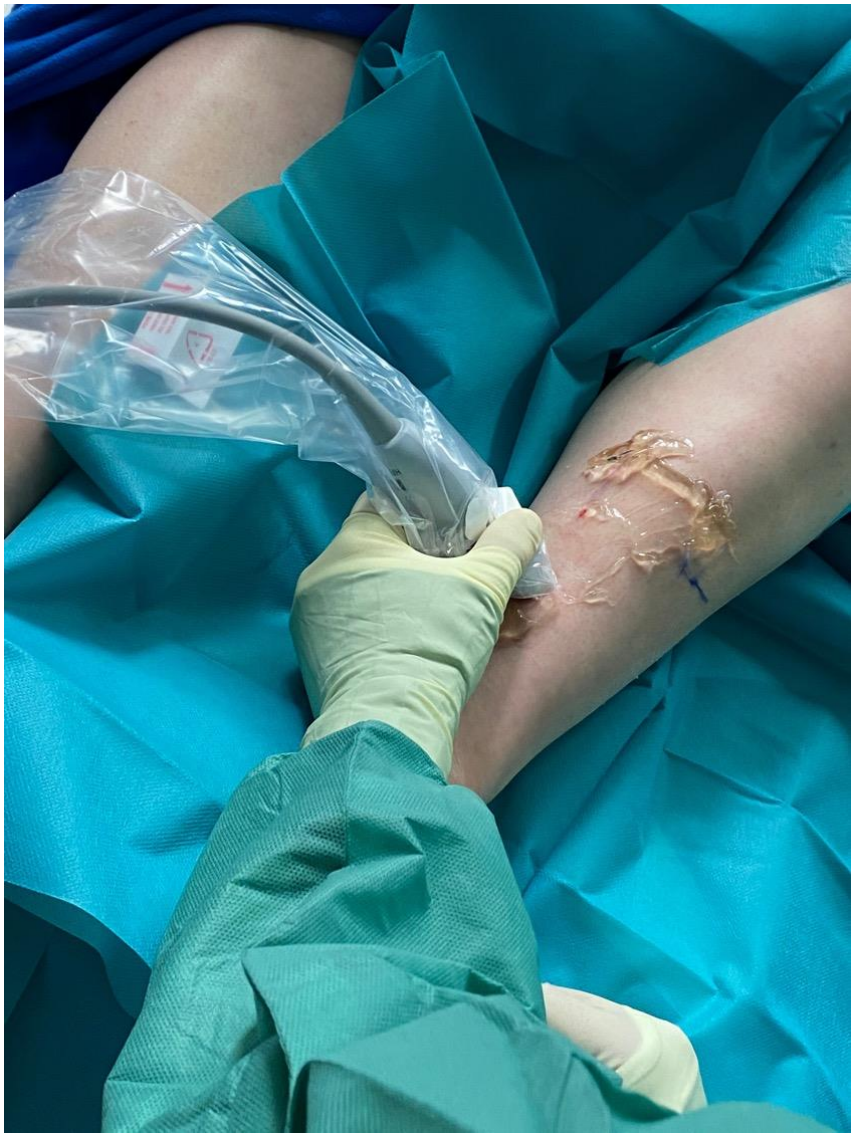

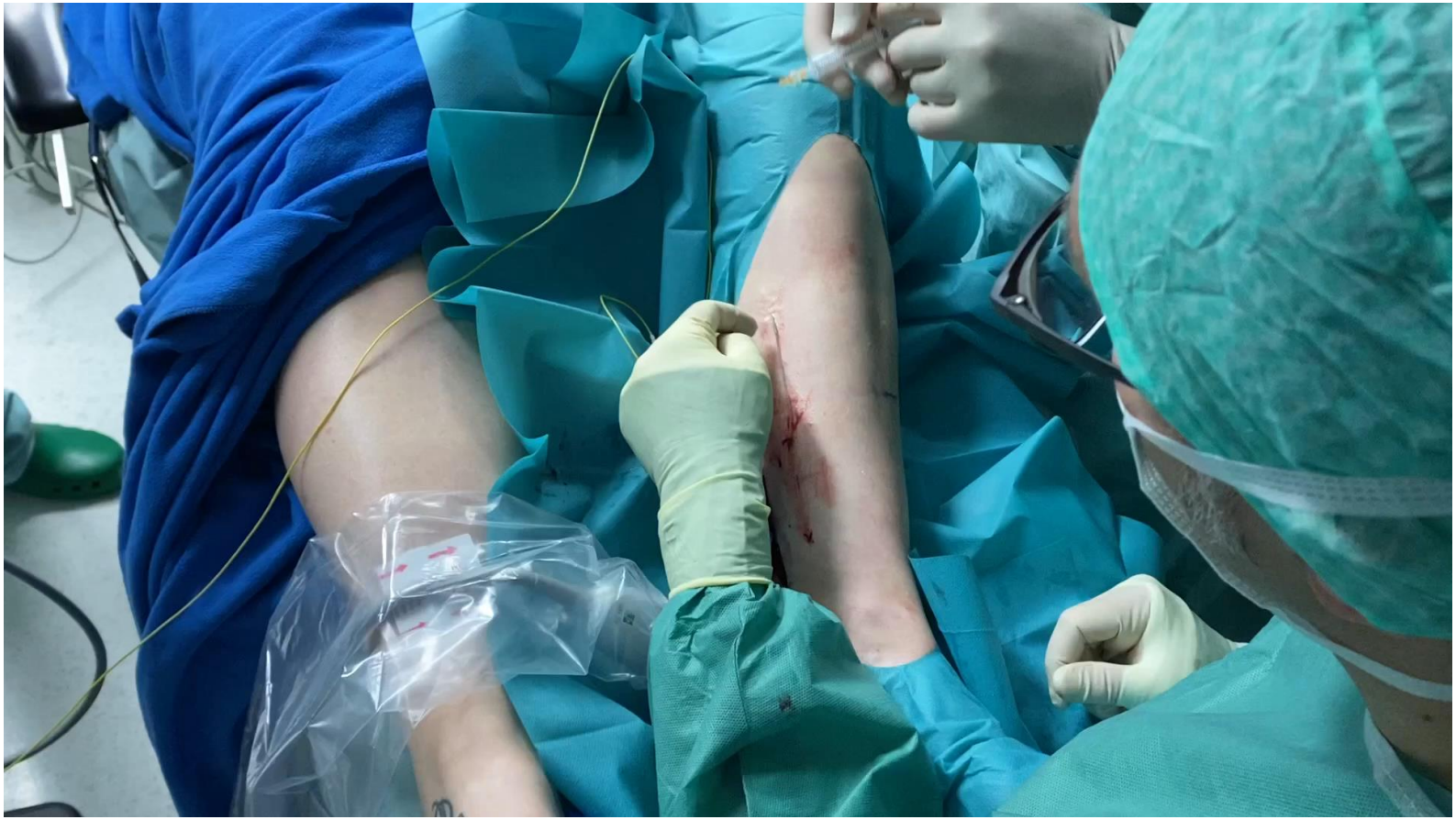

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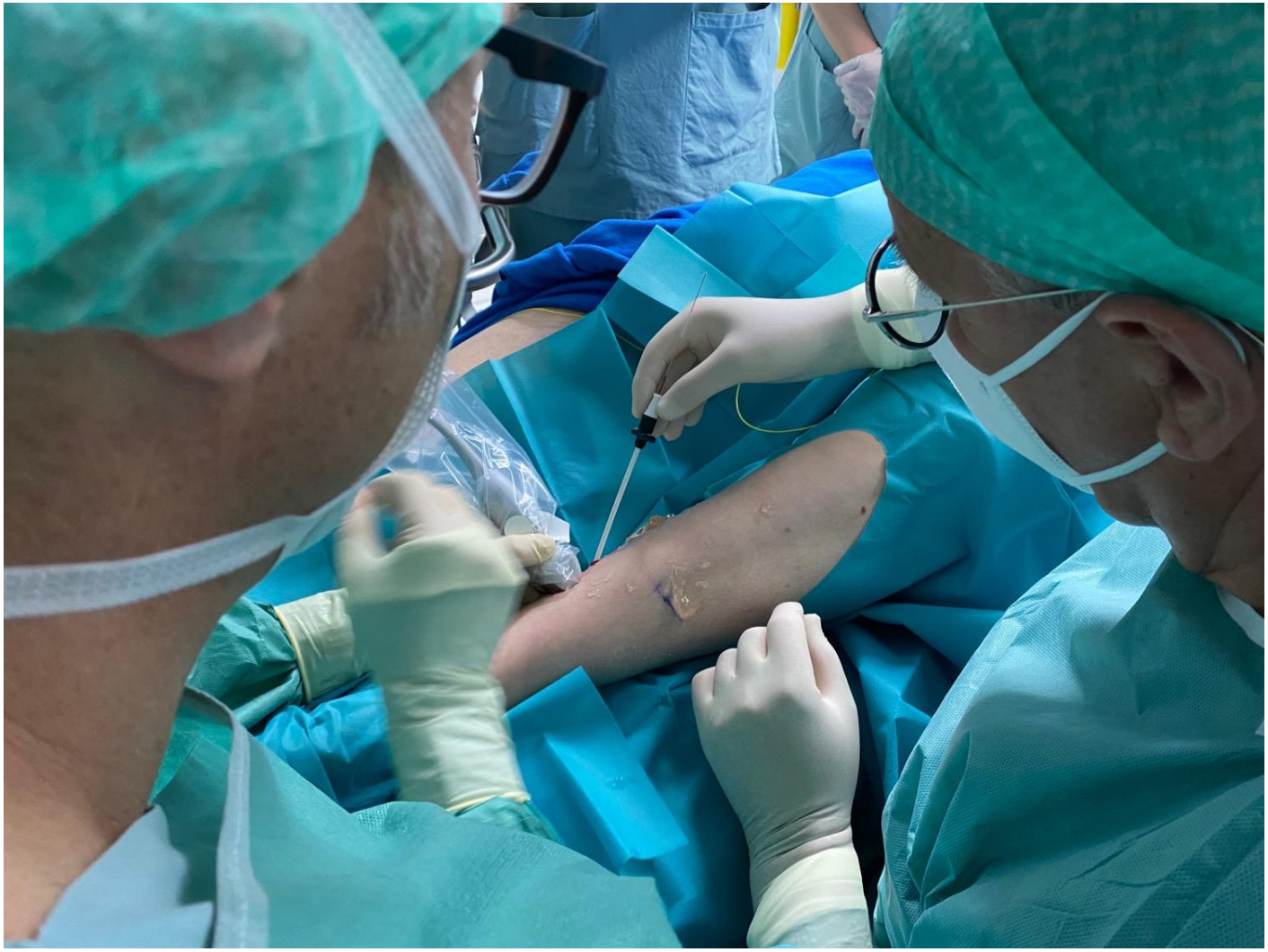

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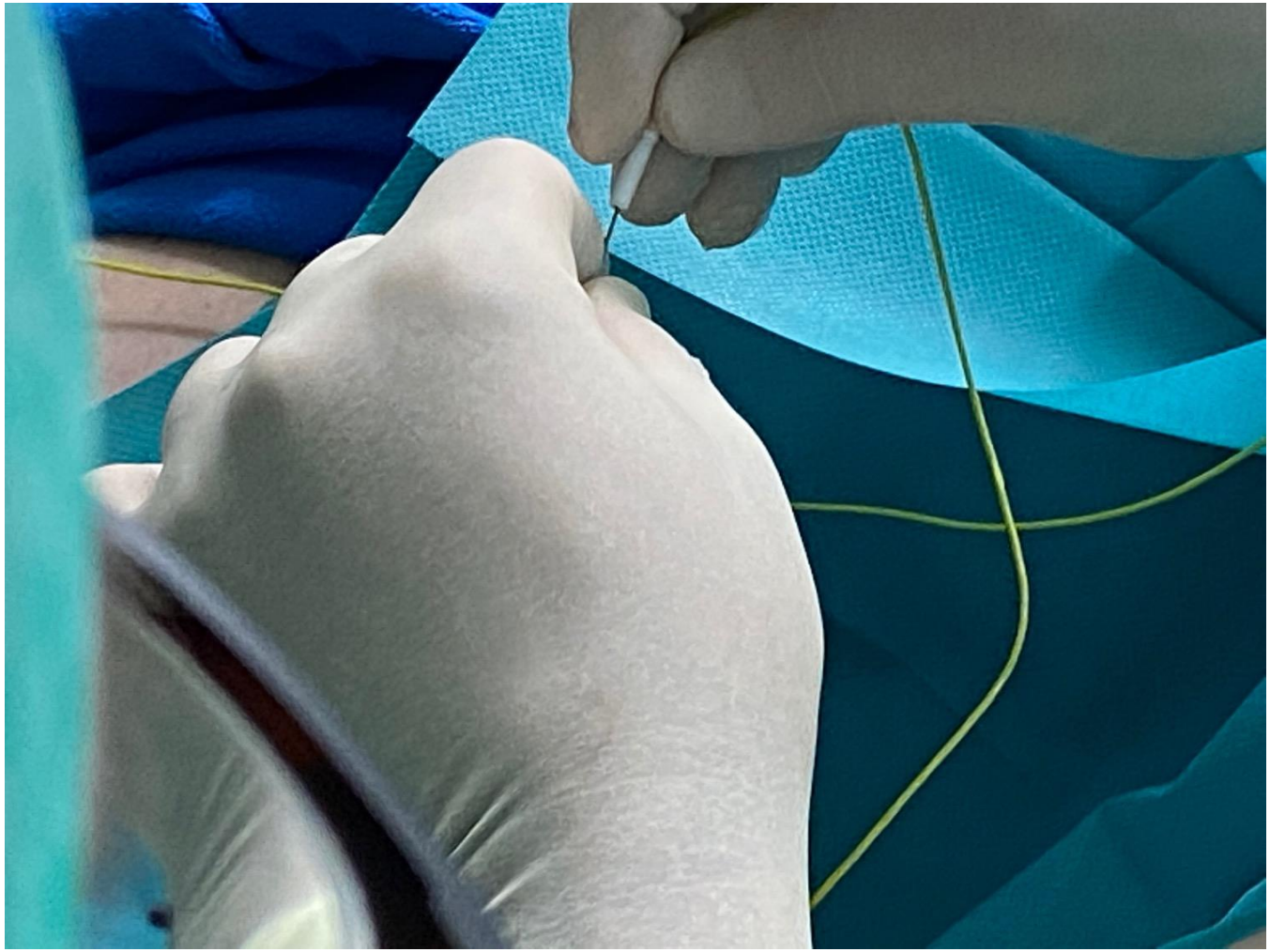

