Pulsed radiofrequency therapy

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Mihails Arons, Edgars Vasiļevskis, prof. Māra Pilmane,
Irina Evansa, Igors Paņihins

Historical overview

- 1931 - the first use in humans for the management of trigeminal neuralgia (direct current of 350 mAmp, 10 mm uninsulated tip) (Kirschner)
- 1965 - RF percutaneous lateral cordotomy for unilateral cancer pain (Rosomoff)
- 1974 - RF lesion of the Gasserian ganglion in the treatment of trigeminal neuralgia (Sweet)

Historical overview

- 1975 - RF lesion of the medial branch for lumbar facetal pain (14G electrode introduced through a 12G needle) (Shealy)
- 1977 - RF lesion of the DRG (14G electrode, 12G needle, 75℃) (Uematsu)
- 1980 - small-diameter electrodes (SMK systems) were introduced (22G needle with a fine thermocouple probe inside) (Sluijter, Mehta)

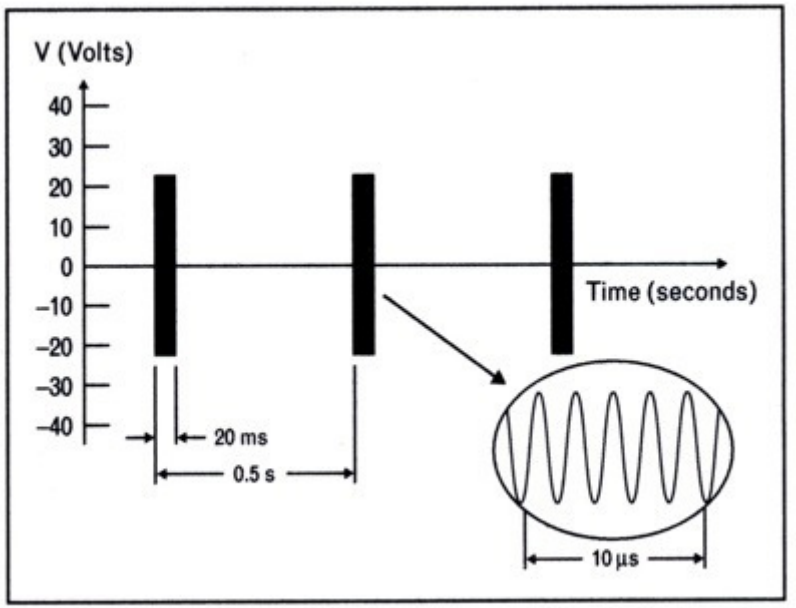
PRF

- 1996 – Pulsed Radiofrequency (Sluijter, Cosman, Rittman, van Kleef)

1. Modified technique: 1 sec., 2 bursts of 20 ms each, 500kHz

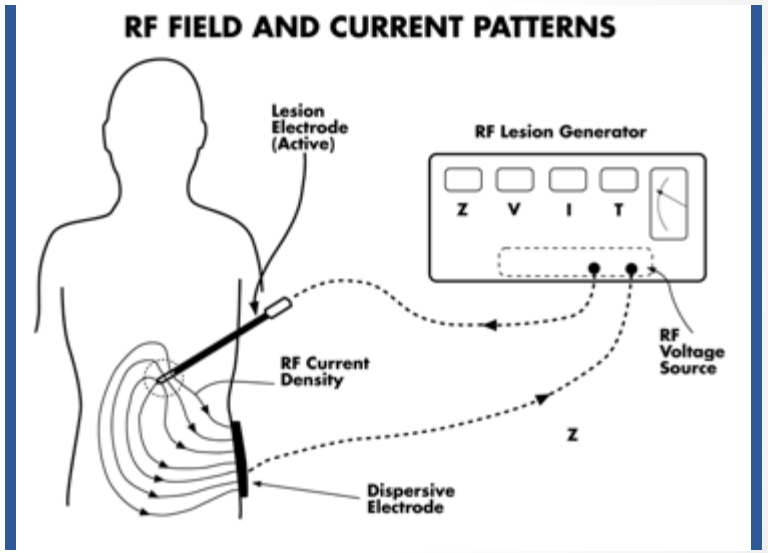
2. One cycle: “active” phase,
   silent period

3. No heat lesion, temperature <42 ℃,
   output 45V

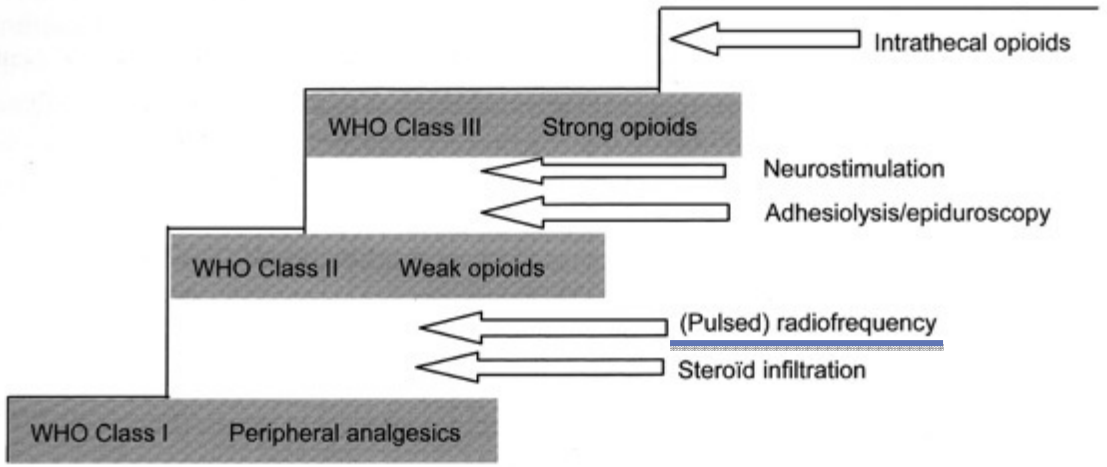


PRF basic elements

- X-ray or Ultrasound
- RF generator
- RF needle with active tip
- Active electrode (thermocouple)
- Dispersive electrode
-



Application of PRF



Ongoing Multi-Disciplinary approach:

- Adjuvant analgesics
- Psychologic counseling
- Physical therapy
- Evaluation of causal diagnosis/treatment

Figure 1: Schematic representation of the step-wise approach of chronic pain.

Indications

- **Chronic Shoulder Pain ?!**

Radiofrequency Treatment of Peripheral Nerves

O.J.J.M. Rohof, MD
Pain Clinic, Maasland Hospital, Sittard, The Netherlands;

- 37 pts. chronic shoulder pain
- Mean pain duration was 26.8 months
- 10 cm needle, 5 mm active tip
- 2 min PRF (42℃, 2 p.p.s, 20 ms, 40V)

Results: VAS pain score was reduced by 4,5 points, improve mobility and treatment satisfaction

PAIN MEDICINE
Volume 10 • Number 1 • 2009

PRELIMINARY RESEARCH

Pulsed Radiofrequency Lesioning of the Suprascapular Nerve for Chronic Shoulder Pain: A Preliminary Report

Po-Chou Liliang, MD,* Kang Lu, MD, PhD,* Cheng-Loong Liang, MD,* Yu-Duan Tsai, MD,* Ching-Hua Hsieh, MD,† and Han-Jung Chen, MD, PhD*

*Department of Neurosurgery, E-Da Hospital, I-Shou University and †Department of Trauma and Emergency Surgery, Chang Gung Memorial Hospital in Kaohsiung, Kaohsiung, Taiwan

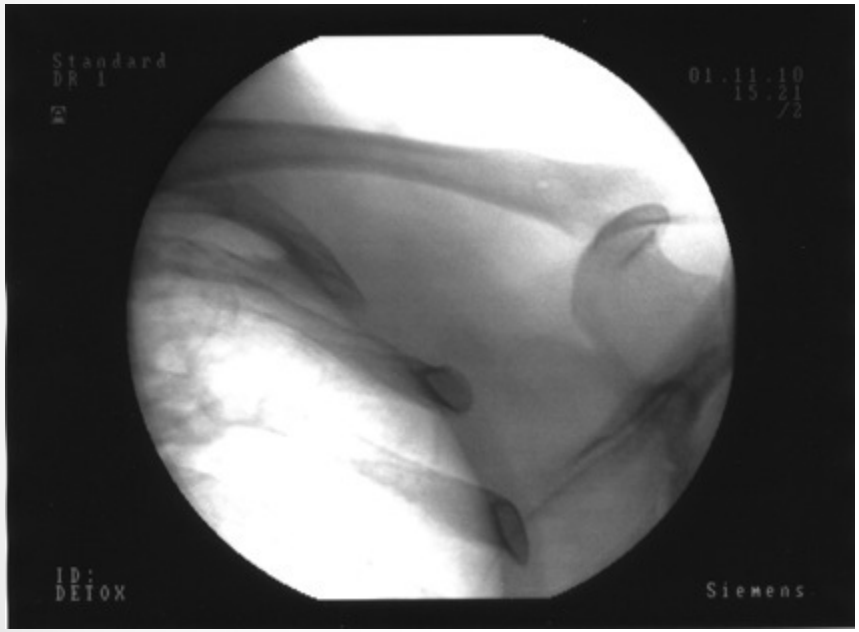
- 11 pts. with chronic shoulder pain (mean age was 43.7, mean pain duration was 41.6 months)
- Positive results of diagnostic suprascapular nerve blocks (50% or more pain relief)
- 10 cm needle, 22-gauge, 10 mm active tip
- Two PRF cycles of 180 seconds (42℃, 2 p.p.s, 20 ms, 45V)