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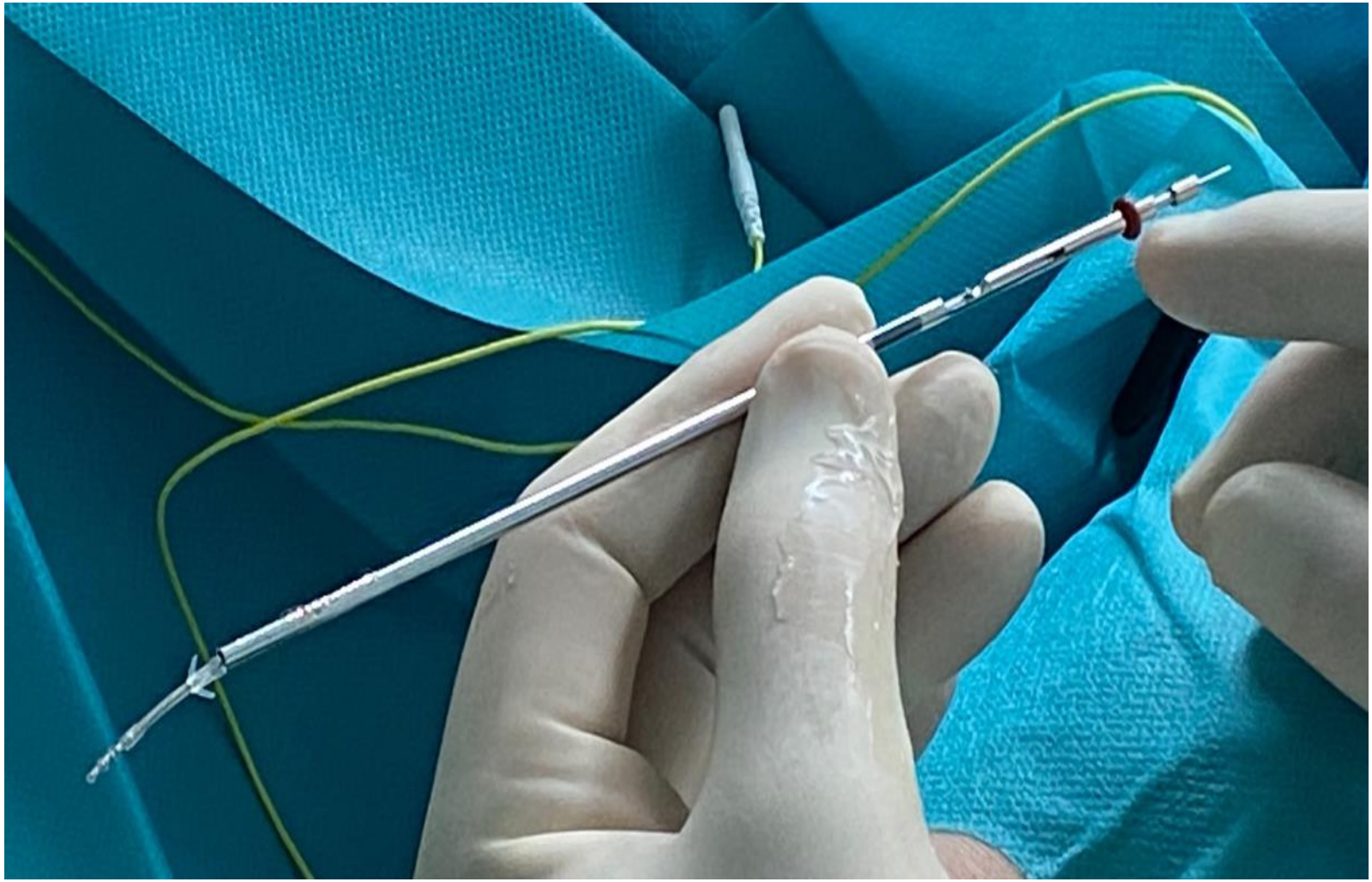
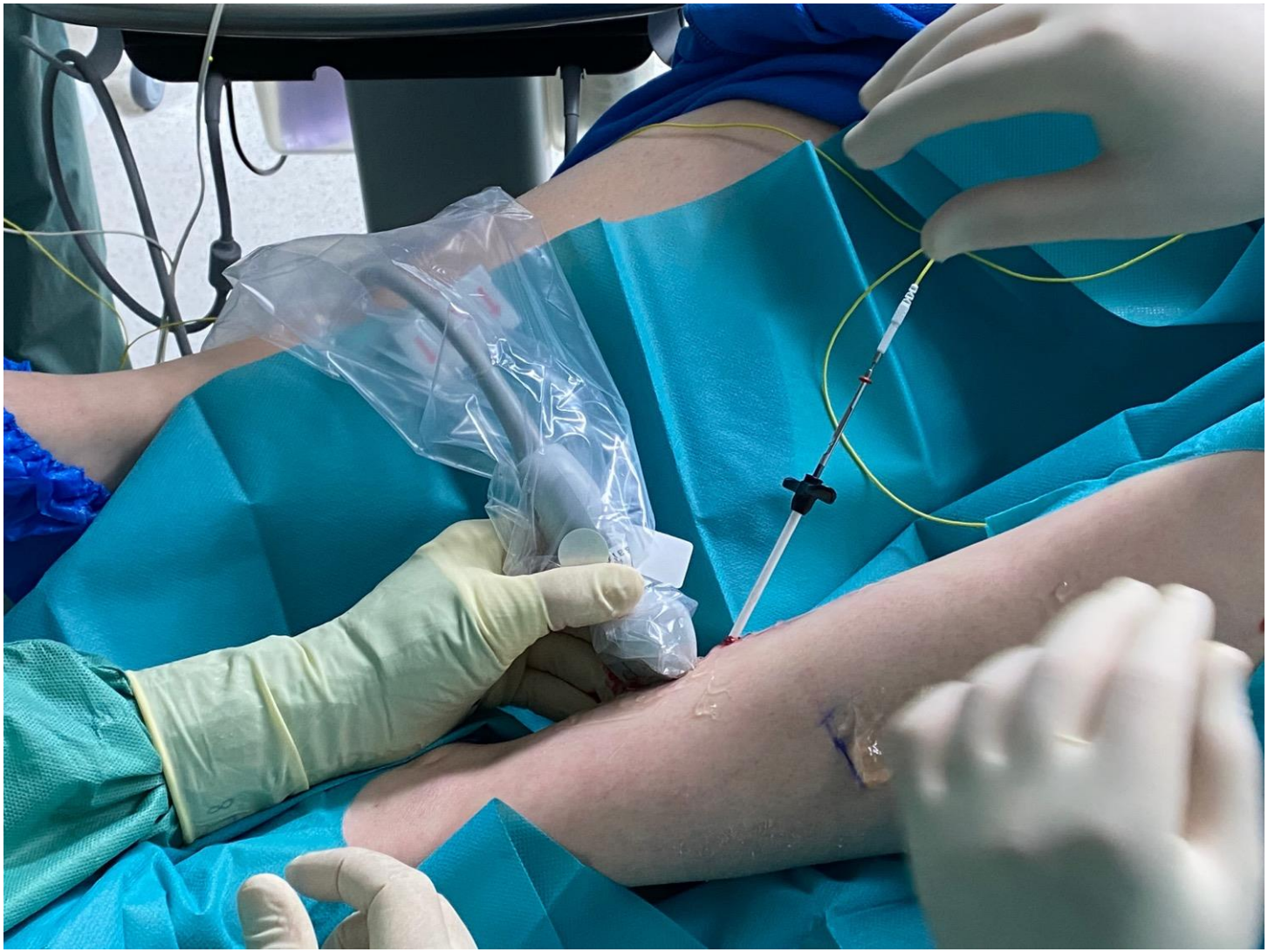
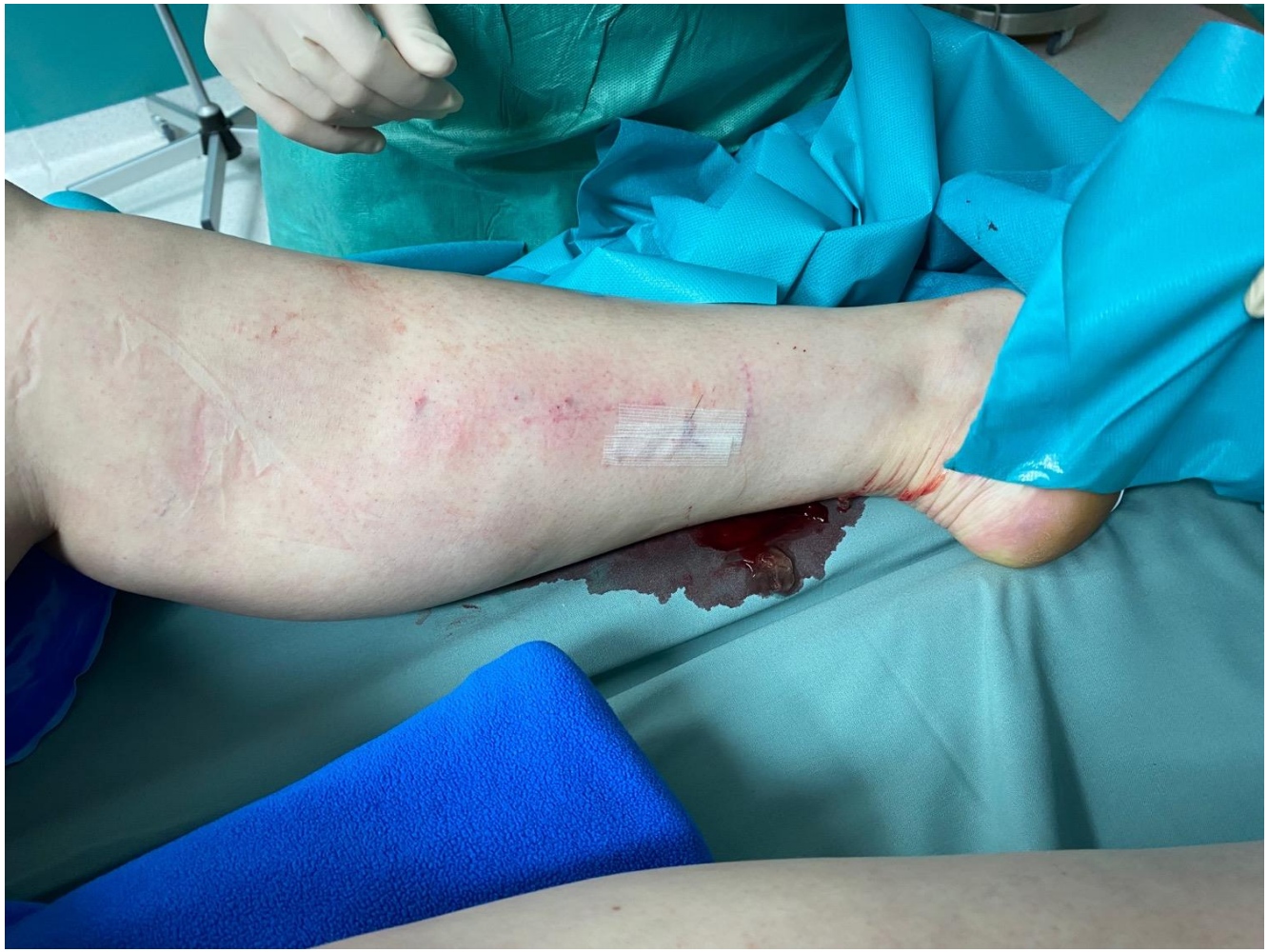
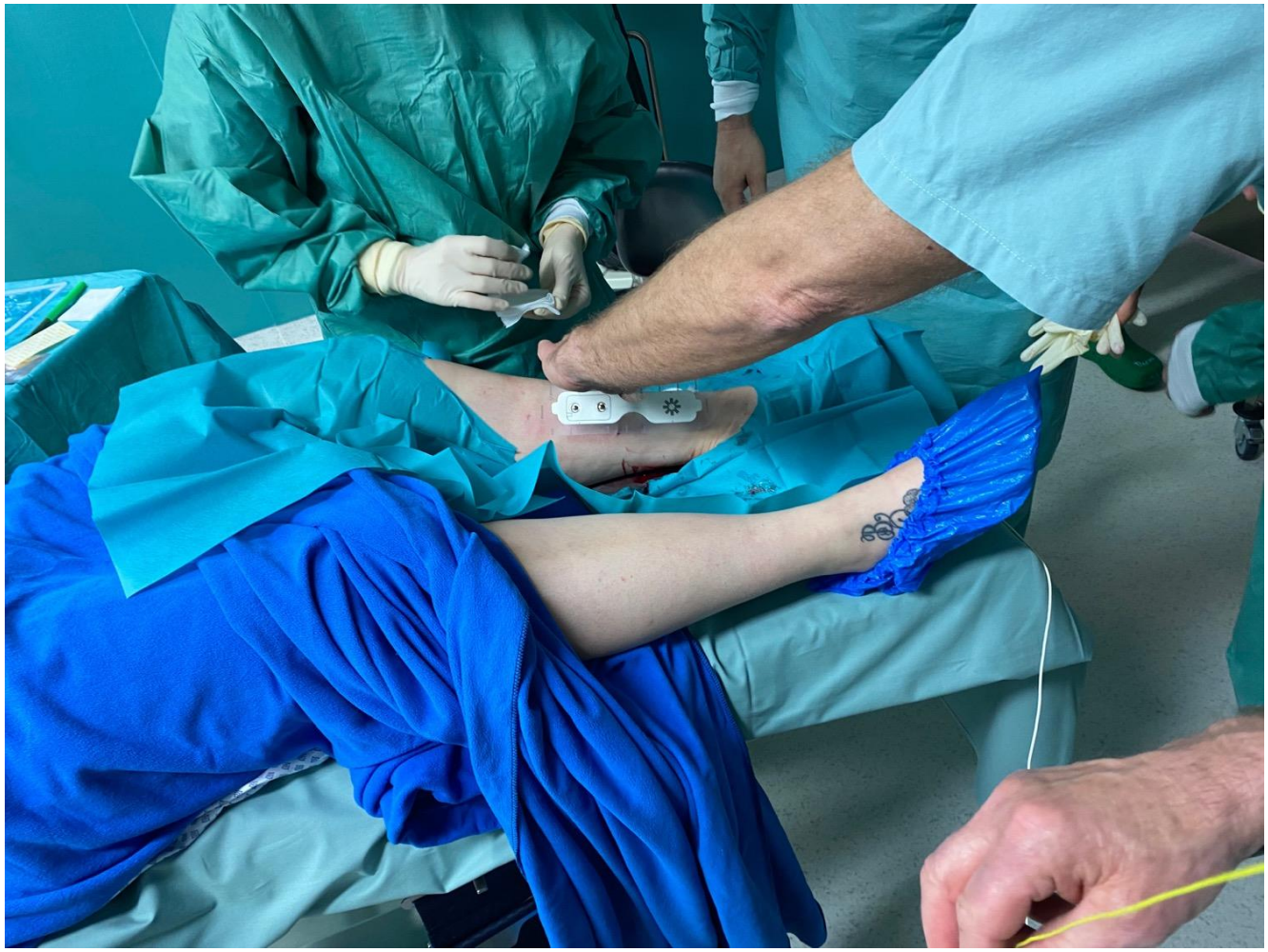
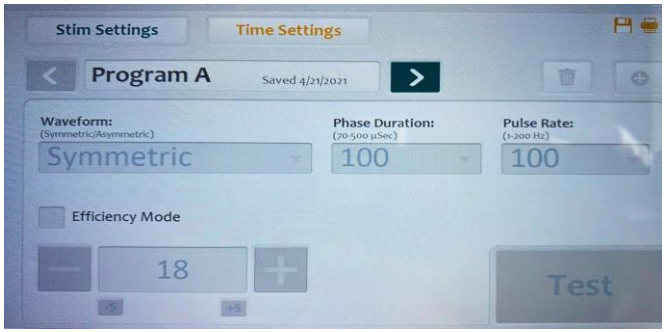


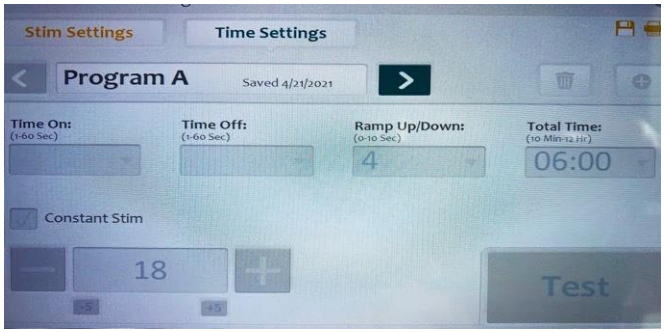


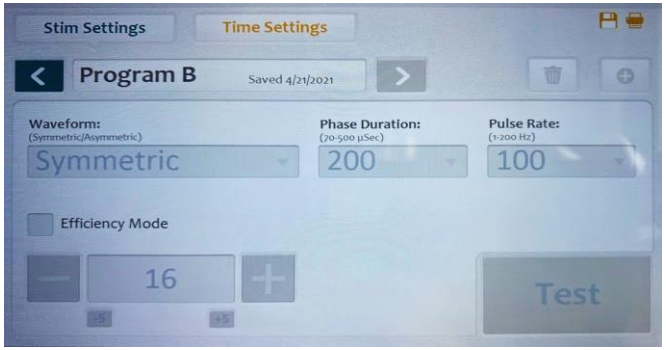


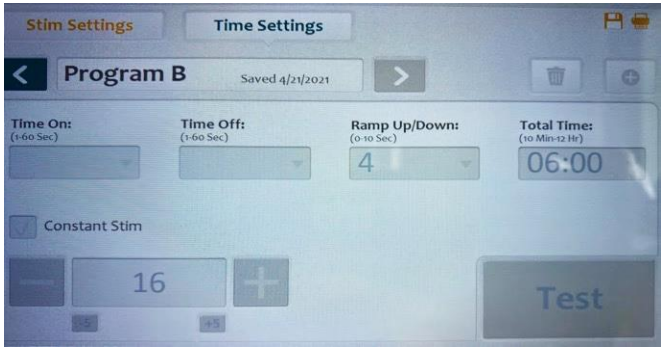


Bis zu 8 verschiedene Programme im Patienten-Gerät einstellbar









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Abstract

Peripheral neuropathic pain (PNP) and complex regional pain syndrome (CRPS) can be effectively treated with peripheral nerve stimulation.