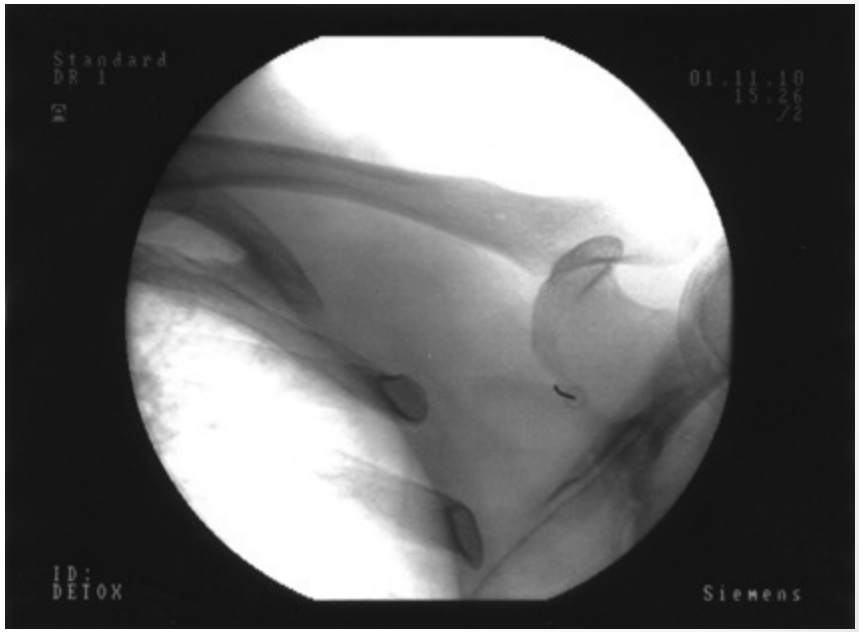
Results

Table 3 Visual analog scale (VAS) and Shoulder Pain and Disability Index (SPADI) scores before and after pulsed lesioning radiofrequency (PRF)

Measurements	Pre-PRF	After 1 m	After 6 m	*P* value
VAS score	7.5 ± 1.0	2.8 ± 2.6*	2.5 ± 2.8*	$P < 0.001$
SPADI-pain subscale	57.3 ± 13.0	—	24.9 ± 26.2	$P < 0.001$
SPADI-disability subscale	38.9 ± 15.9	—	21.4 ± 6.4	$P < 0.001$

Suprascapular nerve PFR





PRF nervus suprascapularis 2C+ (To be considered)

Indications

- **Chronic Cervical Radicular Pain!**

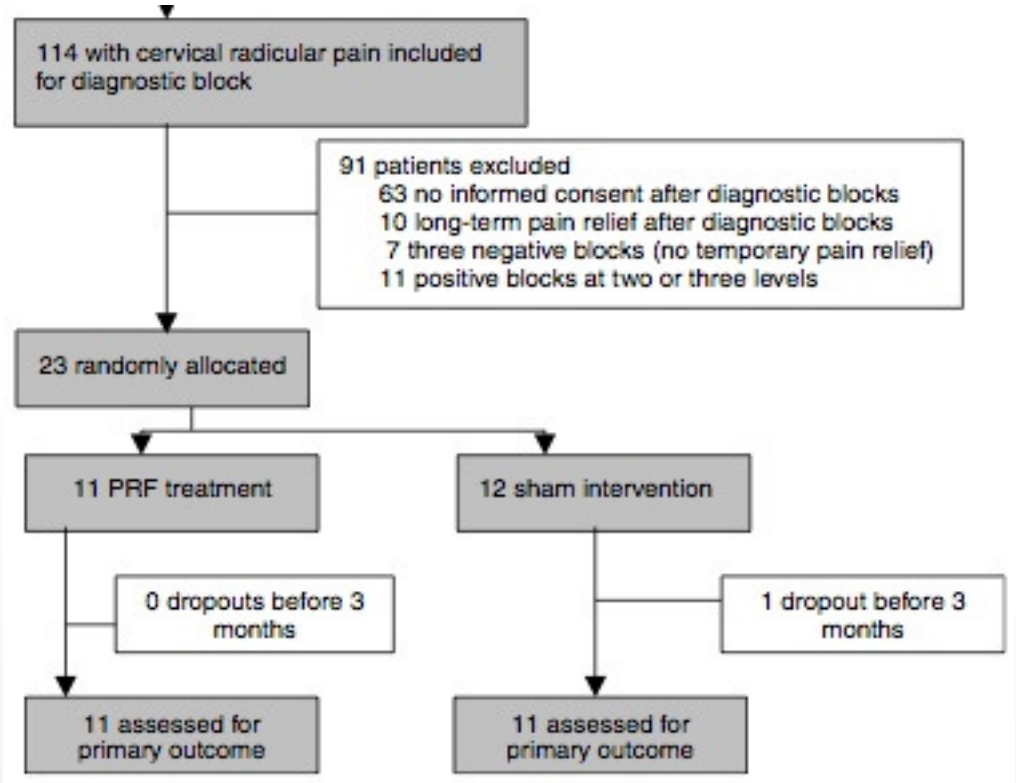
Pain 127 (2007) 173–182

PAIN

www.elsevier.com/locate/pain

Pulsed radiofrequency adjacent to the cervical dorsal root ganglion in chronic cervical radicular pain: A double blind sham controlled randomized clinical trial

Jan Van Zundert [a,d,*], Jacob Patijn [a], Alfons Kessels [b], Inge Lamé [a], Hans van Suijlekom [c], Maarten van Kleef [a]



Results (GPE)

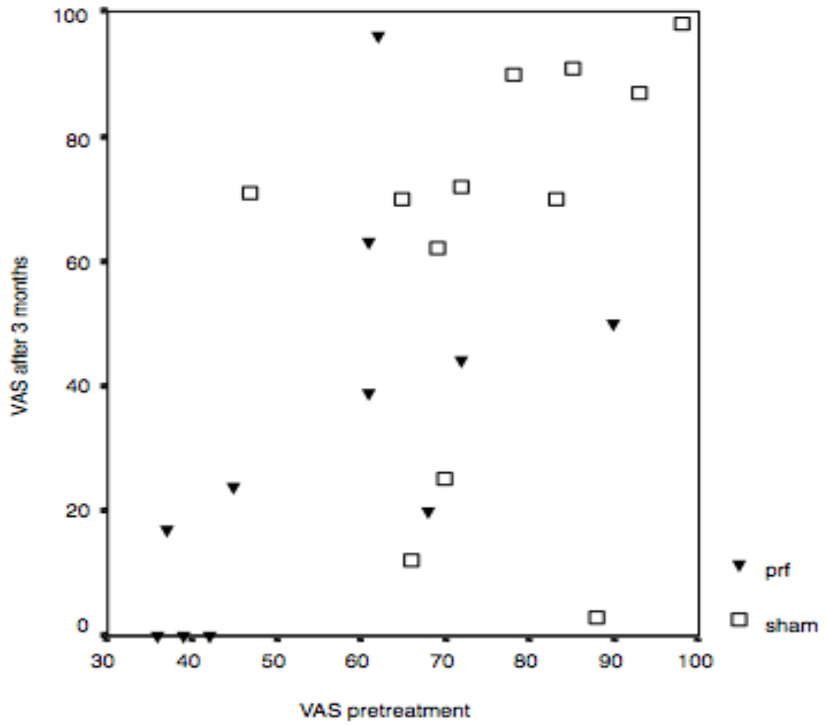
- At least 50% pain improvement of the GPE (global perceived effect)
- 9/11 (82%) patients in the PRF group and in 4/12 (33%) in the sham group (P value = 0.03)

Likert scale 7-point scoring system: global perceived effect

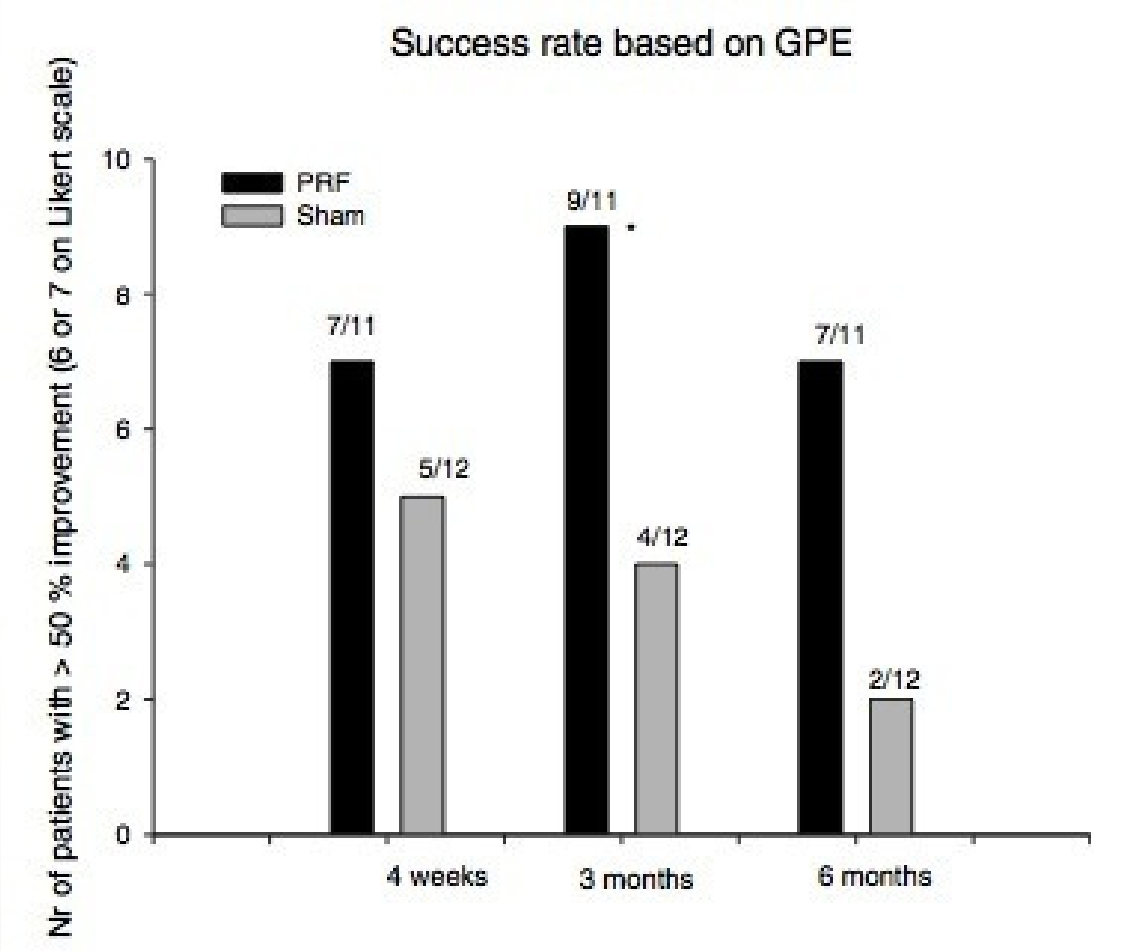
Score	% Change	Description
7	⩾ 75% improvement	Very good
6	50–74% improvement	Good
5	25–49% improvement	Fairly good
4	0–24% improvement or worse	Same as before
3	25–49 % worse	Fairly bad
2	50–74% worse	Bad
1	⩾75% worse	Very bad

Results (VAS)

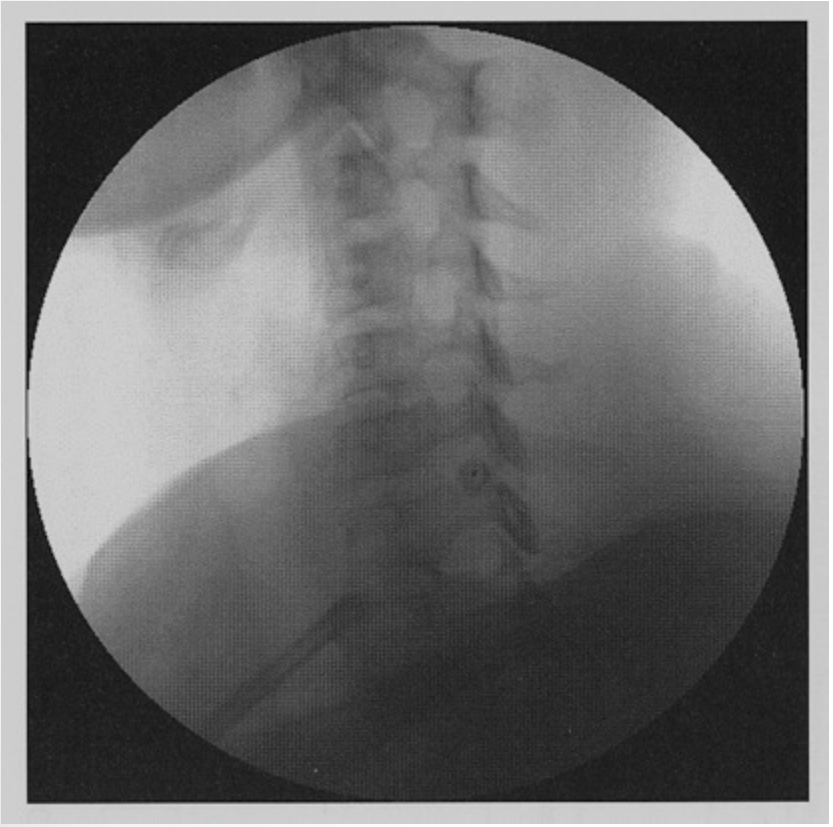
- 20 points reduction in pain intensity measured by VAS score
- 9/11 (82%) patients in the PRF group compared with 3/12 (25%) in the sham group (P = 0.02)

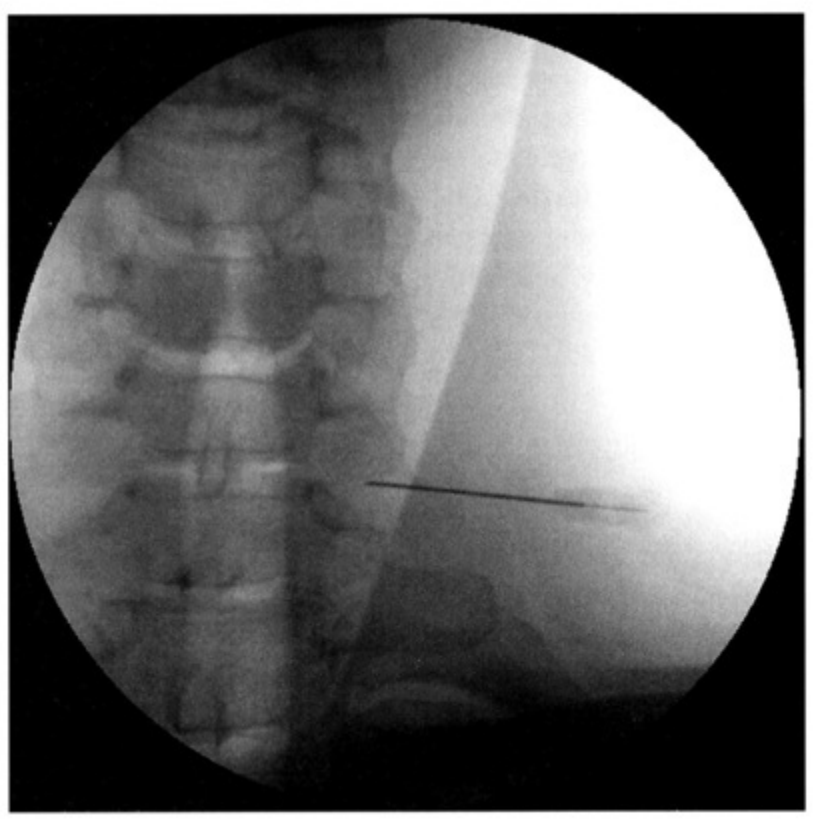


Results (GPE)


Success rate based on GPE
Nr of patients with > 50 % improvement (6 or 7 on Likert scale)
10
8
6
4
2
0
PRF
Sham
7/11
5/12
9/11
*
4/12
7/11
2/12
4 weeks
3 months
6 months

Cervical DRG PRF





PRF treatment adjacent to the DRG 1B+ (recommended)

Indications

- **Discogenic Low Back Pain?!**

PAIN MEDICINE
Volume 7 • Number 5 • 2006

Preliminary Research

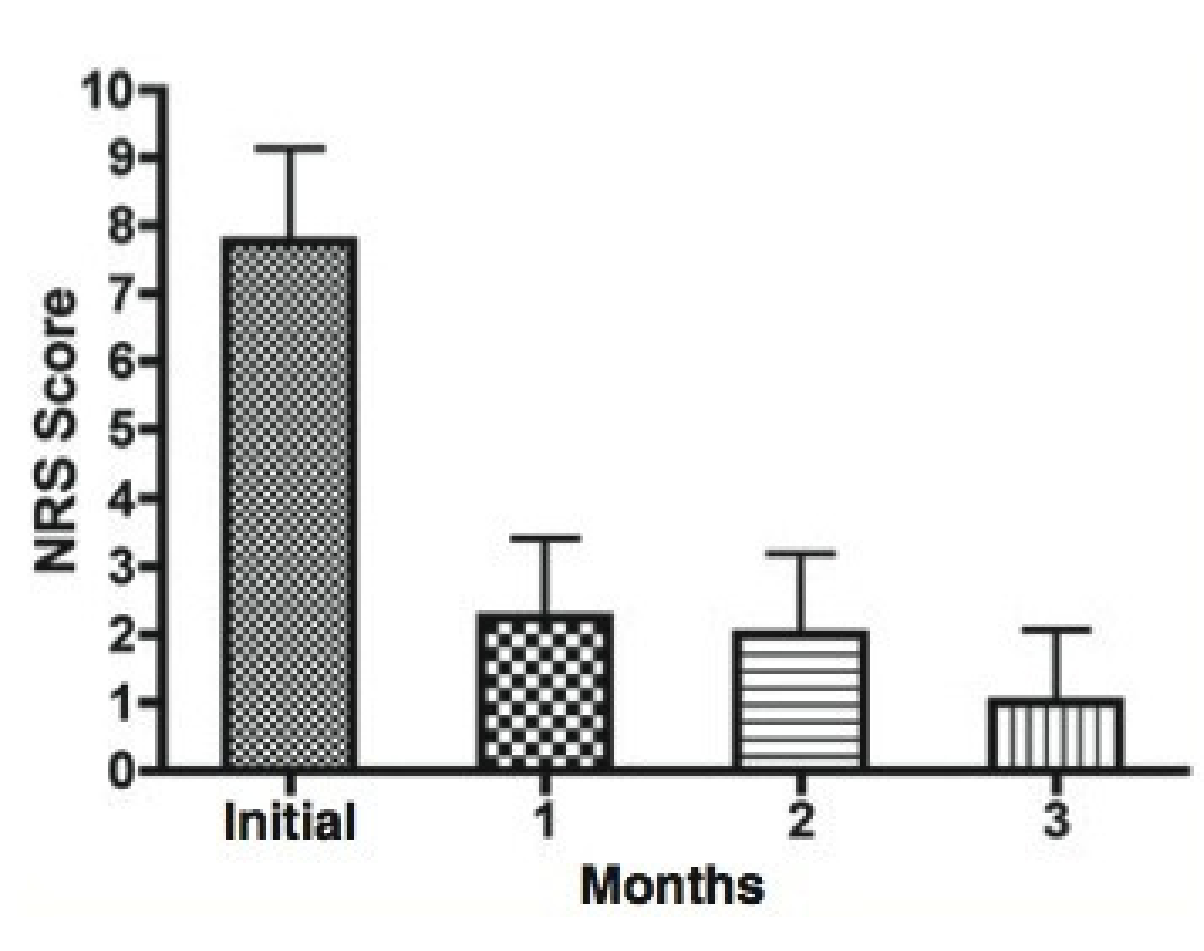
Intradiscal High-Voltage, Long-Duration Pulsed Radiofrequency for Discogenic Pain: A Preliminary Report

Alexandre Teixeira, MD,* and Menno E. Sluijter, MD, PhD†

*Clinica de Dor, Porto, Portugal; †Pain Unit, Swiss Paraplegic Center, Nottwil, Switzerland

- 8 pts.
- Mean duration of pain was 6.3 years
- Mean NRS score was 7.75
- Disc height was reduced 60% in one patient and up to 30% in the others
- 15-cm, 20-gauge needle with a 15-mm active tip
- 20 min, 2 p.p.s., 20 ms, 60 V
-

Results (3 month after PRF)



Intradiscal Pulsed Radiofrequency Application Following Provocative Discography for the Management of Degenerative Disc Disease and Concordant Pain: A Pilot Study

Olav Rohof, MD, PhD, FIPP
Pain Clinic, Orbis Medical Center, Sittard Geleen, The Netherlands

- 76 pts.
- Ventral compartment syndrome
- LBP 6 months duration that was refractory to pharmacological treatment and physical therapy
- Discogenic pain confirmed by magnetic resonance imaging and provocative discography
-

Results (3 month after PRF)