In this clinical trial report, effectiveness of novel, miniature, wirelessly controlled microstimulator of tibial nerve in PNP and CRPS was evaluated.

In this pilot study the average preoperative visual analog scale (VAS) score in six patients was 7.5, with 1, 3 and 6 months: 2.6 (p=0.03), 1.6 (p=0.03), and 1.3 (p=0.02), respectively.

The mean average score in the six patients a week preceding the baseline visit was 7.96, preceding the 1, 3 and 6 month visits: 3.32 (p=0.043), 3.65 (p=0.045), and 2.49 (p=0.002), respectively. The average short-form McGill pain score before surgery was 23.8, and after 1, and 6 months it was 11.0 (p=0.45), 6.3 (p=0.043), and 4.5 (p=0.01), respectively.

Applied therapy caused a reduction of pain immediately after its application and clinical improvement was sustained on a similar level in all patients for six months.
No complications of the treatment were observed.

Intermittent tibial nerve stimulation by using a novel, miniature, wirelessly controlled device can be effective and feasible in PNP and CRPS.
It is a safe, minimally invasive, and convenient neuromodulative method.

Sokal P. Harat M. Zielinski P. et al. Tibial nerve stimulation with a miniature, wireless stimulator in chronic peripheral neur pain. Journal of Pain Research 2017:10 613-619.

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Characteristics of patient N=6

Patient	Characteristics
Patient 1	Female, 39 years old, diabetic PNP with diabetes since 2009, symmetrical feet pain paresthesias, and burning sensation in soles
Patient 2	Female, 62 years old with PNP in soles and toes after boreliosis in 2012
Patient 3	Male, 76 years old, idiopathic PNP: tingling and sharp sensation in sole and heel of left leg for 20 years
Patient 4	Male, 78 years old, idiopathic PNP of left leg with tingling in heel and sole
Patient 5	Male, 46 years old, spinal cauda equina injury after trauma due to motorbike accident in 1989 with CRPS and after failed SCS trial
Patient 6	Male, 55 years old, diabetic PNP lasting 4 years with diabetes in both feet with the predominance on the right side

Abbreviations: CRPS, complex regional pain syndrome; PNP, peripheral neuropathic pain; SCS, spinal cord stimulation.

Sokal P. Harat M. Zielinski P. et al. Tibial nerve stimulation with a miniature, wireless stimulator in chronic peripheral neur pain. Journal of Pain Research 2017:10 613-619.

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Parameters and duration of stimulation

Patient	Rate (Hz)	Pulse width (µs)	Amplitude (mA)	Duration time (hour/24 hours)
Patient 1	20	800	4.4–4.8	2
Patient 2	10–20	500–800	3.7–4.7	1
Patient 3	20	800	4.7	1
Patient 4	20	100	2.3–3.1	0.5
Patient 5	20	800	8.5	2.5
Patient 6	10–20	800–200	8.5	1

Sokal P. Harat M. Zielinski P. et al. Tibial nerve stimulation with a miniature, wireless stimulator in chronic peripheral neur pain. Journal of Pain Research 2017:10 613-619.

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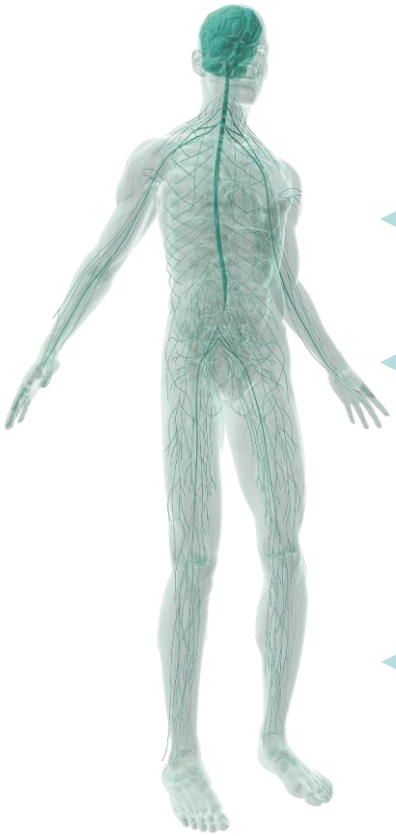
Targeted Peripheral Nerves



Arm

- Ulnar
- Median
- Radial
- Axillary
- Suprascapular

Trunk

- Ilioinguinal
- Intercostal
- Pudendal
- Iliohypogastric
- Coccygea
- Genitofemoral
- Superior Cluneal

Leg

- Saphenous
- Tibial
- Femoral
- Femoral Cutaneous
- Sural

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Common Clinical Applications

Failed surgery pain – knee, hip, back

Nerve compression, injury or trauma

Post-stroke shoulder pain

Foot/neuroma pain

CRPS

Back pain

Spinal cord injury pain

Post-amputation pain

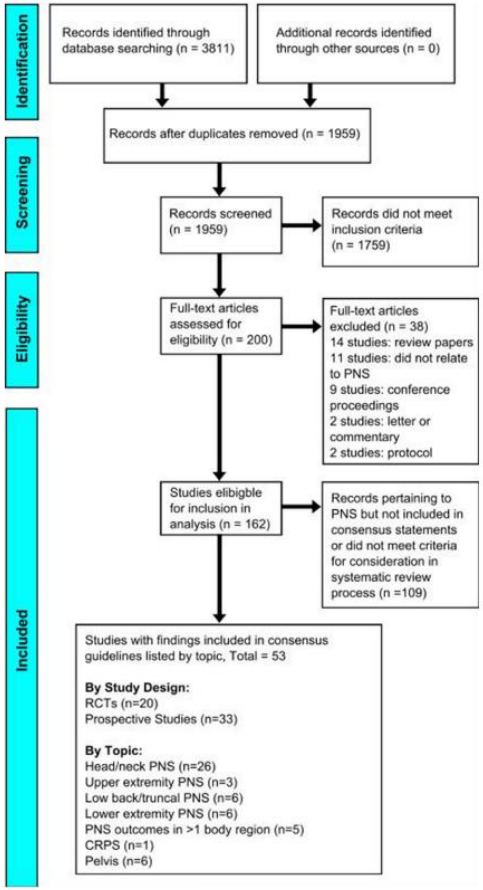

Figure 1 PRISMA diagram depicting the flow of information through the different phases of the systematic review. It shows the data identified, included and excluded, and the reasons for exclusions.
Notes: PRISMA figure adapted from Page MJ, McKenzie JE, Bossuyt PM, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ*. 2021;372:n71. Creative Commons.

Strand N, D'Souza RS, Hagedorn JM, Pritzlaff S, Sayed D, Azeem N, Abd-Elsayed A, Escobar A, Huntoon MA, Lam CM, Deer TR. Evidence-Based Clinical Guidelines from the American Society of Pain and Neuroscience for the Use of Implantable Peripheral Nerve Stimulation in the Treatment of Chronic Pain. J Pain Res. 2022 Aug 23;15:2483-2504. doi: 10.2147/JPR.S362204. PMID: 36039168; PMCID: PMC9419727.

Table 1 Hierarchy of Studies by the Type of Design (US Preventive Services Task Force)

Evidence Level	Study Type
I	At least 1 controlled and RCT, properly designed
II-1	Well-designed, controlled, nonRCTs
II-2	Cohort or case studies and well-designed controls, preferable multicenter
II-3	Multiple series compared over time, with or without intervention, and surprising results in noncontrolled experiences
III	Clinical experience-based opinions, descriptive studies, clinical observations, or reports of expert committee

Notes: Reprinted from Harris RP, Helfand M, Woolf SH, et al. Current methods of the US Preventive Services Task Force: a review of the process. *Am J Prev Med*. 2001;20(3 Suppl):21–35. Copyright 2001, with permission from Elsevier.[112]

Strand N, D'Souza RS, Hagedorn JM, Pritzlaff S, Sayed D, Azeem N, Abd-Elsayed A, Escobar A, Huntoon MA, Lam CM, Deer TR. Evidence-Based Clinical Guidelines from the American Society of Pain and Neuroscience for the Use of Implantable Peripheral Nerve Stimulation in the Treatment of Chronic Pain. J Pain Res. 2022 Aug 23;15:2483-2504. doi: 10.2147/JPR.S362204. PMID: 36039168; PMCID: PMC9419727.

Table 2 Meaning of Recommendation Degrees (I.S. Preventive Services Task Force)

Degree of Recommendation	Meaning
A	Extremely recommendable (good evidence that the measure if effective and that benefits outweigh the harms)
B	Recommendable (at least moderate evidence that the measure if effective and that benefits exceed harms)
C	Neither recommendable nor inadvisable (at least moderate evidence that the measure is effective, but benefits are similar to harms and a general recommendation cannot be justified)
D	Inadvisable (at least moderate evidence that the measure is ineffective or that the harms exceed the benefits)
I	Insufficient, low-quality, or contradictory evidence; the balance between benefit and harms cannot be determined

Strand N, D'Souza RS, Hagedorn JM, Pritzlaff S, Sayed D, Azeem N, Abd-Elsayed A, Escobar A, Huntoon MA, Lam CM, Deer TR. Evidence-Based Clinical Guidelines from the American Society of Pain and Neuroscience for the Use of Implantable Peripheral Nerve Stimulation in the Treatment of Chronic Pain. J Pain Res. 2022 Aug 23;15:2483-2504. doi: 10.2147/JPR.S362204. PMID: 36039168; PMCID: PMC9419727.

Table 3 A List of Common Peripheral Nerve Targets Amenable to Percutaneous PNS Treatment

Upper Extremity	Lower Extremity	Trunk/Pelvis	Head/Neck
• **Suprascapular****	• **Sciatic****	• Genitofemoral	• Greater occipital
• **Axillary****	• Femoral	• Ilioinguinal	
• Radial	• Obturator	• Iliohypogastric	
• Median	• Lateral femoral cutaneous	• Pudendal	
• Ulnar	• Saphenous	• Cluneal	
• Brachial plexus (at interscalene interval)	• Posterior femoral cutaneous	• **Medial Branch****	
	• Common peroneal		
	• **Tibial****		
	• Sural		
	• Superficial peroneal		
	• Genicular nerves (knee)		

Note: Nerves targets denoted by a double asterisk and are in bold (**) are described in detail below.

Strand N, D'Souza RS, Hagedorn JM, Pritzlaff S, Sayed D, Azeem N, Abd-Elsayed A, Escobar A, Huntoon MA, Lam CM, Deer TR. Evidence-Based Clinical Guidelines from the American Society of Pain and Neuroscience for the Use of Implantable Peripheral Nerve Stimulation in the Treatment of Chronic Pain. J Pain Res. 2022 Aug 23;15:2483-2504. doi: 10.2147/JPR.S362204. PMID: 36039168; PMCID: PMC9419727.

Table 4 ASRA Risk Classification of Pain Procedures

High-Risk Procedures	Intermediate-Risk Procedures	Low-Risk Procedures
Spinal cord stimulation trial and implant	Interlaminar ESIs (C,T,L,S)	Peripheral nerve blocks
Dorsal Root Stimulation	Transforaminal ESIs (C,T,L,S)	Peripheral joints and musculoskeletal injections
Intrathecal catheter and pump implant	Cervical facet MBNB and RFA	Trigger point injections including piriformis injection
Percutaneous decompression laminotomy	Sympathetic Blocks (stellate, T, splanchnic, celiac, lumbar, hypogastric)	Thoracic and lumbar facet MBNB and RFA
Epiduroscopy and epidural decompression	Trigeminal and sphenopalatine ganglia blocks	PNS trial and implant

Note: PNS is considered a low to intermediate risk procedure.

Strand N, D'Souza RS, Hagedorn JM, Pritzlaff S, Sayed D, Azeem N, Abd-Elsayed A, Escobar A, Huntoon MA, Lam CM, Deer TR. Evidence-Based Clinical Guidelines from the American Society of Pain and Neuroscience for the Use of Implantable Peripheral Nerve Stimulation in the Treatment of Chronic Pain. J Pain Res. 2022 Aug 23;15:2483-2504. doi: 10.2147/JPR.S362204. PMID: 36039168; PMCID: PMC9419727.

Table 5 Overview of Percutaneous PNS Systems

PNS Device (Manufacturer)	Device Characteristics	Permanent vs Temporary	FDA Cleared Indication	MRI Capability
StimRouter (Bioness/Bioventus)	• 3 contact leads – tined only • Single lead configuration • External power source • Tonic stimulation	Permanent	Severe, intractable chronic pain of peripheral nerve origin.	Conditional
Nalu Neurostimulation System (Nalu Medical)	• 4 and 8 contact leads- tined and untined • Option for 1- or 2-lead configurations • Implantable IPG with external power source • Trial kit available – FDA approved for 30-day use • Multiple waveforms	Permanent	Severe, intractable chronic pain of peripheral nerve origin.	Conditional
StimQ PNS System (Stimwave Technologies)	• 4 and 8 contact leads – tined and untined • External power source • Trial kit available • Multiple waveforms	Permanent	Severe, intractable chronic pain of peripheral nerve origin.	Conditional, full body 1.5T with 4 contact lead
SPRINT PNS System (SPR Therapeutics)	• Single, open-coil, externalized lead • 60-day use • Option for 1- or 2-lead configurations • Tonic stimulation	Temporary	Up to 60 days in the back, extremities, head, neck, and/or torso for: 1. Symptomatic relief of chronic, intractable pain, postsurgical and posttraumatic acute pain 2. Symptomatic relief of posttraumatic pain 3. Symptomatic relief of postoperative pain *Not intended to treat pain in the region innervated by the cranial and facial nerves.	Not compatible
ReActiv8 Implantage Neurostimulation System (Mainstay Medical)	• Tined, 4 contact leads • Leads are implanted bilaterally at the transverse processes of L3 • Implanted non-rechargeable IPG • Handheld activator to start and stop stimulation • Stimulation activates lumbar multifidus muscles	Permanent	To aid in treatment of intractable chronic low back pain associated with multifidus muscle dysfunction	Not compatible

Strand N, D'Souza RS, Hagedorn JM, Pritzlaff S, Sayed D, Azeem N, Abd-Elsayed A, Escobar A, Huntoon MA, Lam CM, Deer TR. Evidence-Based Clinical Guidelines from the American Society of Pain and Neuroscience for the Use of Implantable Peripheral Nerve Stimulation in the Treatment of Chronic Pain. J Pain Res. 2022 Aug 23;15:2483-2504. doi: 10.2147/JPR.S362204. PMID: 36039168; PMCID: PMC9419727.

Table 6 ASPN Best Practices PNS Guidelines

ASPN Best Practices PNS Guidelines	Level of Evidence	Grade
Head/Neck		
Stimulation of occipital nerves may be offered to patients with chronic migraine headache when conservative treatments have failed. The average effect size for relief of migraine symptoms is modest to moderate.	I	B
There is insufficient evidence to recommend stimulation of supraorbital and infraorbital nerves for neuropathic craniofacial pain.	II-3	C
Upper Extremities		
PNS may offer modest and short-term pain relief, improved physical function, and better quality of life for chronic hemiplegic shoulder pain.	I	B
PNS for mononeuropathies of the upper extremity may be offered following a positive diagnostic ultrasound-guided nerve block of the targeted nerve and is associated with modest to moderate pain relief.	II-2	B
Low Back/Trunk		
Subcutaneous peripheral field stimulation and optimal medication management may offer moderate improvement in pain intensity for failed back surgery compared to optimal medication management alone.	I	B
There is evidence that PNS of lumbar medial branch nerves may improve pain intensity, physical function, and pain interference in patients with axial, mechanical low back pain.	II-2	B
There is limited evidence that PNS may alleviate pain in neuropathic pain syndrome involving the trunk and back including radiculopathy and post-herpetic neuralgia.	III	C
Lower Extremities		
PNS may be considered for lower extremity neuropathic pain following failure of conservative treatment options and is associated with modest pain relief.	I	B
PNS may be considered for lower extremity post-amputation pain following failure of conservative treatment options and is associated with modest to moderate pain relief.	I	B
Other Considerations		
As a less-invasive modality compared to SCS therapy, PNS may be offered to patients with CRPS Type I or Type II, and may be associated with modest improvement in pain intensity and functional outcomes. However, high-quality evidence is limited and other neuromodulation interventions such as dorsal root ganglion SCS are recommended for CRPS.	III	C
PNS carries a low-to-intermediate risk for bleeding complications and depends on the proximity of the targeted nerve to critical vessels and invasiveness of PNS implantation.	III	I

Strand N, D'Souza RS, Hagedorn JM, Pritzlaff S, Sayed D, Azeem N, Abd-Elsayed A, Escobar A, Huntoon MA, Lam CM, Deer TR. Evidence-Based Clinical Guidelines from the American Society of Pain and Neuroscience for the Use of Implantable Peripheral Nerve Stimulation in the Treatment of Chronic Pain. J Pain Res. 2022 Aug 23;15:2483-2504. doi: 10.2147/JPR.S362204. PMID: 36039168; PMCID: PMC9419727.

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PERIPHERE NERVENBLOCKADE

Stellenwert

Periphere Nervenblockaden können diagnostisch und therapeutisch eingesetzt werden und stellen ein wirksames Instrument in einem multimodalen Schmerzversorgungskonzept dar (intraoperativ, postoperativ und bei chronischen therapierefraktären Schmerzen).

Eisner W., Kienbacher G, Likar R. et al.; ÖSG-Positionspapier: Invasive Schmerztherapie
Ein Positionspapier der Österreichischen Schmerzgesellschaft (ÖSG); Schmerznachrichten; SD; Jänner 2023.

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DANKE

FÜR IHRE AUFMERKSAMKEIT

Auswahl peripherer Nervenblockaden und ihrer Einsatzgebiete
Obere Extremitäten

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- Interskalenärer Block
- Der kontinuierliche interskalenäre Block für Operation an der Rotatoren-Manschette reduziert das Schmerzniveau bis zum 7. postoperativen Tag im Vergleich zur Einzelinjektion oder Allgemeinanästhesie (Salviz 2013, Evidenzgrad A)
- Zusätzlich kann eine frühere Entlassungsfähigkeit und gesteigerte Patientenzufriedenheit damit erreicht werden (Il-feld 2006, Evidenzgrad A)
- Neuroaxiale oder kontralaterale Ausbreitung des Lokalanästhetikums sind bekannte Komplikationen eines interskalenären Blocks
- Die Lähmung des N. phrenicus ist die häufigste Nebenwirkung eines interskalenären Blocks
- Suprascapulärer Block
- Die Anlage eines suprascapulären Blocks für Schulteroperationen geht ohne Risiko einer Lähmung des N. phrenicus einher (Jeske 2011, Evidenzgrad A)
- Schmerztherapie bei Schulterschmerzen
- Supraklavikulärer Block
- Für die distalen zwei Drittel der oberen Extremität
- Infraklavikulärer Block
- Für Chirurgie am Unterarm, Handgelenk, Hand und Finger
- Axillärer Block
- Kontinuierliche axilläre Katheter-Analgesie ist bei handchirurgischen Eingriffen der Einzelinjektionstechnik nicht überlegen (Salonen 2000 Evidenzgrad A)
- Intercostobrachialer Block
- In Kombination mit Plexus brachialis Block für komplette Analgesie des medialen Oberarms (für Chirurgie und Tourniquet)
- Handgelenksblock
- N. ulnaris, medianus, radialis auf Höhe des Handgelenks geblockt
- Bei inkomplettem Plexus brachialis Block
- Block der Nervi digitales
- Regionale Anästhesie einzelner Finger

Eisner W., Kienbacher G, Likar R. et al.; ÖSG-Positionspapier: Invasive Schmerztherapie
Ein Positionspapier der Österreichischen Schmerzgesellschaft (ÖSG); Schmerznachrichten; SD; Jänner 2023.

Untere Extremitäten

- Plexus lumbalis Block
- Der kontinuierliche Block des Plexus lumbalis geht mit einem höheren Sturzrisiko einher verglichen mit der Einzelinjektionstechnik oder keiner Blockade (Johnson 2013)
- Der kontinuierliche hintere lumbale Plexus Block zeigt im Vergleich zum kontinuierlichen FNB keine Unterschiede in der postoperativen Schmerzstärke, jedoch weniger motorische Beeinträchtigung (Ilfeld 2011 Evidenzgrad A)
- N. femoralis Block (FNB)
- Im Vergleich zur IV PCA alleine zeigt der FNB bei totalem Kniegelenksersatz eine verbesserte Schmerzreduktion in Bewegung, reduzierten Morphinverbrauch und weniger Übelkeit (Paul 2010, Evidenzgrad A)
- Im Vergleich zur periartikulären Infiltration von Lokalanästhetika zeigt der kontinuierliche FNB bei totalem Kniegelenksersatz reduzierten Opioid-Bedarf und verbesserte Funktionalität (Carli 2010, Evidenzgrad A)
- Fascia iliaca Block (N. cut. fem. lat)
- Der kontinuierliche Fascia iliaca Block erzeugt in den ersten 48 Stunden nach einem totalen Kniegelenksersatz ähnliche Analgesie-Qualitäten wie der kontinuierliche FNB (Brisbane 2010, Evidenzgrad A)
- N. obturatorius Block
- Anästhesie des medialen distalen Oberschenkels
- In Kombination mit Block des N. femoralis, N.cut.fem.lat. und Ischiadicus für distalen Oberschenkel und Unterschenkel
- N. ischiadicus Block
- Operation Knie, Unterschenkel, Fuß
- Regionale Sympathikolyse, Schmerztherapie
- Popliteal Block
- Die kontinuierliche Analgesie über einen popliteal liegenden Katheter am N. ischiadicus zeigt eine bessere Schmerzreduktion als die alleinige Opioid-Gabe nach Operationen an der unteren Extremität (Ilfeld 2002, Evidenzgrad B) [87]
- und am Fuß (White 2003, Evidenzgrad B)
- Adduktoren-Kanal Block
- Der N. saphenus und Äste des N. obturatorius verlaufen gemeinsam im Adduktoren-Kanal
- Der Block an beide Nerven wirkt analgetisch bei Knieoperationen
- Im Hinblick auf die geringer ausgebildete motorische Schwäche des M. quadriceps kann der Adduktoren-Kanal
- Block als eine Alternative zum FNB gewertet werden (Jaeger 2013, Evidenzgrad A)
- Der Adduktoren-Kanal Block zeigt eine mit dem FNB vergleichbare Analgesiequalität in den ersten 8 Stunden nach totalem Kniegelenksersatz (Kim 2014, Evidenzgrad A) [90]

Periphere Blockaden

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- Plexus cervicalis Block
- Oberflächliche Eingriffe im Bereich Nacken, Hals und der supraklavikulären Region, Karotisendarteriektomie
- Oberflächliche und tiefe Blockadetechnik
- Block der Intercostalnerven
- Schmerztherapie des ipsilateralen Hemithorax
- Ein intercostaler Block in mehreren Etagen verbessert die Analgesie-Qualität im Vergleich zur alleinigen systemischen Opioid-Analgesie, vor allem während des 1. postoperativen Tages (Detterbeck 2005, Evidenzgrad A)
- Durch Platzierung eines Katheters in den interpleuralen Spalt im Zwischenrippenbereich (paravertebral oder lateral davon) kann eine kontinuierliche Lokalanästhetika-Analgesie erzielt werden. Bei einer posteriolateralen Thorakotomie ist dieses Verfahren einer thorakalen Epidural-Analgesie jedoch unterlegen (Debreceni 2003, Evidenzgrad A)
- Thorakaler paravertrebraler Block
- Alle Formen einer PVB (Einzel-Injektion, Mehretagen-Injektion und kontinuierliche Applikation mittels Katheters) sind hinsichtlich der Analgesie-Qualität in den 48 Stunden nach einer Brustoperation einer systemischen Analgesie überlegen. Zusätzlich ist die Inzidenz an PONV reduziert (Schnabel 2010, Evidenzgrad A)
- Bei einer Thorakotomie ist die kontinuierliche thorakale PVB verglichen mit einer thorakalen Epiduralanalgesie gleich effizient in der Schmerzreduktion, hat aber ein besseres Nebenwirkungsprofil hinsichtlich Harnretention, Hypotension, Übelkeit und Erbrechen (Davies 2006, Evidenz-grad A)

Eisner W., Kienbacher G, Likar R. et al.; ÖSG-Positionspapier: Invasive Schmerztherapie
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- Block auf Ebene des Transversus abdominis (TAP)
- Postoperative Schmerztherapie bei bauchchirurgischen und geburtshilflichen Eingriffen
- Bei laparoskopischen Bauchoperationen reduzieren TAP Blöcke den Ruheschmerz in den ersten 4 Stunden im Vergleich zu Kontrollgruppen (De Oliveira 2014, Evidenzgrad A)
- Der TAP Block bringt keinen Vorteil bei
- Gynäkologischer Krebschirurgie im Vergleich mit systemischer Analgesie (Griffiths 2010, Evidenzgrad A)
- Inguinaler Hernien-Verschluss im Vergleich mit Lokalanästhetika-Infiltration (Petersen 2013, Evidenzgrad A)
- Rektusscheiden-Block
- Bauchwand von Proc. xyphoideus bis Symphyse
- Auch bilateral möglich
- Postoperative Schmerztherapie nach Nabelhernienoperation, mediane Laparatomie
- N. iIlioinguinalis und N. iliohypogastricus Block
- Inguinalhernien-OP, Orchidopexie
- Block auf Ebene der Fascia transversalis
- Hintere Version des Ilioinguinal- und Iliohypogastricus Block, z.B. für Knochenmarkspunktion am Beckenkamm
- Quadratus lumborum Block
- Laparatomie in Kombination mit Allgemeinnarkose, Eingriffe an Bauchwand, Sectio, Hüftchirurgie
- Pudendus Block
- Pudendusneuralgie, Schmerzen Perineum, Geburt

Eisner W., Kienbacher G, Likar R. et al.; ÖSG-Positionspapier: Invasive Schmerztherapie
Ein Positionspapier der Österreichischen Schmerzgesellschaft (ÖSG); Schmerznachrichten; SD; Jänner 2023.

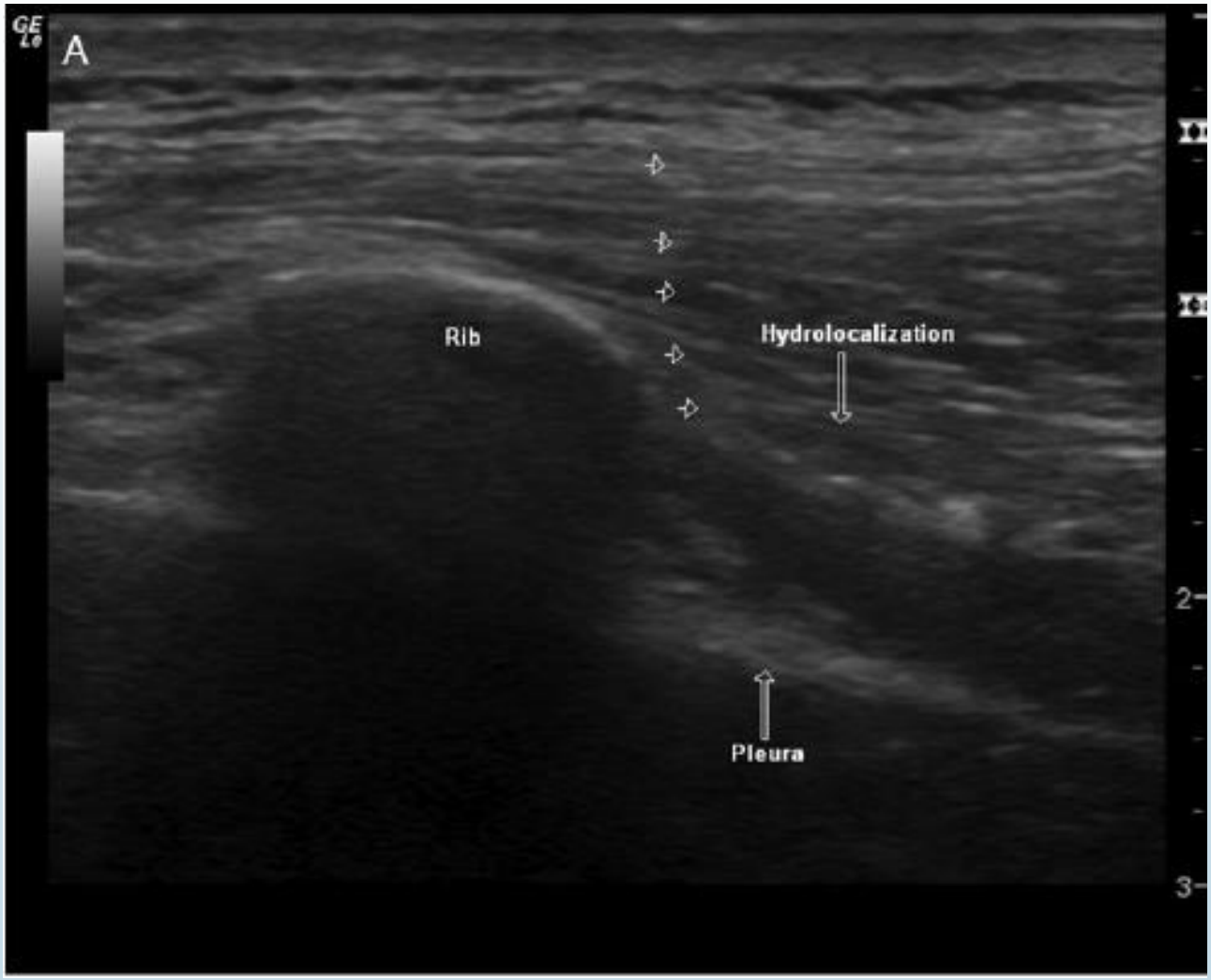
Indikationen

Gesicht und Kopf:
- **Trigeminusneuralgie**
- **Andere Neuralgien des Gesichts und Kopfs, z. B. Okzipitalisneuralgie**
- **Clusterkopfschmerz**

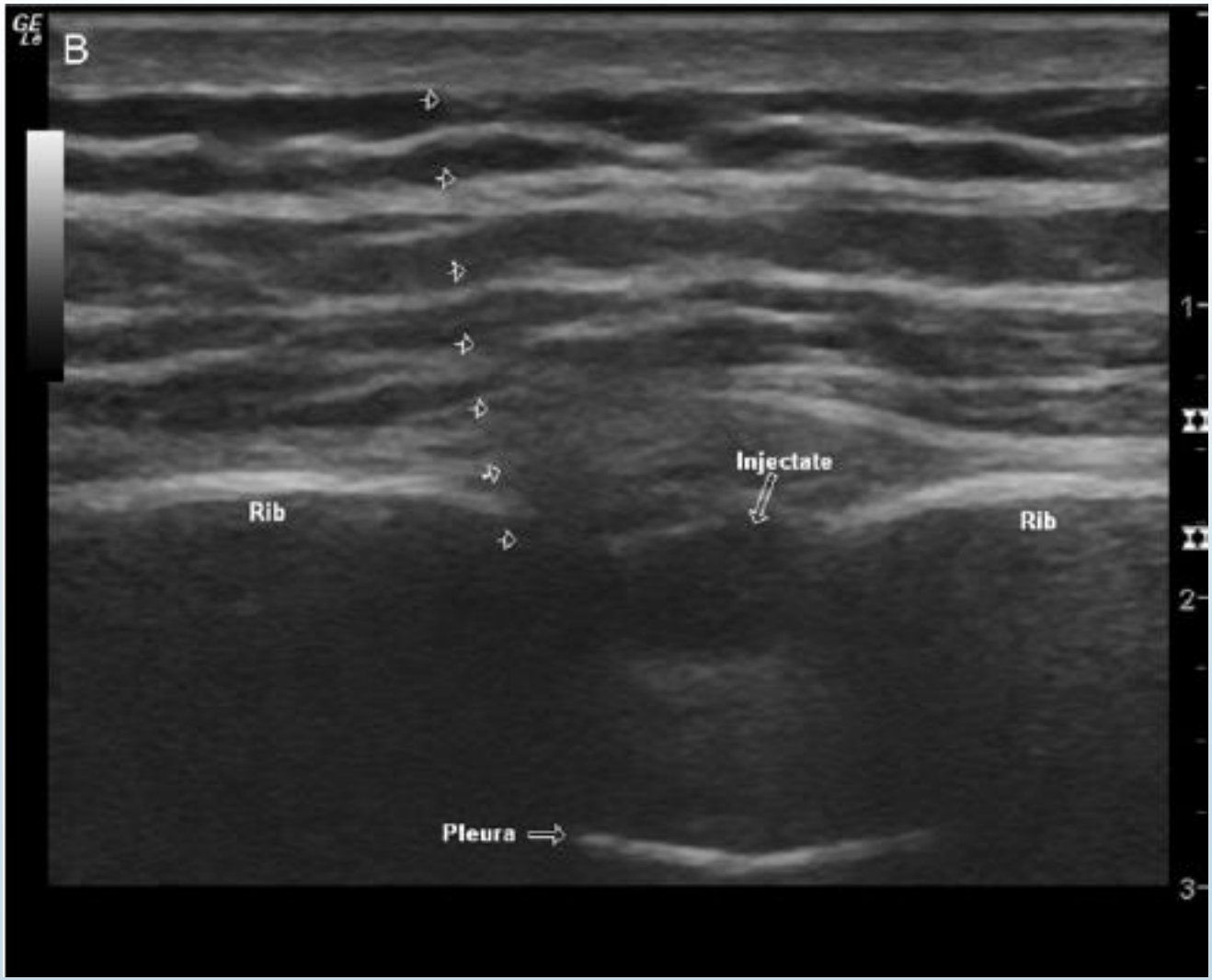
Interkostalneuralgien:
- **Zum Beispiel Neuralgien nach Mastektomie oder Thorakotomie**
- **Postzosterneuralgie**

Andere Neuralgien, wobei es hier für die meisten Indikationen vorwiegend Fallberichte gibt:
- **Des Nervus pudendus**
- **Des Nervus iliohypogastricus**
- **Des Nervus ilioinguinalis**
- **Des Nervus genitofemoralis**
- **Des Nervus cutaneus femoris lateralis**
- **Phantom- oder Stumpfschmerzen durch Neurinome**

Likar R., Auer J., Chavanne A. et al., Interdisziplinäres Positionspapier: der Stellenwert der Radiofrequenzdenervierung in der Therapie chronischer Schmerzen. Der Schmerz 2021. 35:124-129.