Effect of PRF	Number of Patients (%)
No effect	22 (28.9)
Numeric rating scale > 2 better	23 (30)
> 50% better	29 (38)
Surgery	2 (2.6)

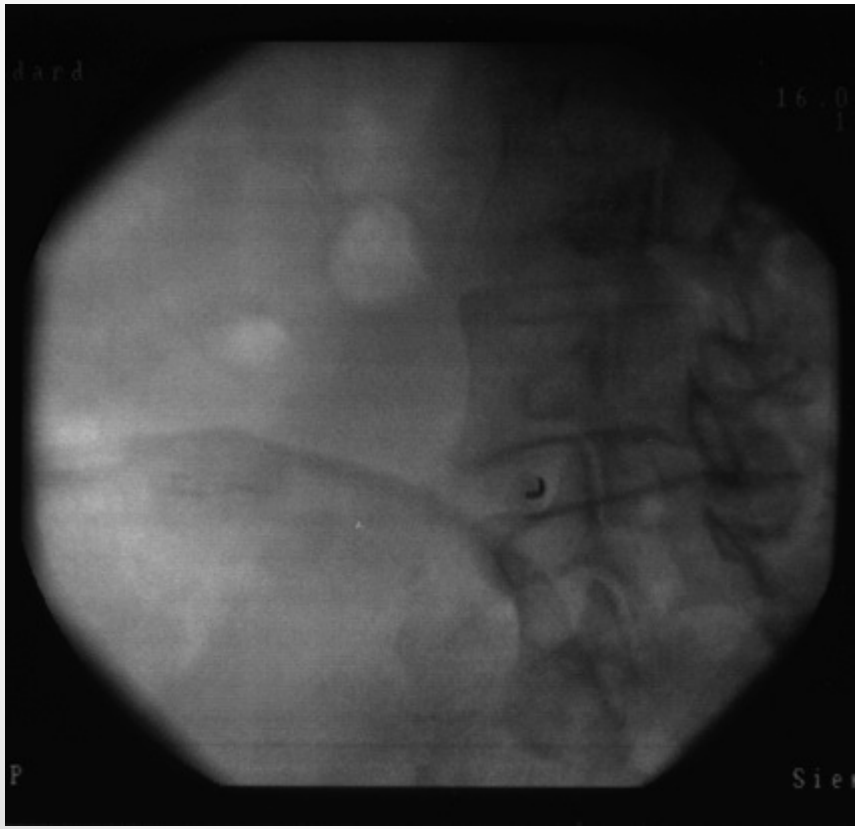
Results (12 month after PRF)

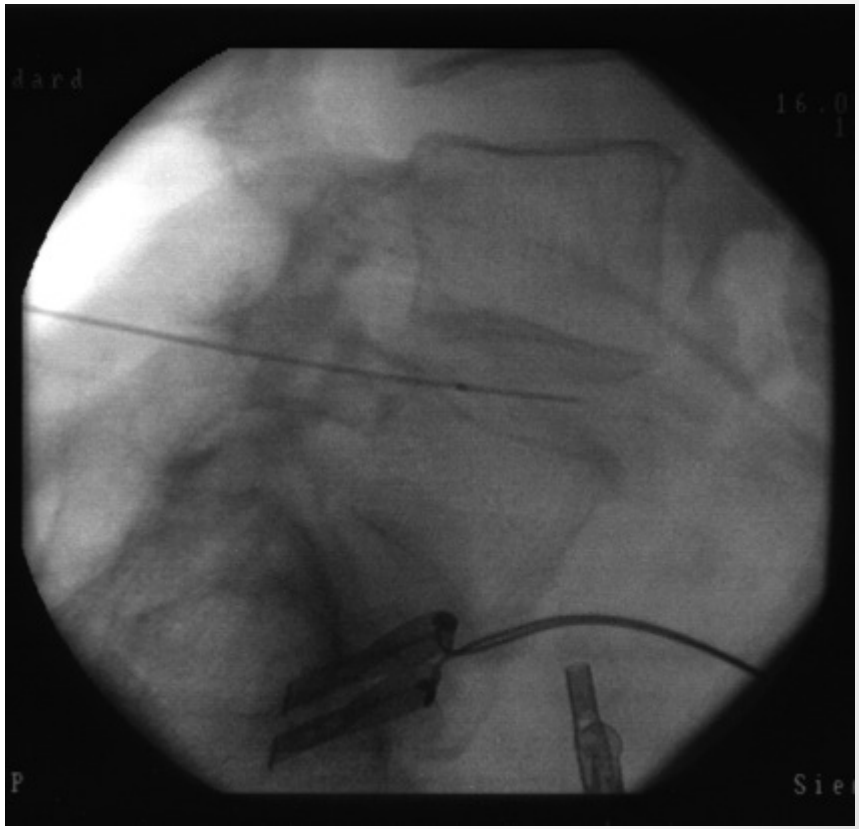
Outcome Groups	Effect at 3 Months Number of Patients	Effect at 12 Months Number of Patients
No effect	*N* = 22	*N* = 10 *N* = 5 vas > 2 *N* = 7 > 50%
Numeric rating scale > 2 better	*N* = 23	*N* = 6 *N* = 13 > 50% *N* = 4 no effect
> 50% better	*N* = 29	*N* = 23 *N* = 6 recidive
To surgery	*N* = 2	*N* = 2

Results (3 and 12 month after PRF + additional interventions)

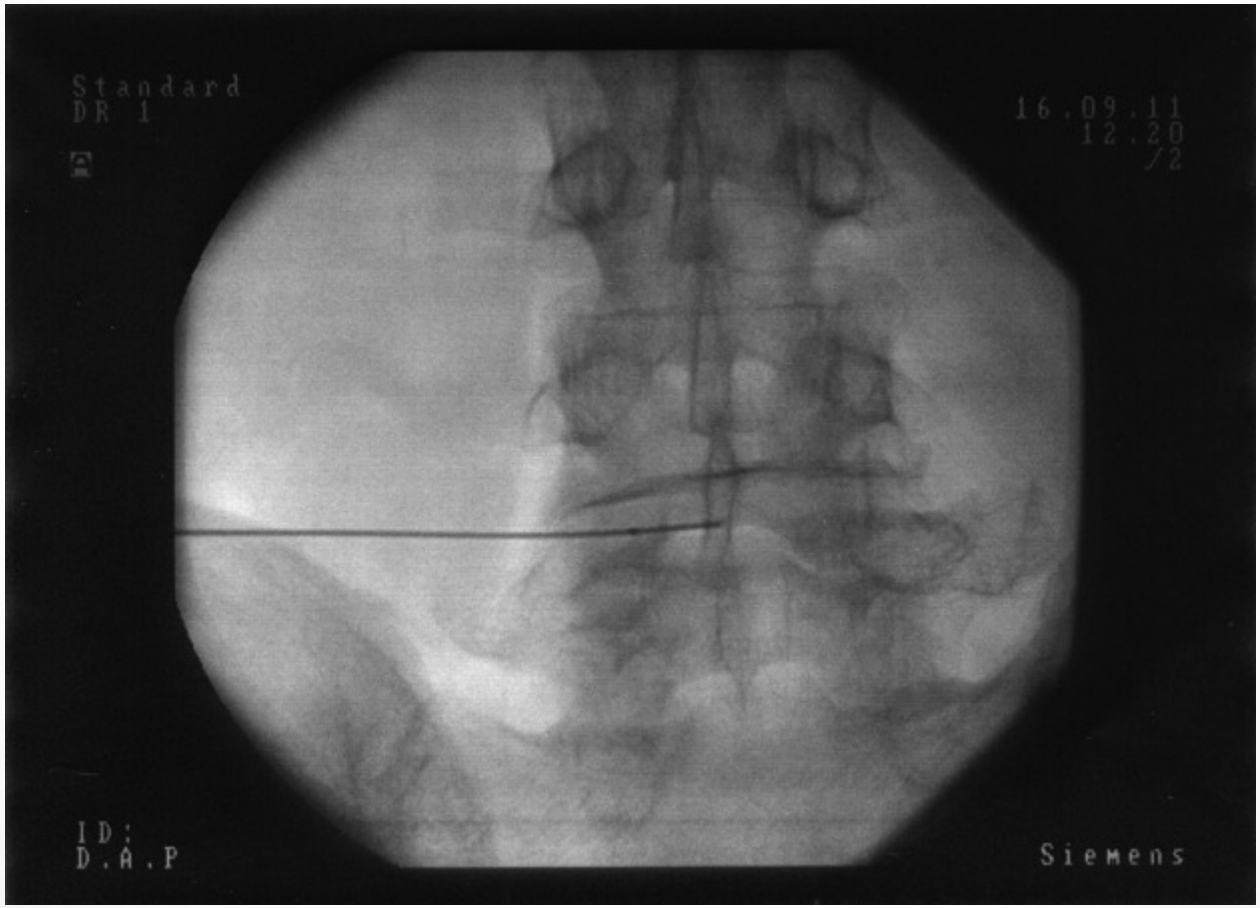
Treatment Outcome	3 Months	12 Months
No effect	22 (28.9%)	20 (26.3%)
Numeric rating scale > 2	23 (30%)	11 (14.4%)
> 50% better	29 (38%)	43 (56.5%)
Surgery	2 (2.6%)	2 (2.6%)