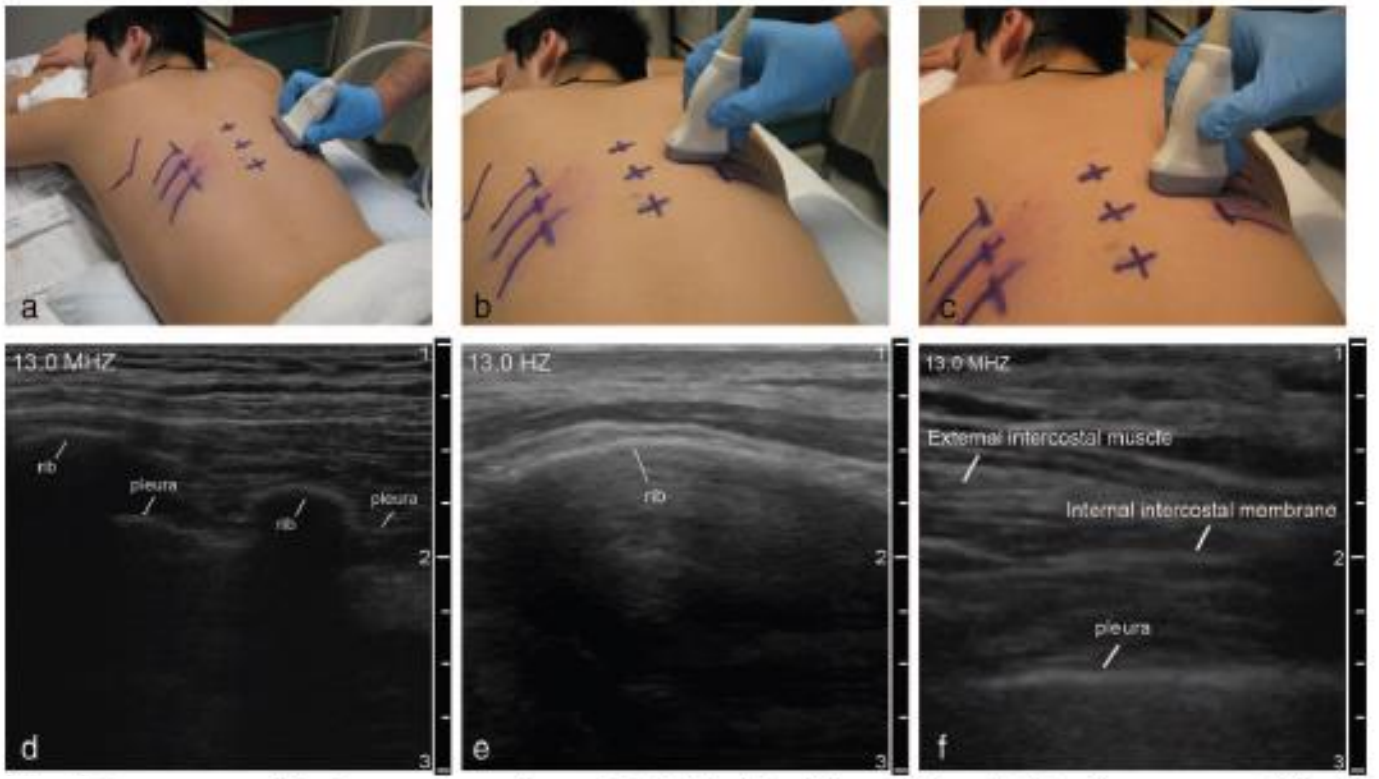


Shankar H, Khatri V, Eastwood D; Retrospektive Comparison of Ultrasound and Fluoroscopic Image Guidance for Intercostal Steroid Injections; Pain Practice, Volume 10, Issue 4, 2010 312-317



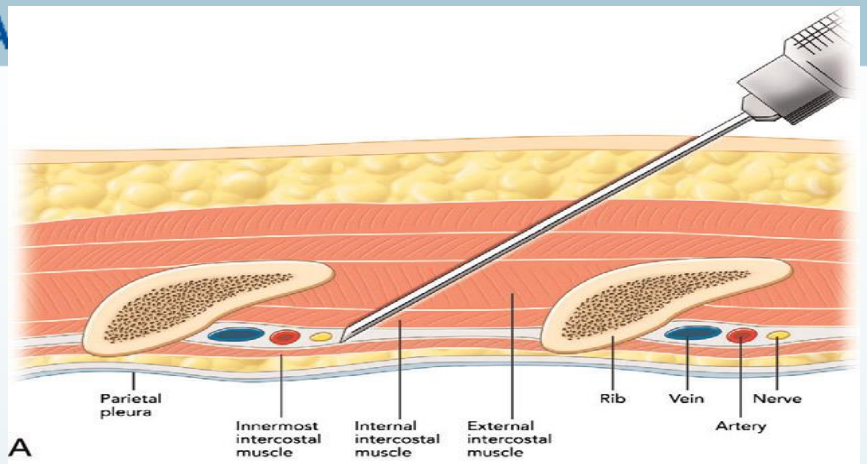
Shankar H, Khatri V, Eastwood D; Retrospektive Comparison of Ultrasound and Fluoroscopic Image Guidance for Intercostal Steroid Injections; Pain Practice, Volume 10, Issue 4, 2010 312-317

Ultrasound-Guided Paravertebral Block Using an Intercostal Approach

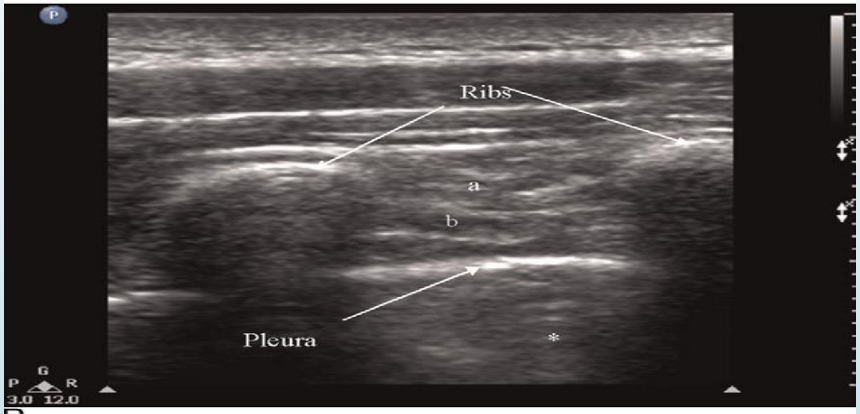


Sonoanatomy of the intercostal space in a model (GE Logic E platform, 12L probe). Toggling maneuver (tilting the probe) shown on a model in (b) and (c). Figure 2a, longitudinal position of probe/Figure 2d, longitudinal somogram of the intercostal space/Figure 2e, transverse sonogram of the intercostal space showing the rib/Figure 2f, transverse sonogram of the intercostal space showing the intercostal muscles and pleura.

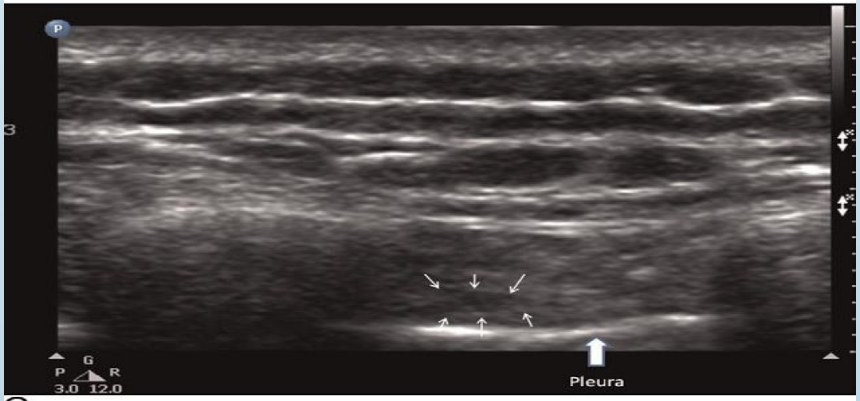
Ben-Ari A, Moreno M, Chelly J et al; Ultrasound-Guided Paravertebral Block Using an Intercostal Approach; International Anesthesia Research Society, Vol 109, No 5, November 2009


Parietal pleura
Innermost intercostal muscle
Internal intercostal muscle
External intercostal muscle
Rib
Vein
Artery
Nerve

A

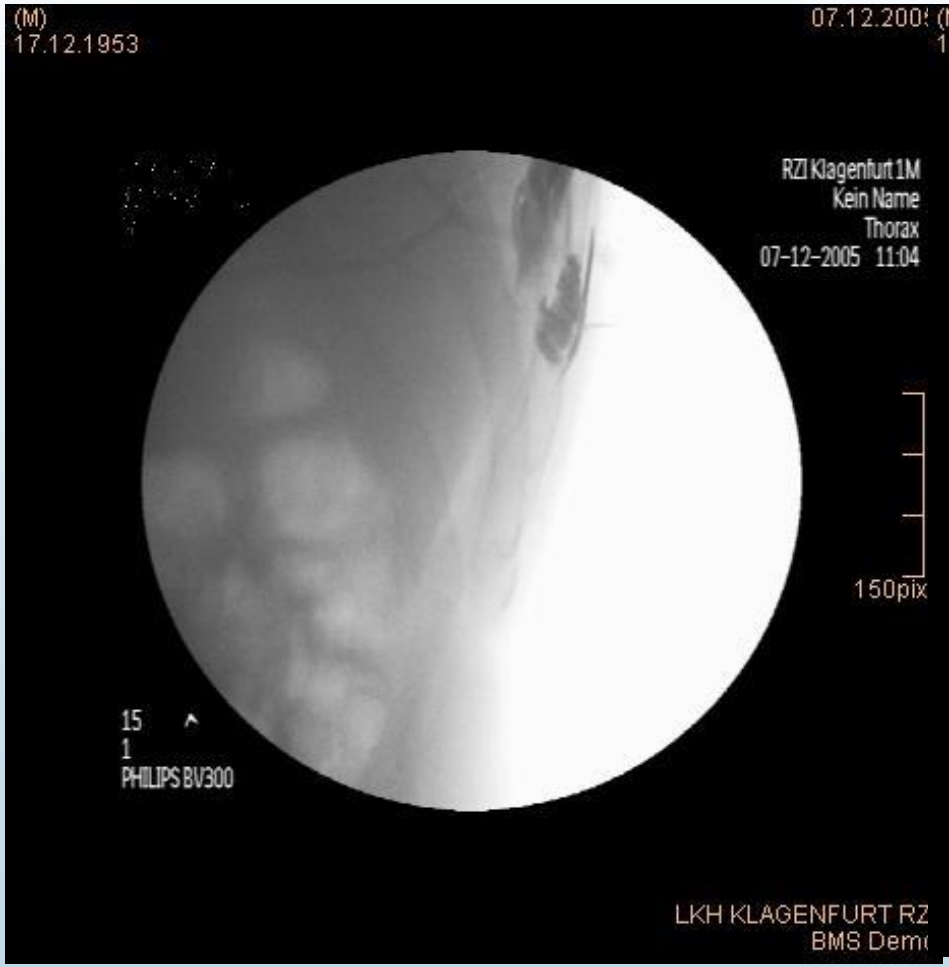

Ribs
a
b
Pleura

B


Pleura

C

P.J., 52 Jahre


(M)
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07.12.200
RZI Klagenfurt 1M
Kein Name
Thorax
07-12-2005 11:04
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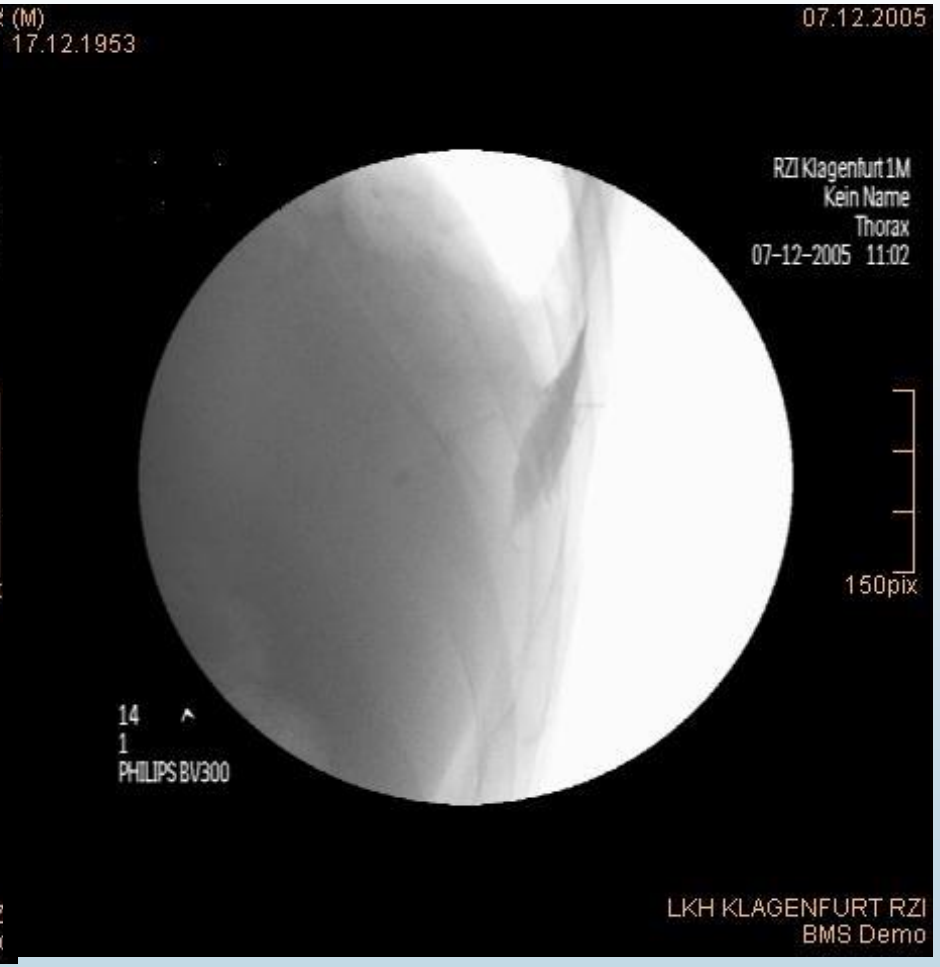
PHILIPS BV300
LKH KLAGENFURT RZ
BMS Demo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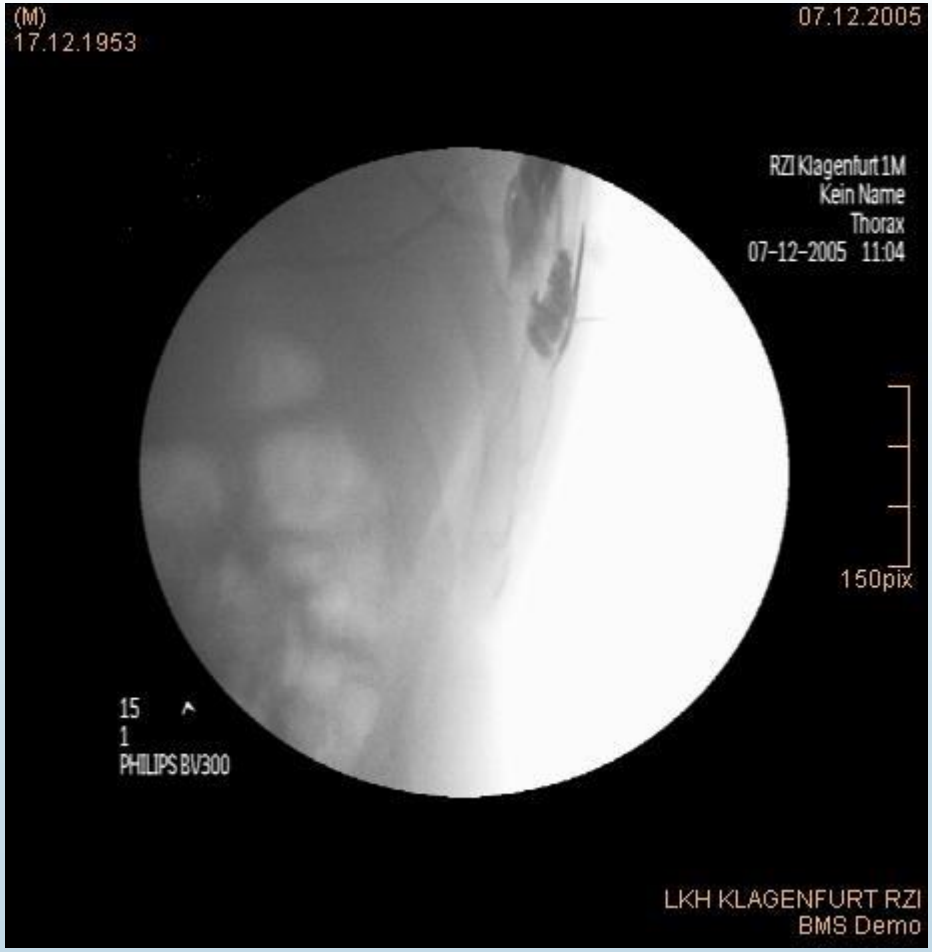
P.J., 52 Jahre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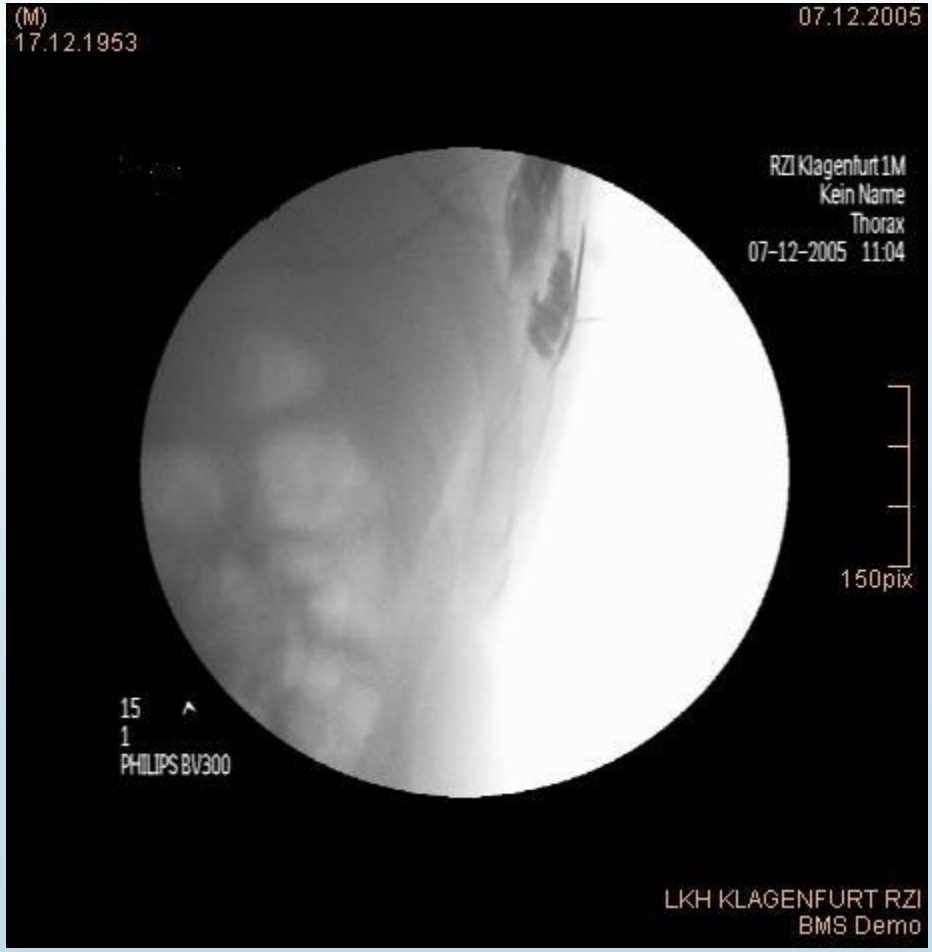
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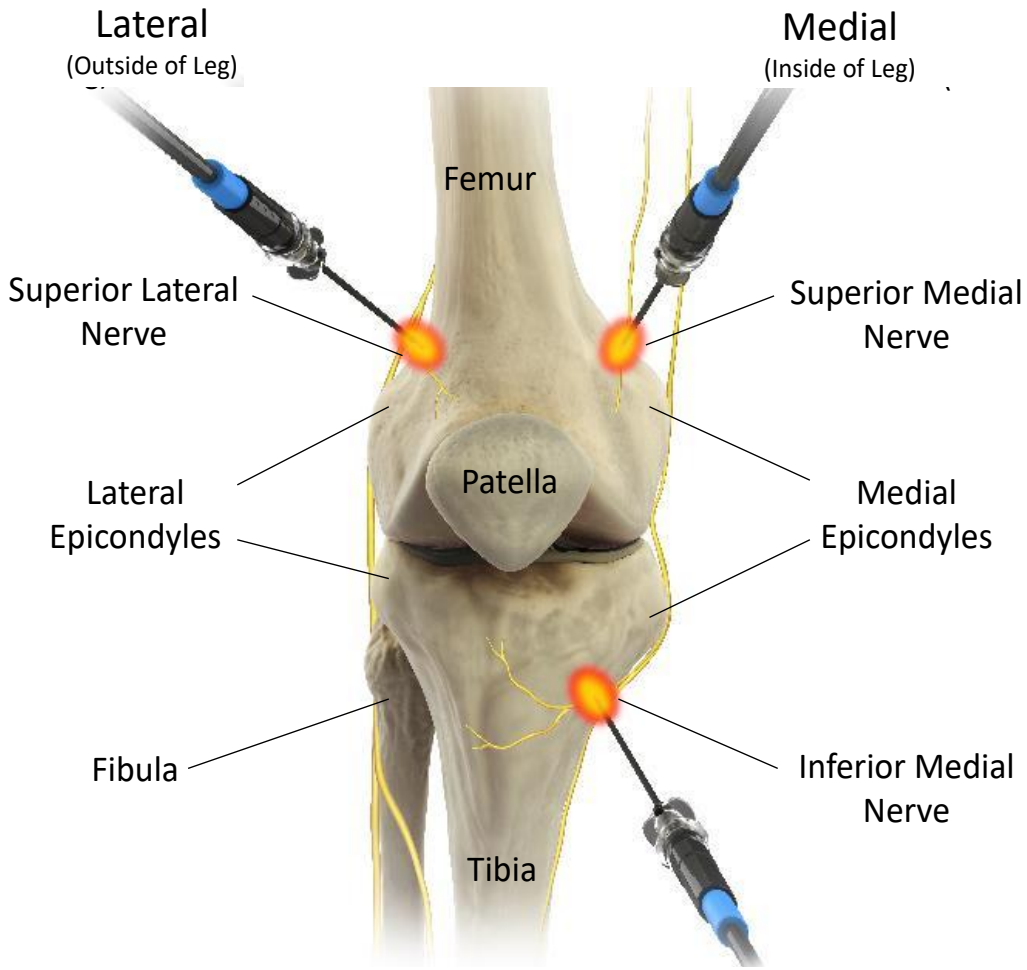
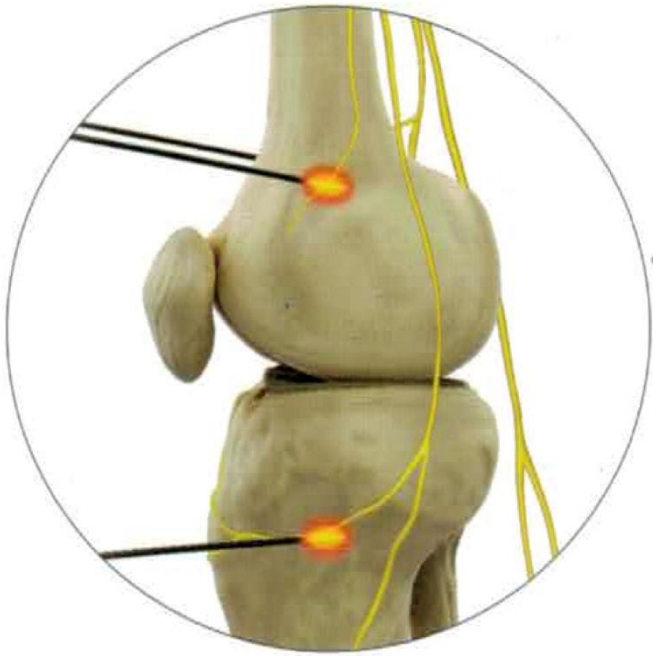

Lateral
(Outside of Leg)
Medial
(Inside of Leg)
Femur
Superior Lateral Nerve
Superior Medial Nerve
Patella
Lateral Epicondyles
Medial Epicondyles
Fibula
Inferior Medial Nerve
Tibia



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Radiofrequenz-Therapie bei chronischen Knieschmerzen

Vorgehensweise

Patientenlagerung:

Rückenlage über Polsterunterlage leicht angewinkeltes Knie (15°)

Platzierung der großflächigen Neutralelektrode

ca. 10cm oberhalb des zu behandelten Knies.

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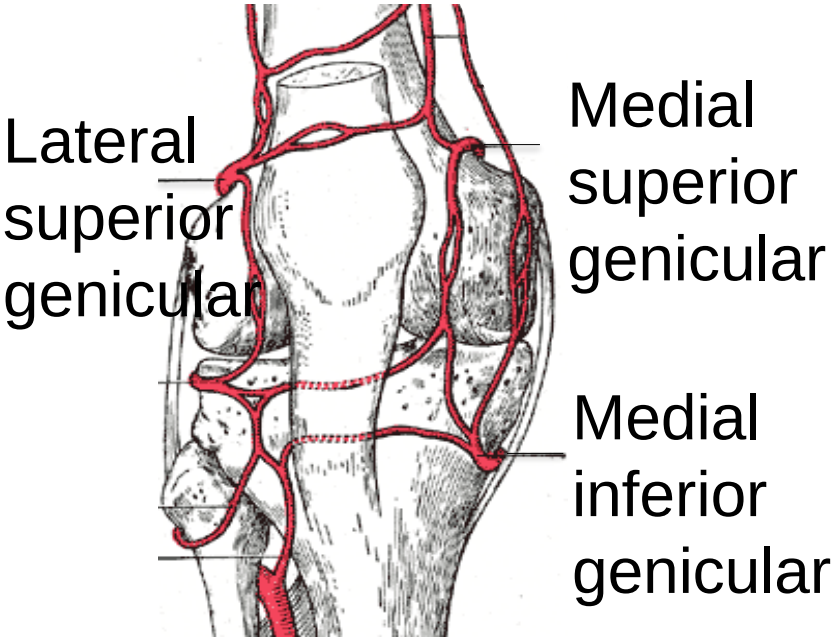
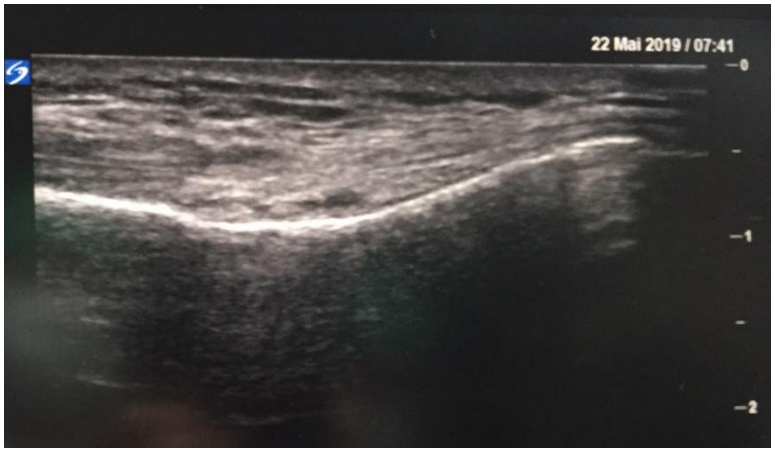
Radiofrequenz-Therapie bei chronischen Knieschmerzen

Mittels Ultraschall Darstellung der Genicular - Arterien:

Lateral superior, medial superior und medial inferior.





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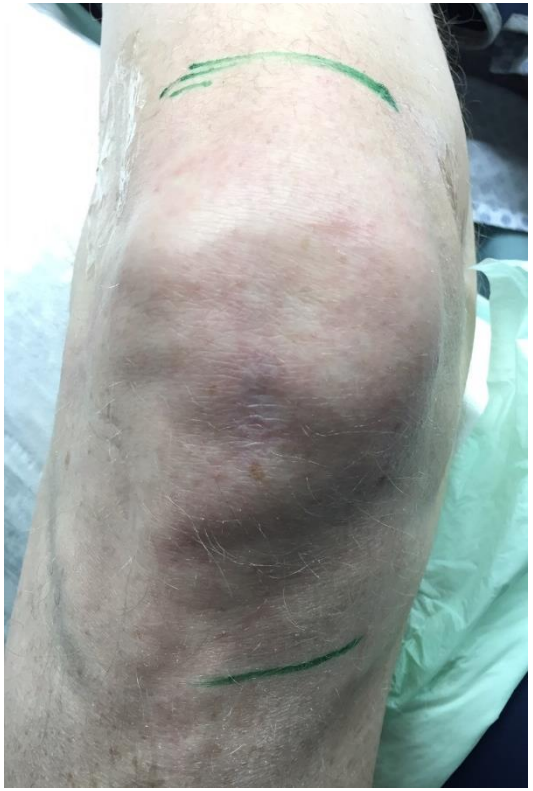
Radiofrequenz-Therapie bei chronischen Knieschmerzen

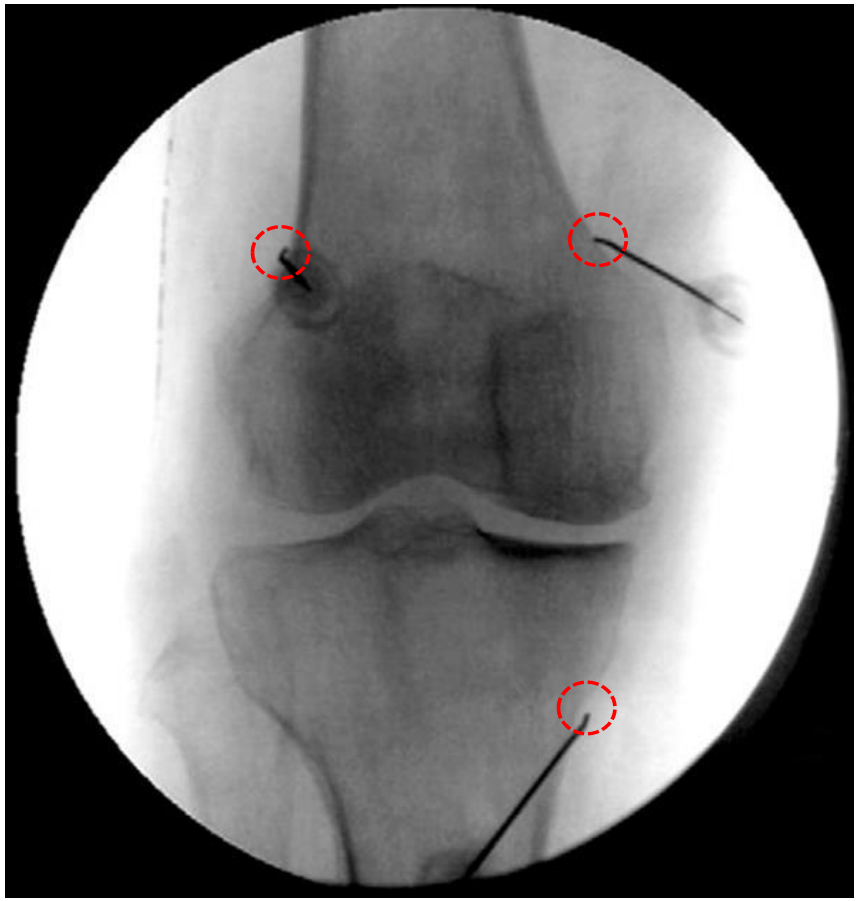
<u>Platzierung der Kanüle:</u>
Kanüle mit 10cm Länge, 10mm aktiver Spitze und 20-22G (evt. gebogen) an den vorher markierten Punkten unter Röntgenkontrolle Richtung Schnittpunkt zwischen Schaft und Epicondylus bis zum Knochenkontakt vorschieben.