Intradiscal PRF

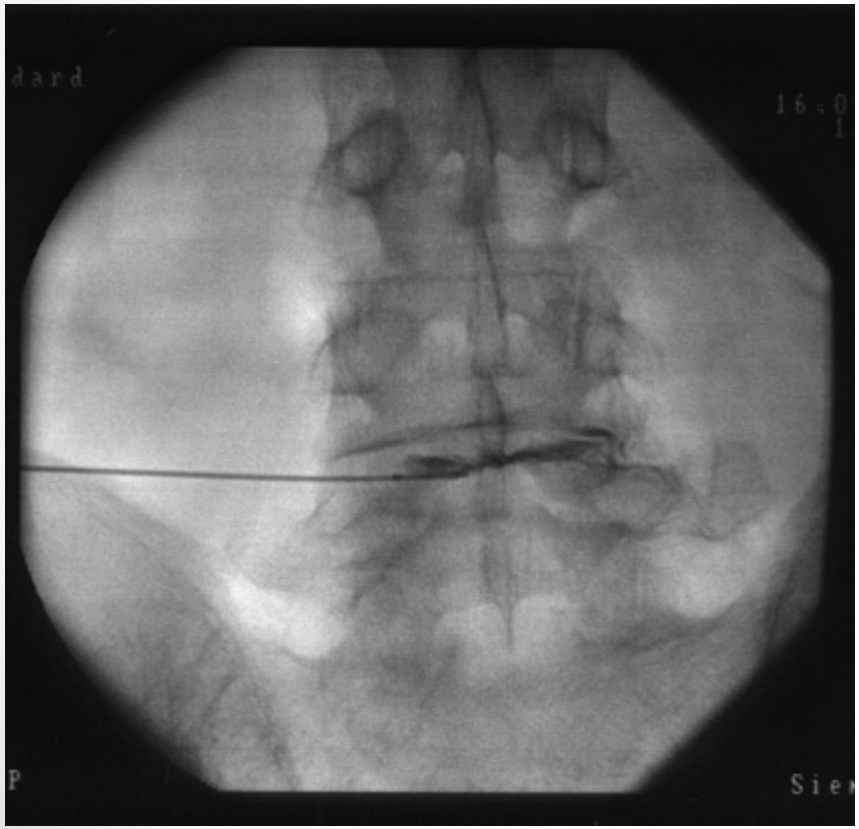


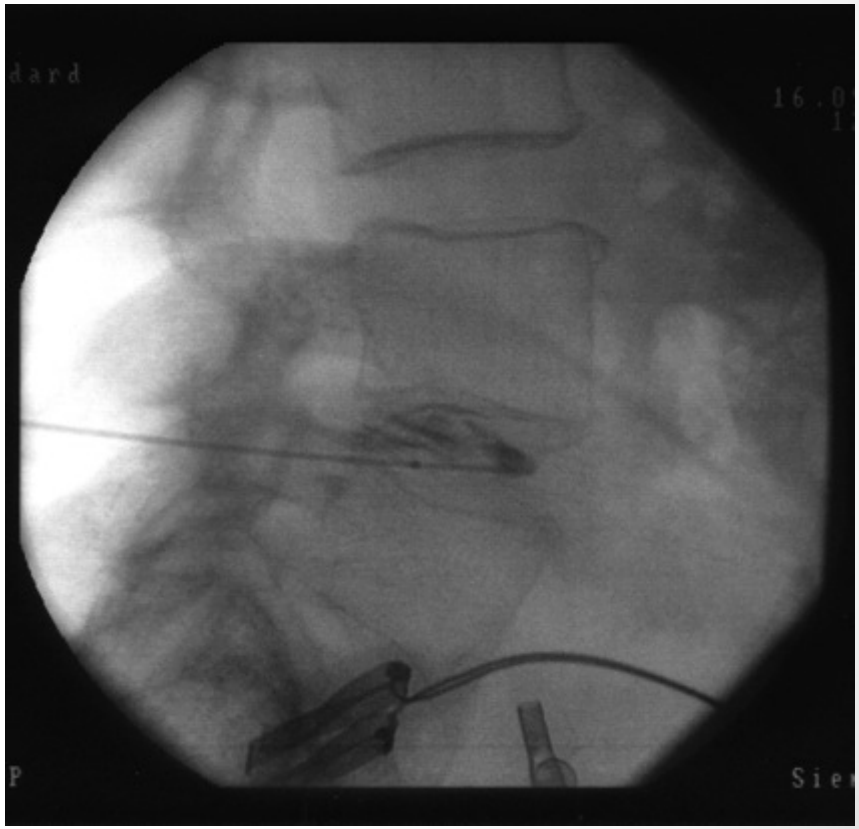


Intradiscal PRF



Intradiscal PRF





- Intradiscal PRF 2B± (to be considered)

Indications

- **Lumbar Radicular Pain ?!**

ORIGINAL ARTICLE

Pulsed Radiofrequency in Lumbar Radicular Pain: Clinical Effects in Various Etiological Groups

David Abejón, MD, FIPP*; Santiago Garcia-del-Valle, MD†; María Lorenza Fuentes, MD‡; Juan Ignacio Gómez-Arnau, MD, PhD†; Enrique Reig, MD, PhD, FIPP§; Jan van Zundert, MD, PhD, FIPP¶

Hospital Universitario Clínica Puerta de Hierro, Madrid; †Department of Anesthesia and Critical Care, Fundación Hospital Alcorcón, Madrid; ‡Department of Anesthesia and Critical Care, Anesthesia and Pain Unit, Fundación Hospital Alcorcón, Madrid; §Clínica del Dolor de Madrid, Madrid, Spain; ¶Department of Anesthesiology, Intensive Care, Emergency Medicine and Multidisciplinary Pain Therapy, Ziekenhuis Oost-Limburg, Campus Andre Dumont, Stalenstraat, Belgium

- Retrospective analysis
- 54 pts.
- HD (n=29), SS (n=12) or FBSS (n=13)
- Selective radicular nerve block (bupivacaine 0.125%)
- Efficacy of PRF was assessed: Numeric Rating Scale (NRS), Global Perceived Effect (GPE)
-

Results (D30, D60)

	HD	*n*	SS	*n*	FBSS	*n*
NRS						
Baseline	7 ± 1.30	27	6.9 ± 2.97	11	6.7 ± 2.07	13
30 days	3.04 ± 1.89	27	3.5 ± 2.85	11	5.6 ± 1.91	13
60 days	3.13 ± 2.13	25	2.7 ± 2.56	10	5.9 ± 1.84	13
GPE						
30 days	79.3% (71.7–86.9)		66.6% (59.9–73.3)		30.7% (18–43.4)	
60 days	72.4% (63.8–80.9)		66.6% (59.9–73.3)		15.3% (5.4–24.9)	

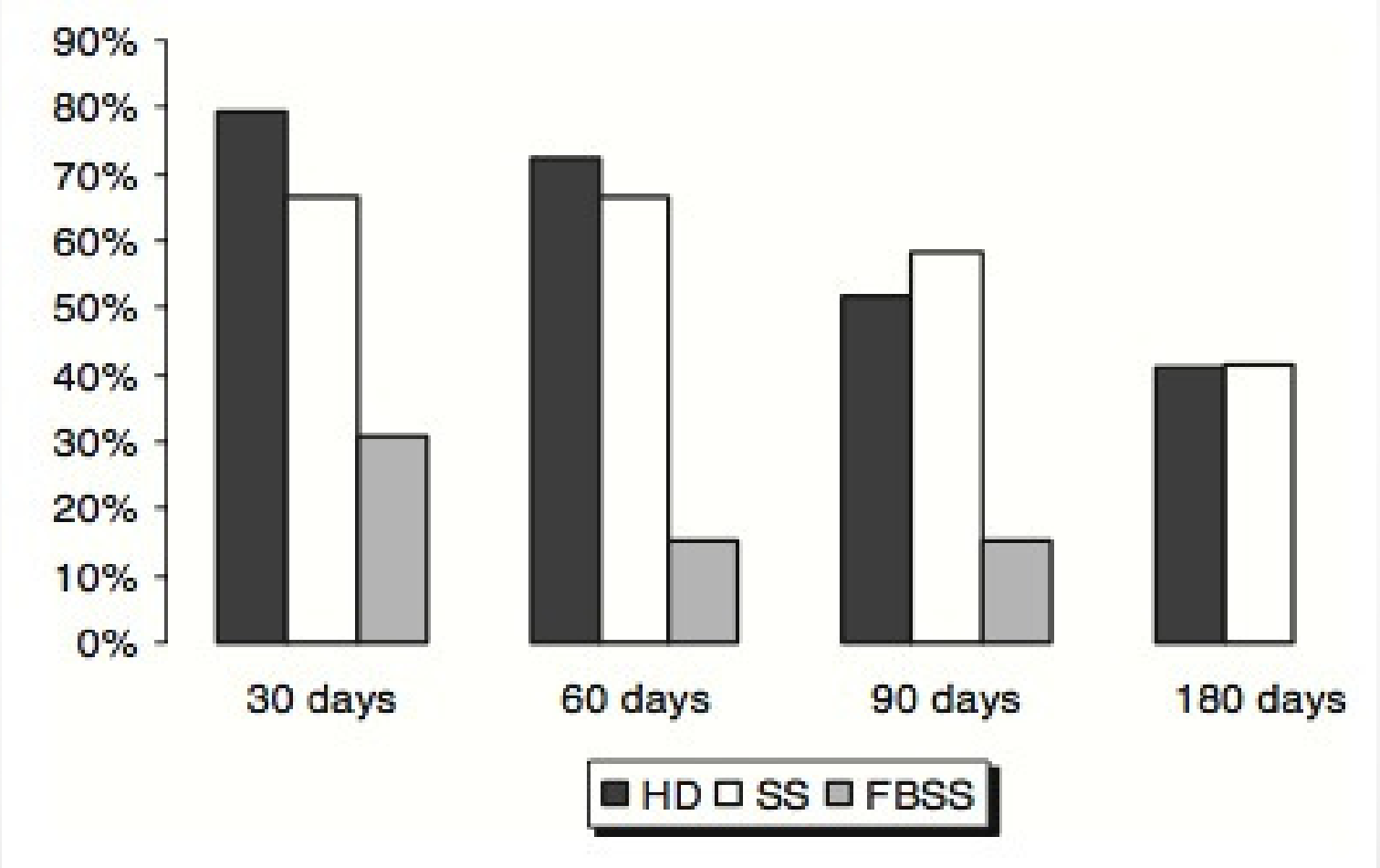
NRS score: 11-point NRS.
GPE results: percentages of patients with a GPE score ≥6.
FBSS, failed back surgery syndrome; HD, herniated disc; SS, spinal stenosis.

Results (D90, D180)

	HD	*n*	SS	*n*	FBSS	*n*
NRS score						
90 days	3 ± 1.93	21	2.8 ± 2.60	9	6.0 ± 2.69	6
180 days	2.6 ± 1.81	16	2.6 ± 2.92	8	—	—
GPE score						
90 days	51.7% (40.8–62.6)		58.3% (50,2–66.4)		15.3% (8–29.8)	
180 days	41.3% (29.1–53.5)		41.6% (24.3–58.9)		—	

NRS score: 11-point NRS.
GPE results: percentages of patients with a GPE score ≥6.
FBSS, failed back surgery syndrome; HD, herniated disc; SS, spinal stenosis.