<u>Unter lateraler Röntgenkontrolle:</u>
Lagebestätigung bzw. Anpassung. Die aktive Spitze sollte sich in der Mitte des Knochens befinden.



AP Durchleuchtung: Darstellung des Tibiofemoral-Gelenks so, dass der Gelenksspalt auf beiden Seiten ca. gleich groß ist. Platzierung der RF – Nadeln in AP Darstellung

Lateral
(Outside of Leg)



Medial
(Inside of Leg)

Results:

We identified nine relevant clinical trials, which included 592 patients, evaluating knee RFA for osteoarthritis and persistent postsurgical pain. These included one randomized, placebo-controlled trial, one randomized controlled trial evaluating RFA as add-on therapy, four comparative-effectiveness studies, two randomized trials comparing different techniques and treatment paradigms, and one non-randomized, controlled trial. The results of these studies demonstrate significant benefit for both reduction and functional improvement lasting between 3 and 12 months, with questionable utility for prognostic blocks. There was considerable variation in the described neuroanatomy, neural targets, radiofrequency technique, and selection criteria.

Conclusion:

RFA of the knee appears to be a viable and effective treatment option, providing significant benefit to well-selected patients lasting at least 3 months. More research is needed to better identify neural targets, refine selection criteria to include the use of prognostic blocks,optimize treatment parameters, and better elucidate relative effectiveness compared to other treatments.

Jamison D. et al.; Radiofrequency techniques to treat chronic knee pain: a comprehensive review of anatomy, effectiveness, treatment parameters, and patient selection. Journal of Pain Research 2018:11 1879-1888.

Fazit für die Praxis

- **Ultraschallgezielte Interventionen im Rahmen der Schmerztherapie werden sowohl in diagnostischer als auch in therapeutischer Absicht durchgeführt.**
- **Eine sichere Hand-Hand-Augen-Koordination ist unbedingt erforderlich. Diese sollte möglichst an Punktionsphantomen trainiert werden.**

- **Bei neurodestruktiven Verfahren werden im Allgemeinen nur rein sensible Nerven zerstört.**
- **Ultraschallgezielte Interventionen ermöglichen eine durchgehende Sichtkontrolle der Nadel, insbesondere unter Einsatz der sog. In-plane-Technik. Zudem können bei anatomischen Variationen, die sich mit blinden Techniken kaum erfassen lassen, atypische Zugangswege gewählt werden.**

- **Ein eindeutiger Vorteil der ultraschallgezielten Regionalanästhesie ist die verbesserte Trefferquote mit verkürzter Anschlagzeit und längerer Wirkdauer. Darüber hinaus kann die Dosis des eingesetzten Lokalanästhetikums reduziert werden, wodurch sich auch Toxizitätsprobleme vermeiden lassen.**

Blunk J.A., Ultraschall in der interventionellen Schmerztherapie; Schmerz 2013, 27:325-339

Table 7. *Continued*

Study date/ author	Society affiliation	Sponsorship/ funding	Indications	Level of evidence (if identified)	Recommendations	Recommendation strength (if identified)
Rosenquist et al. 2010 (19)	ASA and the ASRA and Pain Medicine	Not reported	CRPS; FBSS; "other conditions" (peripheral neuropathic pain, peripheral vascular disease, postherpetic neuralgia)	CRPS: Category A3; FBSS: A3; "other conditions": B2	SCS should be used for persistent radicular pain, other conditions, CRPS, PHN, visceral pain, PVD, with demonstrated efficacious trial	
Hunter Integrated Pain Service 2010 (20)	HIPS	Hunter New England	CRPS, FBSS, ischemic pain		SCS has limited evidence for sustainable treatment for FBSS or CRPS type 1. SCS can improve tissue perfusion and should be considered when bypass surgery is not feasible	
Mailis and Taenzer 2012 (21)	CPS	CPS	CRPS, FBSS, traumatic neuropathy, or brachial plexopathy; other neuopathic pain syndromes	FBSS and CRPS: Good; traumatic neuropathy/brachial plexopathy: fair; other neuropathic pain syndromes: poor	In patients with FBSS or CRPS who are not candidates for corrective surgery and have failed conservative therapy, trial should be considered; B; neuropathy/brachial plexopathy: consider trial if no corrective surgery and conservative therapies failed; other neuropathic pain syndromes: SCS trial not recommended because of lack of evidence	FBSS and CRPS: Grade B; neuropathy/brachial plexopathy: Grade C; other neuropathic pain syndromes: Grade I
Tronnier et al. 2010 (22)	Summary S3 Guidelines		CRPS type I and FBSS radiculaopathy; peripheral arterial occlusive disease; refractory angina pectoris		SCS is effective in treating CRPS type I, FBSS radiculopathy; peripheral arterial occlusive disease and refractory angina pectoris	
Neuromodulation Therapy Access Coalition 2010 (23)	NTAC	Device company sponsorship	Chronic neuropathic pain		SCS is effective in treating chronic neuropathic pain	
Dworkin et al. 2013 (24)	Neuropathic Pain Special Interest Group	International association for the study of Pain	FBSS; CRPS type I		SCS is effective in treating FBSS and CRPS type I	Weak

*Based on USPSTF (1).
†Based on Guyatt et al. 2006 (25).
‡Based on grading system (11).
§Other: peripheral neuropathic pain, phantom limb pain/postamputation syndrome, postherpetic neuralgia, root injury pain, spinal cord injury/lesion.
¶Based on level of evidence as defined by Rosenquist et al. (19).
**Based on definitions of magnitude of estimating effects (18).
††Based on literature quality assessment and strength of evidence (9).
ACOEM, American College of Occupational and Environmental Medicine; APS, American Pain Society; ASA, American Society of Anesthesiologists; ASIPP, American Society of Interventional Pain Physicians; ASRA, American Society of Regional Anesthesia; BPS, British Pain Society; CPS, Canadian Pain Society; CRPS, complex regional pain syndrome; EFNS, European Federation of Neurological Societies; FBSS, Failed Back Surgery Syndrome; HIPS, Hunter Integrated Pain Service; NICE, National Institute for Health and Clinical Excellence; NTAC, Neuromodulation Therapy Access Coalition; RSD, reflex sympathetic dystrophy; SCS, spinal cord stimulation; USPSTF, US Preventative Services Task Force.

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Deer TR, Thomson S, Pope JE et al.International Neuromodulation Society Critical Assessment: Guideline Review of Implantable Neurostimulation Devices. Neuromodulation 2014; 17: 678–685

Table 7. Selected and Chronologically Presented SCS Guideline or Consensus Statements.

Ades et al. 2008 (15)	NICE	Non-departmental public body	Chronic pain of neuropathic origin (and ischemic pain if research trial)		Recommended for chronic neuropathic pain with 5/10 on VAS, >6 mo pain, s/p successful trial, ischemic pain in the context of an experimental trial	
Manchikanti et al. 2009 (16)	ASIPP	Not reported	CRPS, FBSS	Il-1 or Il-2 for long-term relief in managing patients with FBSS	SCS is recommended for FBSS and CRPS	FBSS and CRPS: 1B or 1C/strong†
Simpson et al. 2009 (17)	BPS	Sponsorship was BPS and SBNS and endorsed by NSUKI	Chronic neuropathic pain		SCS is effective in treating FBSS and CRPS and recommends for these and refractory neuropathic pain; SCS is recommended for selected patients with CCLI and RA only as part of robust clinical trial	
Chou R et al. 2009 (18)	APS	APS	Nonspecific low back pain, radiculopathy from FBSS, radiculopathy from prolapsed disc	SCS for FBSS with persistent radiculopathy: Fair** SCS for nonspecific low back pain; persistent radiculopathy with herniated disc no trials or evidence	SCS provides moderate benefit for patients with FBSS with persistent radiculopathy **SCS for treatment of nonspecific low back pain or radiculopathy from prolapsed disc: unable to estimate	SCS for FBSS with persistent radiculopathy: B; SCS for nonspecific low back pain or from prolapsed disc with persistent radiculopathy: I

Deer TR, Thomson S, Pope JE et al.International Neuromodulation Society Critical Assessment: Guideline Review of Implantable Neurostimulation Devices. Neuromodulation 2014; 17: 678–685

Table 1 Summary of GRADE results in neurostimulation studies of neuropathic pain, CRPS I and fibromyalgia

Procedure	Neuropathic pain				Complex regional pain syndrome type I				Fibromyalgia			
Assessment	Final quality of evidence	Effect size	Tolerability/ safety	Values and preferences	Final quality of evidence	Effect size	Tolerability/safety	Values and preferences	Final quality of evidence	Effect size	Tolerability/ safety	Values and preferences
SCS[a]	Low	Low	Moderate	ND	Low	Low	Moderate	ND				
DBS	Very low	Very low	Moderate	ND								
MCS	Very low	Low	Moderate	High[b]								
rTMS of M1	Low	Low	High	ND	Very low	Low	High	ND	Low	Low	High	ND
rTMS of DLPFC	Very low	Low	High	ND					Very low	Low	High	ND
tDCS of M1	Low	Low	High	ND					Low	Low	High	ND
tDCS of DLPFC	Very low	Low	High	ND					Very low	Low	High	ND

CRPS I, complex regional pain syndrome type I; DBS, deep brain stimulation; DLPFC, dorsolateral prefrontal cortex; M1, primary motor cortex; MCS, epidural motor cortex stimulation; ND, not determined; rTMS, repetitive transcranial magnetic stimulation; SCS, spinal cord stimulation; tDCS, transcranial direct current stimulation.

[a]SCS is the only procedure that was studied specifically in post-surgical chronic back and leg pain (two randomized controlled studies): final quality of evidence was low, effect size was moderate, tolerability/safety was moderate and patients' preferences compared to reoperation or standard of care were high; [b]in one study, a number of patients with insignificant pain relief were willing to be reoperated for the same outcome [14].

Cruccu G, Garcia-Larrea L; Hansson P et al.EAN guidelines on central neurostimulation therapy in chronic painconditions. European Journal ofNeurology 2016, 23: 1489–1499

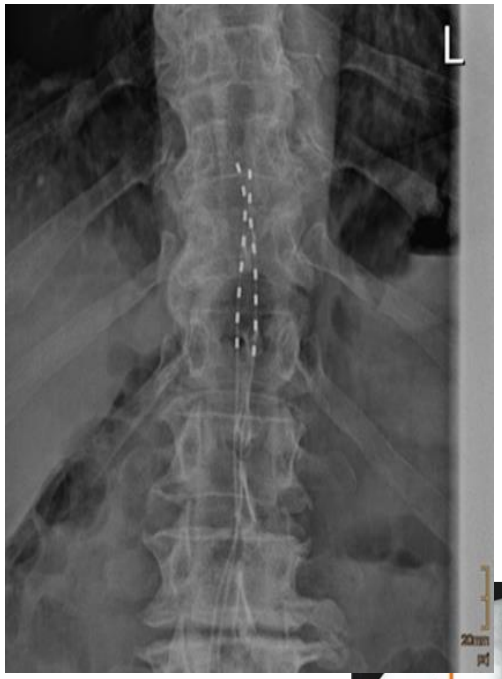
North RB, Kidd DH, Farrokhi F, et al. Spinal cord stimulation versus repeated lumbosacral spine surgery for chronic pain: a randomized, controlled trial. Neurosurgery 2005; 56: 98–106.

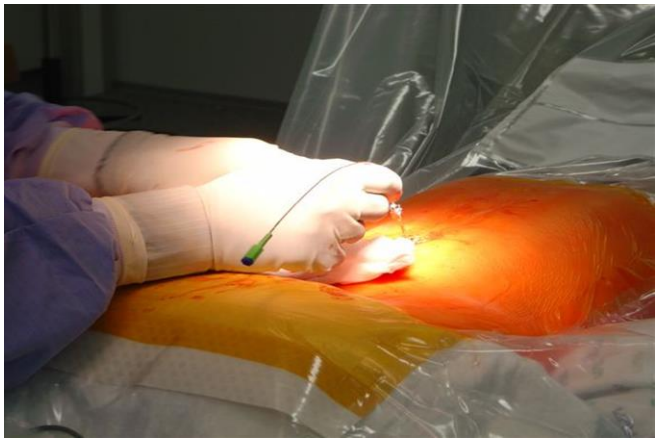
Table 2 Summary of GRADE recommendations for neurostimulation in chronic pain

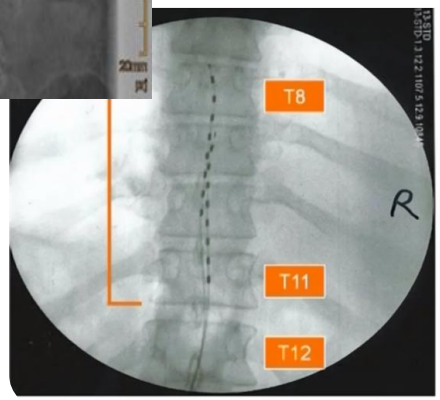
Procedure	Neuropathic pain	Post-surgical chronic back and leg pain	CRPS I	Fibromyalgia
Spinal cord stimulation				
SCS versus conventional management	Weak for	Weak for	Weak for	
SCS versus reoperation		Weak for		
Deep brain stimulation	Inconclusive			
Epidural motor cortex stimulation	Weak for			
Repetitive transcranial magnetic stimulation				
rTMS of M1	Weak for		Inconclusive	Weak for
rTMS of DLPFC	Inconclusive			Inconclusive
Transcranial direct current stimulation				
tDCS of M1	Weak for (inconclusive in SCI)			Inconclusive
tDCS of DLPFC	Inconclusive			Inconclusive

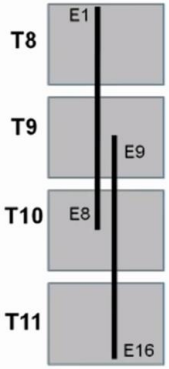
CRPS I, complex regional pain syndrome type I; DLPFC, dorsolateral prefrontal cortex; M1, primary motor cortex; rTMS, repetitive transcranial magnetic stimulation; SCI, spinal cord injury; SCS, spinal cord stimulation; tDCS, transcranial direct current stimulation.