Results


90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
30 days
60 days
90 days
180 days
HD
SS
FBSS

Available online at www.sciencedirect.com
ScienceDirect
Surgical Neurology 70 (2008) 59–65
SURGICAL NEUROLOGY
www.surgicalneurology-online.com

Pain

Percutaneous pulsed radiofrequency in the treatment of cervical and lumbar radicular pain

Shao-Ching Chao, MD[a], Hsu-Tung Lee, MD[a], Ting-Hsien Kao, MD[a], Meng-Yin Yang, MD[a], Yuang-Seng Tsuei, MD[a], Chiung-Chyi Shen, MD[a], Hsi-Kai Tsou, MD[a,b,*]

[a]*Department of Neurosurgery, Taichung Veterans General Hospital, Taichung, Taiwan 40705, ROC*
[b]*Division of Neurosurgery, Shun-Tain Hospital, Taichung, Taiwan 40445, ROC*

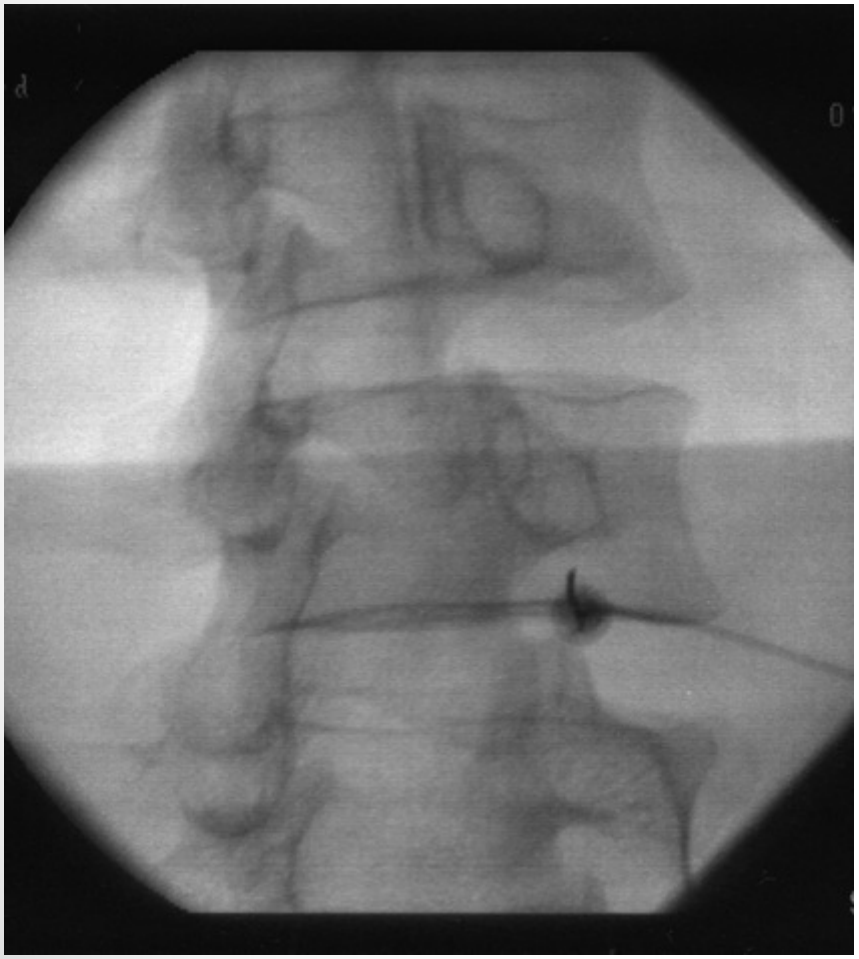
- 116 pts., the mean age 62.42 ± 13.16 years
- 88 - lumbar HIVD with radiculopathy, 28 – FBSS
- 10-cm, 22-gauge curved-tip cannula, 1-cm active tip
- 2 p.p.s, 20 ms, 120 seconds, 45 V, 42℃ (2-4 levels)
- The results were classified as symptom-free (100% improvement), better (≥50% improvement), slightly better (≤50% improvement), unchanged.

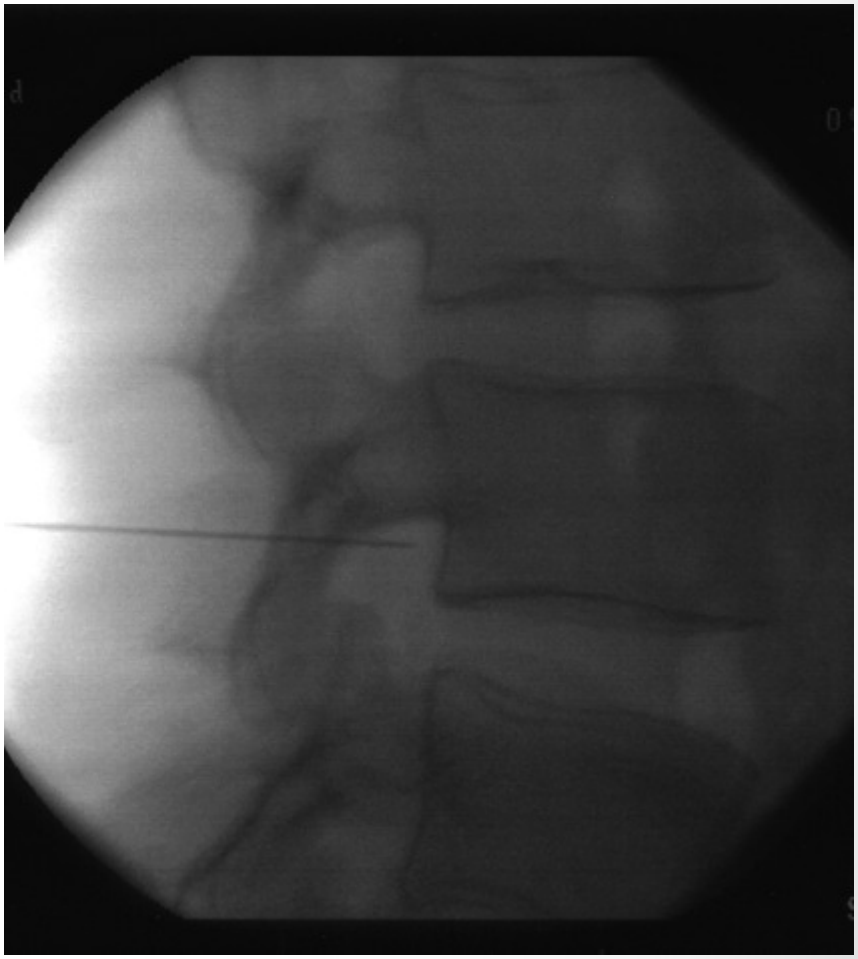
Results

	1 wk (n = 116)	1 mo (n = 116)	3 mo (n = 116)	6 mo (n = 108)	9 mo (n = 58)	1 y (n = 43)
Worse	0	0	0	0	0	0
0%	21	26	34	48	28	20
0< and <50%	36	34	30	17	14	13
50≤ and <100	51	44	39	32	11	7
100%	8	12	13	11	5	3
Improvement rate (%)[a]	81.90	77.59	70.69	55.56	51.72	53.49
Satisfactory rate (%)[a]	50.86	48.28	44.83	39.81	27.59	23.26

[a] The *improvement* was defined as patient who has pain relief of more than 0. The *satisfaction* was defined as a patient who has the pain relief of ≧50%.

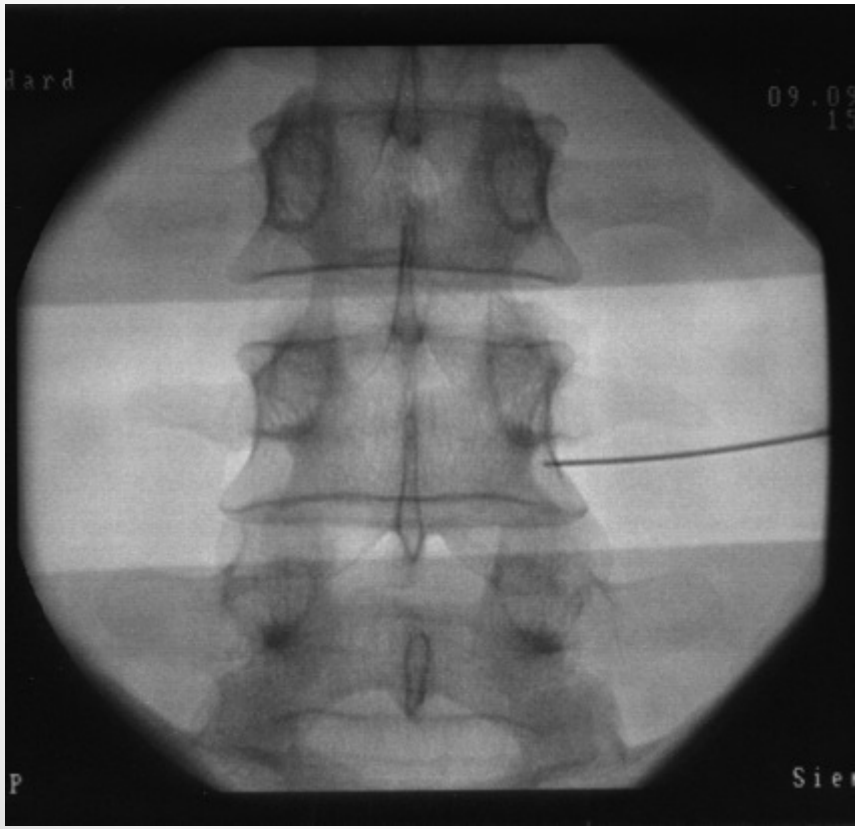
L4 DRG PRF



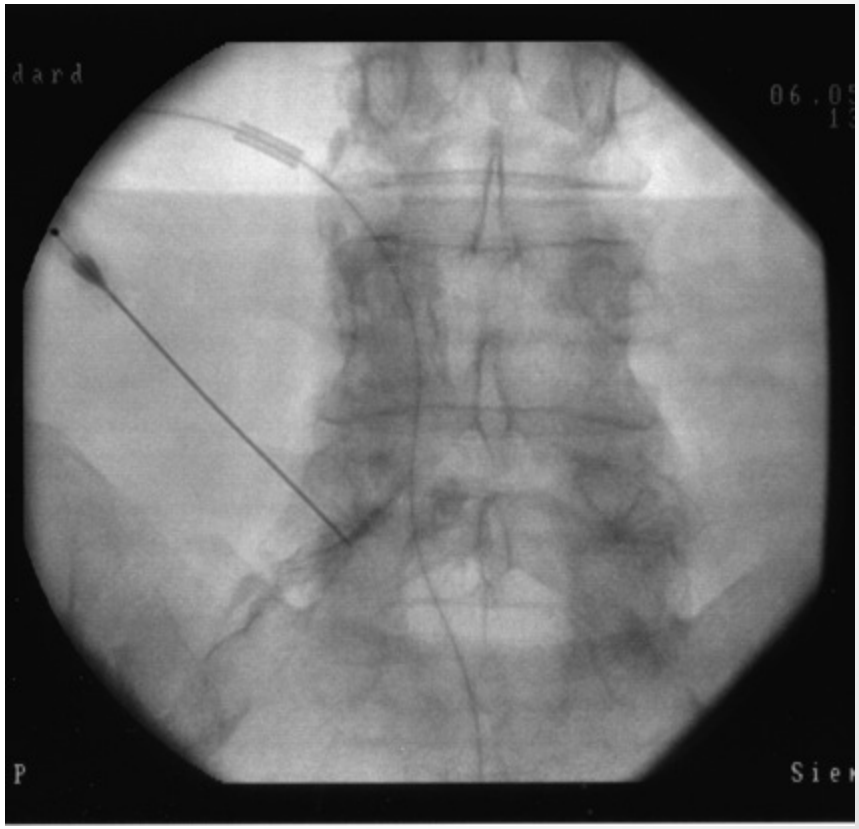


DRG PRF

L4 dxt.



L5 sin.



- DRG PRF 2C+ (to be considered)

PRF: mechanism of action

- PRF applied to dorsal root ganglia induces cellular stress as measured by expression of neuron ATF3, sensory fibers appear to be selectively targeted by it (Hamann W. et al. 2006)

- RRF causes only transient endoneurial edema (Podhajsky RJ. et al. 2005)

SPINE Volume 30, Number 9, pp 1008–1013

The Histologic Effects of Pulsed and Continuous Radiofrequency Lesions at 42°C to Rat Dorsal Root Ganglion and Sciatic Nerve

Ronald J. Podhajsky, PhD,* Yasufumi Sekiguchi, MD, PhD,† Shinichi Kikuchi, MD, PhD,† and Robert R. Myers, PhD‡

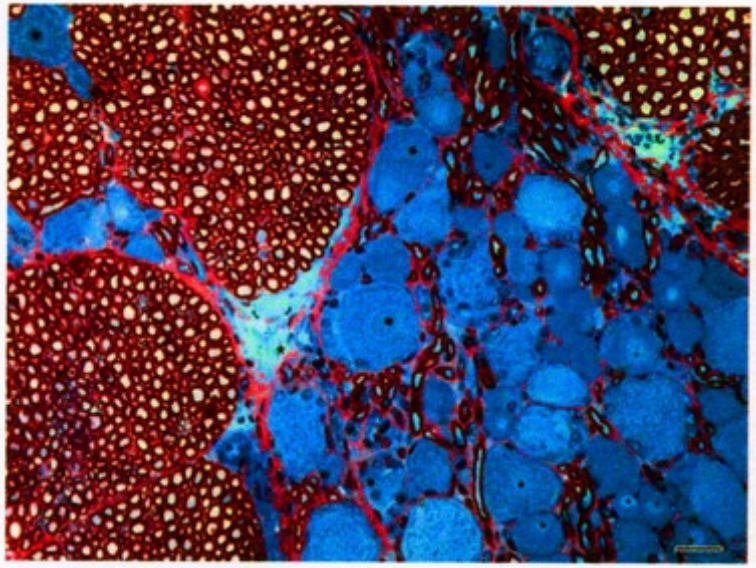


Figure 2. Rat DRG stimulated with pulsed RF energy at 42°C for 120 seconds, day 2. Only mild edema (*) is evident is this photomicrograph. Sciatic nerve axons are seen in tight apposition in the left and upper right of the micrograph, with both large- and small-diameter L5 DRG neurons throughout the field. Methylene blue Azure II stain. Scale bar = 50 μm.

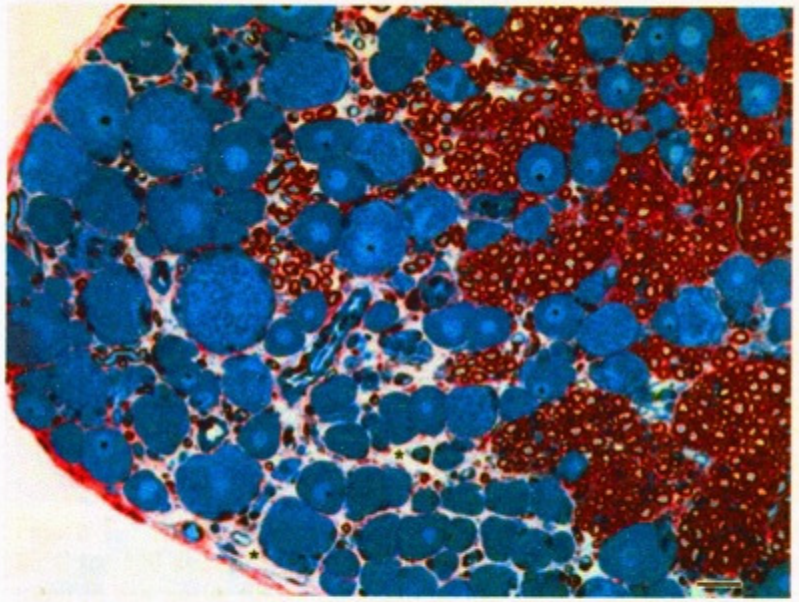


Figure 3. Rat DRG stimulated with pulsed RF energy at 42°C for 120 seconds, day 7. There is edema (*) separating L5 DRG neurons, but no other structural changes are evident in this micrograph. Methylene blue Azure II stain. Scale bar = 50 μm.

SPINE Volume 30, Number 9, pp 1008–1013

The Histologic Effects of Pulsed and Continuous Radiofrequency Lesions at 42°C to Rat Dorsal Root Ganglion and Sciatic Nerve

Ronald J. Podhajsky, PhD,* Yasufumi Sekiguchi, MD, PhD,† Shinichi Kikuchi, MD, PhD,† and Robert R. Myers, PhD‡

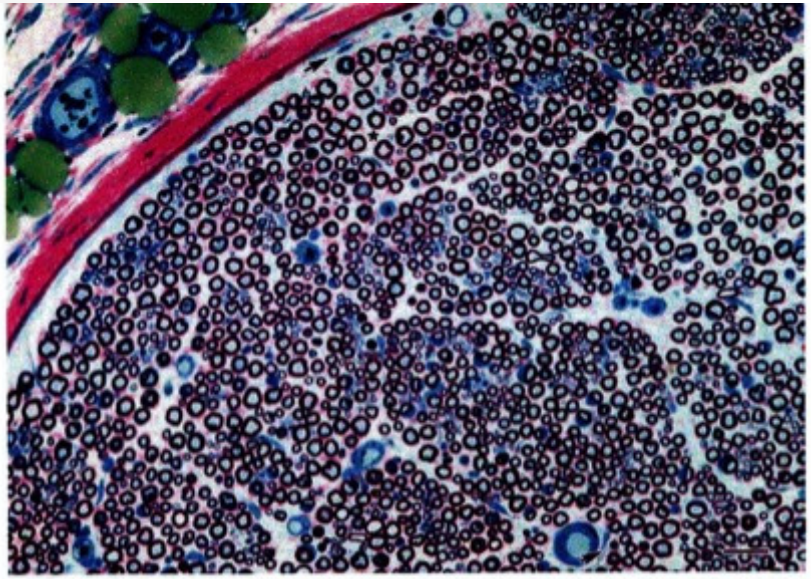


Figure 4. Rat sciatic nerve stimulated with pulsed RF energy at 42°C for 120 seconds, day 2. The nerve fascicle adjacent to the stimulation probe had edema (*), which separated individual nerve fibers, but otherwise there was no significant change in the morphology of the fascicle. Edema is associated with fibroblast activation, and fibroblasts (arrows) can be seen in the subperineurial and perivascular spaces. Methylene blue Azure II stain.

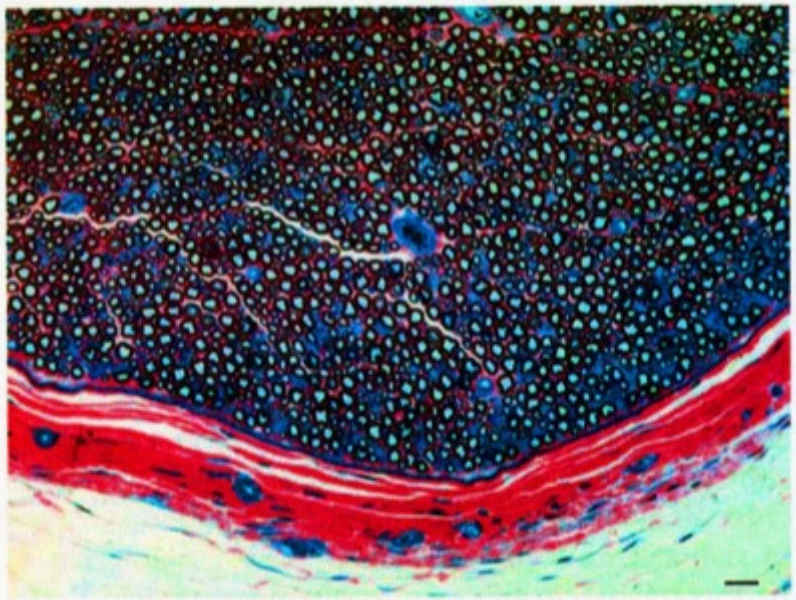


Figure 5. Rat sciatic nerve stimulated with pulsed RF energy at 42°C for 120 seconds, day 7. By day 7, the edema seen at day 2 had resolved, but there are indications of collagen deposition (pink) in the epineurial space surrounding the fascicle and in the subperineurial region. Collagen deposition is a result of fibroblast activation. Methylene blue Azure II stain. Scale bar = 50 μm.