Cruccu G, Garcia-Larrea L; Hansson P et al.EAN guidelines on central neurostimulation therapy in chronic painconditions. European Journal ofNeurology 2016, 23: 1489–1499





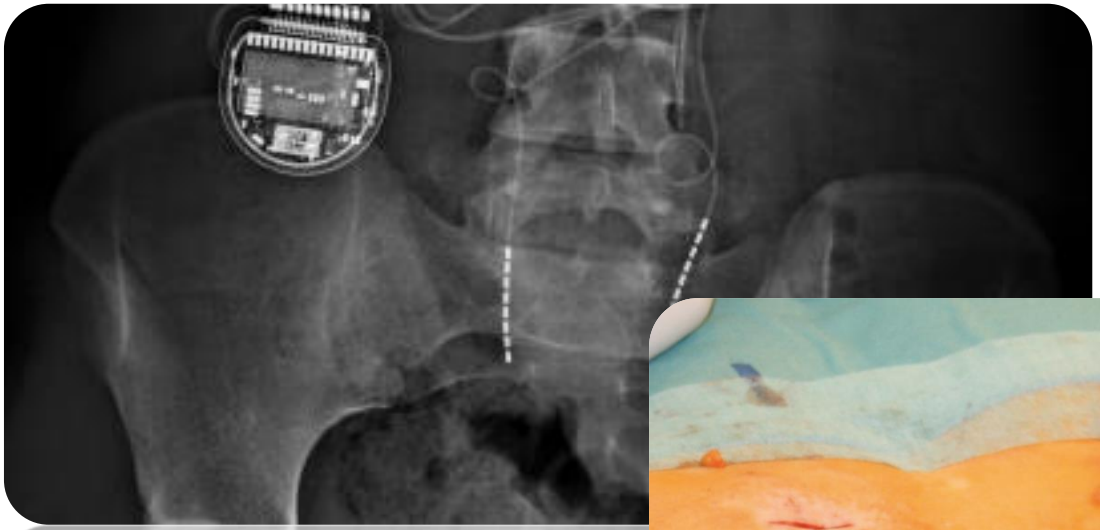




Correct Positioning:

- Offset leads
- Electrode tips at Top T8 and Mid T9
- Staggered electrodes
- Anatomical midline

SCS subkutan



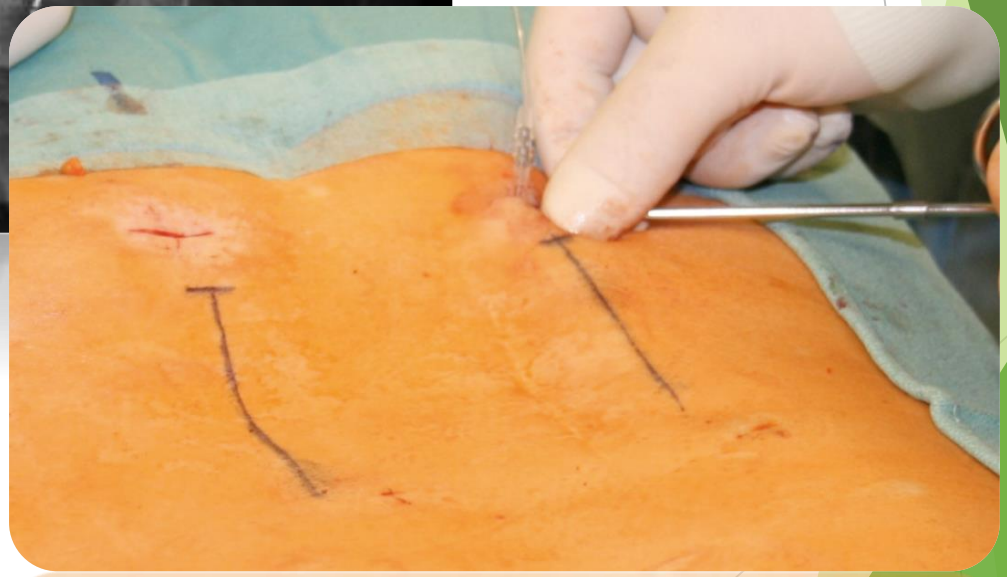


Table 2. Summary of Evidence Scores and Implications for Recommendation

Score	Description	Implication
1 A +	Effectiveness demonstrated in various RCTs of good quality. The benefits clearly outweigh risk and burdens	Positive recommendation
1 B +	One RCT or more RCTs with methodological weaknesses, demonstrate effectiveness. The benefits clearly outweigh risk and burdens	
2 B +	One or more RCTs with methodological weaknesses, demonstrate effectiveness. Benefits closely balanced with risk and burdens	
2 B ±	Multiple RCTs, with methodological weaknesses, yield contradictory results better or worse than the control treatment. Benefits closely balanced with risk and burdens, or uncertainty in the estimates of benefits, risk and burdens.	
2 C +	Effectiveness only demonstrated in observational studies. Given that there is no conclusive evidence of the effect, benefits closely balanced with risk and burdens	Considered, preferably study-related
0	There is no literature or there are case reports available, but these are insufficient to prove effectiveness and/or safety. These treatments should only be applied in relation to studies.	Only study-related
2 C –	Observational studies indicate no or too short-lived effectiveness. Given that there is no positive clinical effect, risk and burdens outweigh the benefit	
2 B –	One or more RCTs with methodological weaknesses, or large observational studies that do not indicate any superiority to the control treatment. Given that there is no positive clinical effect, risk and burdens outweigh the benefit	Negative recommendation

Jan Van Zundert et at, Editorial Evidence-Based Interventional Pain Medicine According to Clinical Diagnoses; Pain Practice 2011 Volume 11, Issue 5, 2011 423-429

Summary of the Recommendations

Trigeminal neuralgia			
Microvascular decompression		Very low	Very weak
Stereotactic radiosurgery		Very low	Very weak
Radiofrequency treatment of the ganglion Gasseri	2 B+	Low	Weak
Pulsed radiofrequency	2 B–	Very low	Very weak
Cluster headache			
Uni- or bilateral injection of nervus occipitalis		Not graded	Very weak
Radiofrequency treatment of ganglion pterygopalatinum	2 C+	Very low	Weak
Stimulation of ganglion pterygopalatinum		Very low	Very weak
Occipital nerve stimulation	2 C+	Low	Very weak
Persistent idiopathic facial pain			
Pulsed radiofrequency of ganglion pterygopalatinum	2 C+	Very low	Very weak
Radiofrequency of ganglion pterygopalatinum		Very low	Very weak
Cervical radicular pain			
Interlaminar epidural corticosteroid administration	2 B+	Moderate	Weak
Transforaminal epidural preservative-free dexamethasone	2 B– (not dexamethasone)	Very low	Very weak
Pulsed radiofrequency treatment adjacent to de DRG	1 B+	Moderate	Moderate
Radiofrequency treatment adjacent to de DRG	2 B+	Moderate	Weak
Spinal cord stimulation	0	Not graded	Very weak
Cervical facet joint pain			
Intra-articular corticosteroid administration	0	Low	Weak against
Therapeutic (repetitive) cervical medial branch injections of local anesthetic with or without corticosteroid	2 B+	Moderate	Weak
Radiofrequency treatment of ramus medialis of the ramus dorsalis	2 C+	Low	Weak
Cervicogenic headache			
Injection of the nervus occipitalis major with local anesthetic with or without steroid	1 B+	Moderate	Weak
Injection of atlanto-axial joint with local anesthetic with or without steroid	2 C–	Not graded	Weak against
Radiofrequency treatment of cervical ramus medialis	2 B+/–	Very low	Very weak
Pulsed radiofrequency treatment of nervus occipitalis major		Low	Weak
Pulsed radiofrequency treatment of atlanto-axial joint		Not graded	Very weak
Pulsed radiofrequency of cervical DRG (C2–C3)	0		
Whiplash-associated disorder			
Botulinum toxin injections	2 B–	Moderate	Moderate against
Radiofrequency treatment of cervical ramus medialis of the ramus dorsalis	2 B+	Low	Moderate
Intra-articular corticosteroid injections	2 C–	Very low	Very weak against
Occipital neuralgia			
A single infiltration of the nervi occipitales with local anesthetic and corticosteroids	2 C+	Very low	Very weak
Pulsed radiofrequency of the nervi occipitales	2 C+	Very low	Weak
Pulsed radiofrequency adjacent to the DRG	0		
Peripheral nerve stimulation	2 C+	Very low	Very weak
Botulinum toxin injections	2 C+/–	Very low	Very weak
Stimulation of the nervi occipitales	2 C+	Very low	Very weak
Thoracic radicular pain syndrome			
Intercostal nerve blocks	0	Not graded	Not applicable
(Pulsed) radiofrequency of thoracic DRG	2 C+	Low	Weak
Pain originating from the thoracic facet joint			
Addition of corticosteroids to local anesthetic for thoracic medial branch blocks		High	Moderate against
Lumbosacral radicular pain			
Epidural corticosteroid administration (interlaminar, transforaminal contained herniation, and transforaminal extruded herniation)		Moderate	Weak
Epidural TNF-α inhibitors		Low	Weak against
Radiofrequency treatment adjacent to lumbar DRG	2 A–	Moderate	Moderate against
Pulsed radiofrequency treatment adjacent to lumbar DRG	2 C+	Moderate	Moderate
Failed back surgery syndrome			
Adhesiolysis	2 B+/–	Very low	Very weak
Epiduroscopy	2 B +/–	Moderate	Weak
Spinal cord stimulation (tonic)	2 A+	Moderate	Moderate
Spinal cord stimulation (HF-10)		Not graded	Moderate
Subcutaneous stimulation as add-on to spinal cord stimulation		Not graded	Very weak
Pain originating from the lumbar facet joints			
Intra-articular injection of local anesthetic with or without corticosteroid	2 B+/–	Low	Very weak
Radiofrequency treatment of the ramus medialis of the ramus dorsalis	1 B+	Low	Weak
Pulsed radiofrequency treatment of ramus medialis of the ramus dorsalis		Low	Very weak against

Huygen F. et al.; „Evidence-Based Interventional Pain Medicine According to Clinical Diagnoses“: Update 2018: Pain Practice, Volume 19, Issue 6, 2019 664-675.

(Continued)

Treatment	Recommendations in 2010†	GRADE Level of Evidence in 2015	Recommendations in 2018
Spinal canal stenosis			
Spinal cord stimulation		Very low	Very weak
Pulsed radiofrequency treatment adjacent to DRG		Moderate	Moderate
Epidural local injections (without steroids)		Low	Weak
Epidural corticosteroid injections		High	Moderate against
Sacroiliac joint pain			
Intra-articular corticosteroid injections	1 B+	Low	Weak
Radiofrequency treatment of rami dorsalis and lateralis (palisade)	2 C+	Very low	Very weak
Radiofrequency treatment of rami dorsalis and lateralis (palisade) SIJ pain due to ankylosing spondylitis		Moderate	Moderate
Radiofrequency treatment of rami dorsalis and lateralis (simplicity)		Not graded	Moderate against
Pulsed radiofrequency treatment of rami dorsalis and lateralis	2 C+	Not graded	Very weak
Radiofrequency treatment of ramus dorsalis at L4–L5 and cooled radiofrequency of the ramus lateralis	2 B+	Low	Weak
Cooled radiofrequency treatment of ramus dorsalis at L4–L5 and ramus lateralis		Moderate	Moderate
Discogenic pain			
Intradiscal methylene blue injection		Moderate	Weak
Intradiscal corticosteroid injection	2 B–	Low	Weak against
Intradiscal radiofrequency treatment	2 B+/–	Low	Weak against
Intradiscal electrothermal therapy		Low	Weak
Intradiscal pulsed radiofrequency treatment	2 B+/–	Very low	Very weak
Intradiscal biacuplasty	0	Moderate	Moderate
Disctrode	0		
Radiofrequency treatment of ramus communicans	2 B +	Very low	Very weak against
Complex regional pain syndrome			
Sympathetic blocks with local anesthetics	2 B+	Moderate	Moderate against
Thoracic block (T2–T3) with ropivacaine and triamcinolone		Low	Weak
IV regional blocks with guanethidine	2 A–	Moderate	Moderate against
Spinal cord stimulation	2 B+	Moderate	Moderate
DRG stimulation (for lower extremity CRPS)		Moderate	Moderate
Peripheral nerve stimulation	2 C+	Very low	Very weak
Low-dose IV ketamine		Moderate	Weak
Herpes zoster and postherpetic neuralgia			
Acute phase: epidural injection of corticosteroid with local anesthetics	2 B+	Moderate	Moderate
Acute phase: paravertebral injections of corticosteroids with local anesthetics		Moderate	Moderate
Acute phase: repeated epidural injections of corticosteroid with local anesthetics and epinephrine		Moderate	Weak
Acute phase: stellate ganglion block	2 C+	Low	Weak
Treatment of postherpetic neuralgia: epidural corticosteroid injections or combined therapy with intrathecal midazolam	0	Low	Weak
Treatment of postherpetic neuralgia: sympathetic nerve block	2 C+	Very low	Very weak against
Treatment of postherpetic neuralgia: spinal cord stimulation	2 C+	Very low	Very weak
Treatment of postherpetic neuralgia: pulsed radiofrequency on intercostal nerve		Moderate	Moderate
Treatment of postherpetic neuralgia: pulsed radiofrequency adjacent to DRG		Very weak	Moderate
Treatment of postherpetic neuralgia: intrathecal administration of corticosteroid		Low	Strong against
Treatment of postherpetic neuralgia: lumbar sympathetic block		Very low	Very weak
Painful diabetic polyneuropathy			
Spinal cord stimulation	2 C+	Moderate	Moderate
Lumbar sympathetic block		Very low	Very weak
Meralgia paresthetica			
Infiltration of LFCB with local anesthetic with or without corticosteroid	2 C+	Very low	Very weak
Pulsed radiofrequency of LFCB	0	Very low	Very weak
Spinal cord stimulation	0	Not graded	Very weak
Carpal tunnel syndrome			
Intracarpal corticosteroid injection(s)	1 B+	Moderate	Moderate
Pulsed radiofrequency treatment of median nerve	0	Very low	Very weak
Phantom pain			
Pulsed radiofrequency treatment of the most tender part of the neuroma	0	Very low	Very weak
Spinal cord stimulation	0	Very low	Very weak
DRG stimulation		Very low	Very weak
Traumatic plexus lesion			
Spinal cord and DRG stimulation	0	Not graded	Very weak
Chronic refractory angina pectoris			
Spinal cord stimulation	2 B+	Low	Weak

Huygen F. et al.; „Evidence-Based Interventional Pain Medicine According to Clinical Diagnoses“: Update 2018: Pain Practice, Volume 19, Issue 6, 2019 664-675.

(Continued)

Treatment	Recommendations in 2010†	GRADE Level of Evidence in 2015	Recommendations in 2018
Raynaud's phenomenon			
Radiofrequency of T2–T3 and T2 thermolesion with a local application of phenol	2 C+	Very low	Very weak
Spinal cord stimulation		Very low	Very weak
Ischemic pain of the extremities			
Sympathectomy	2 B+/–	Not graded	Very weak
Spinal cord stimulation	2 B+/–	High	Moderate
Chronic pancreatitis			
Plexus coeliacus block with local anesthetic and corticosteroid		Low	Weak against
Splanchnic nerve block	2 C+ (radiofrequency)	Very low	Very weak
Spinal cord stimulation	2 C+	Very low	Very weak
Pain in patients with cancer			
Intrathecal drug administration	2 B+	Moderate	Weak
Epidural drug administration	2 C+	Very low	Very weak
Spinal cord stimulation		Very low	Very weak
Cervical percutaneous cordotomy	2 C+	Very low	Very weak
Neurolytic plexus coeliacus block	2 A+	High	Strong
Neurolytic plexus hypogastricus block	2 C+	Low	Weak
Intrathecal phenolization of lower sacral roots of cauda equina (lower end block)	0	Very low	Very weak
Kyphoplasty	2 B+	Not graded	Very weak
Vertebroplasty	2 B+	Very low	Very weak

*2010 recommendations as reported in the previous guideline; the level of evidence in 2015 as identified by independent evaluation using GRADE; and the strength of recommendation as updated by the Guideline Committee in 2018, taking into consideration newer publications and potential risks for side effects and complications.
†A is the highest level of evidence (various RCTs of good quality), B stands for RCTs with methodological limitations or large observational studies and C stands for observational studies or case series.[3]
CRPS, chronic regional pain syndrome; DRG, dorsal root ganglion; GRADE, Grading of Recommendations Assessment, Development and Evaluation; HF-10, High frequency 10-kHz stimulation; LFCB, lateral femoral cutaneous nerve; SIJ, sacroiliac joint; TNF-α, tumor necrosis factor-α.

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KEYWORDS

• Epidural • Facet • Interventional spine • Interventional pain • Pain management
• Sonography • Spine injections • Ultrasonography

KEY POINTS

- Ultrasound (US) has become a more common imaging modality for spinal interventions.
- US has some advantages and disadvantages compared with fluoroscopy and other imaging modalities.
- Most typical spinal pain procedures described under fluoroscopy have also been described with US guidance.
- Although there are multiple studies demonstrating the accuracy of US-guided spine procedures using cadaveric dissections as well as comparing their accuracy to procedures with CT or fluoroscopic guidance, there are no large studies comparing the safety or efficacy of US-guided spinal interventions to CT or fluoroscopic guidance.
- Some spinal interventions where the spinal vascular supply may be at risk may still benefit from fluoroscopic or CT-confirmed contrast-controlled verification.

Hurdle MFB. Ultrasound-Guided Spinal Procedures for Pain. Phys Med Rehabil Clin N Am 27 (2016) 673-686

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