PRF: mechanism of action

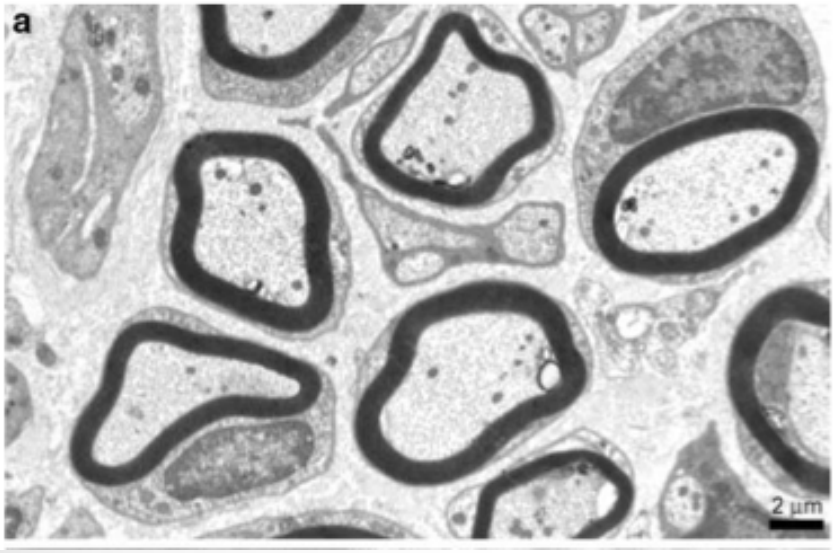
- PRF procedure should partly destroy the myelin envelope of nervous fibers (M. Protasoni et al. 2005)

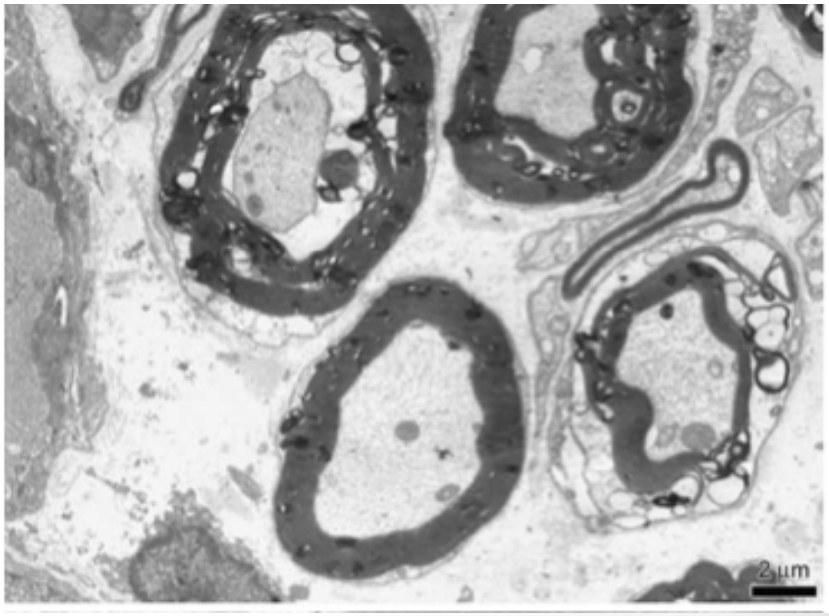
Eur Spine J (2009) 18:473–478
DOI 10.1007/s00586-008-0870-z

ORIGINAL ARTICLE

Pulsed radiofrequency effects on the lumbar ganglion of the rat dorsal root: a morphological light and transmission electron microscopy study at acute stage

Marina Protasoni · Marcella Reguzzoni · Simone Sangiorgi · Claudio Reverberi · Elisa Borsani · Luigi F. Rodella · Alessandro Dario · Giustino Tomei · Carlo Dell'Orbo





PRF: mechanism of action

- The rapidly changing electric fields produced by PRF alter the transmission of pain signals (Van Zundert S. et al 2005)

PAIN AND REGIONAL ANESTHESIA

Anesthesiology 2005; 102:125–31

Pulsed and Continous Radiofrequency Current Adjacent to the Cervical Dorsal Root Ganglion of the Rat Induces Late Cellular Activity in the Dorsal Horn

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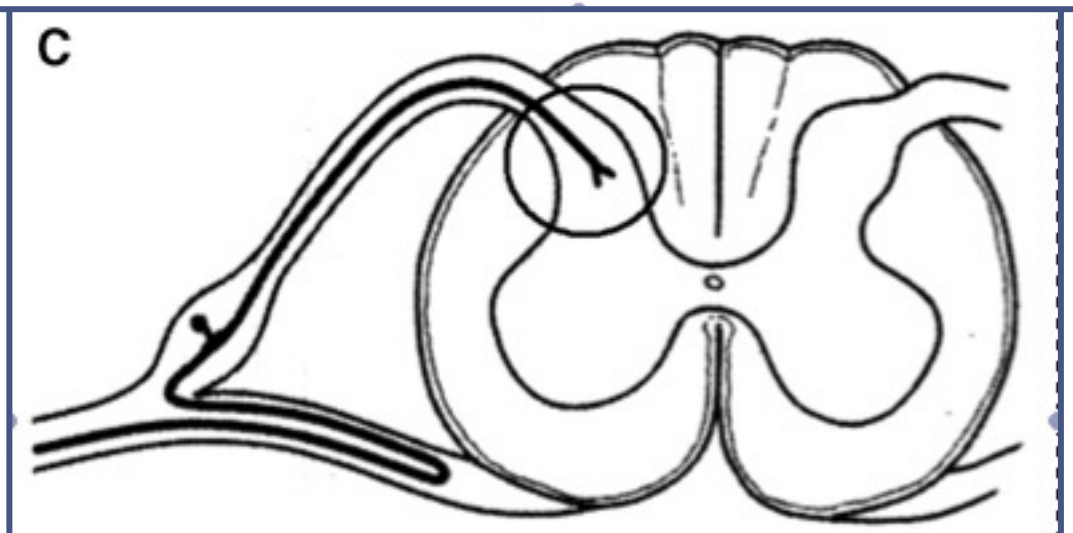

Fig. 1. Transverse sections of the cervical spinal cord at C5: nuclear c-Fos immunoreactive cells located in the dorsal horn of an animal treated with pulsed radiofrequency adjacent to the dorsal root ganglion (*A*) as compared with a sham operated animal (*B*). Schematic drawing of a transverse section of rat spinal cord at C5. The position of the area shown in *A* and *B* is indicated (*C*).

■ PAIN AND REGIONAL ANESTHESIA

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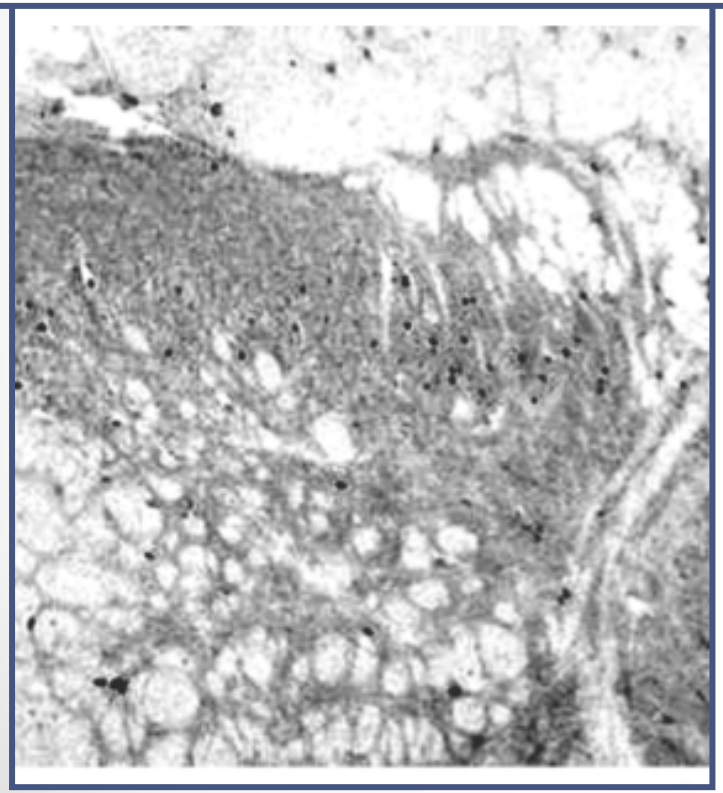
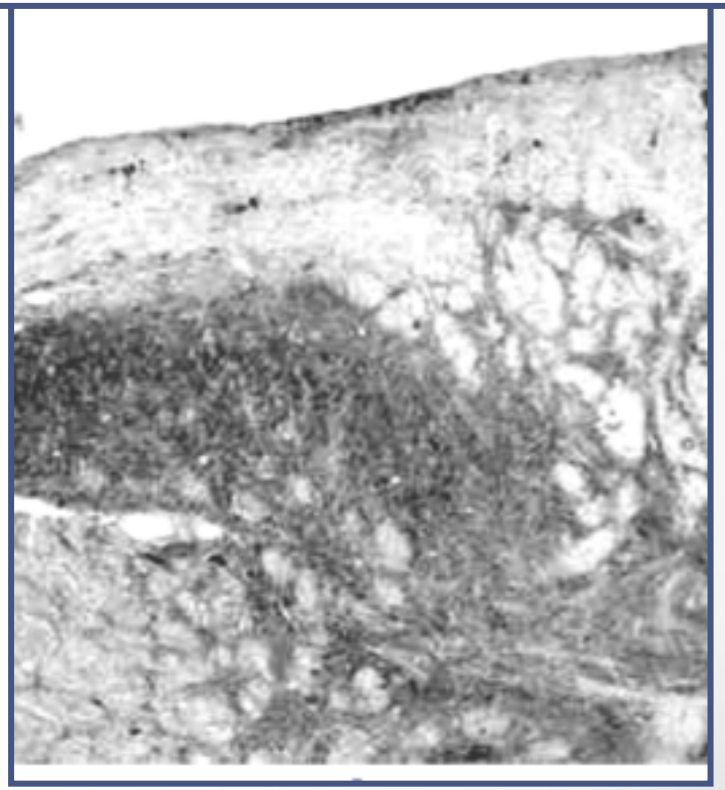




Conclusions

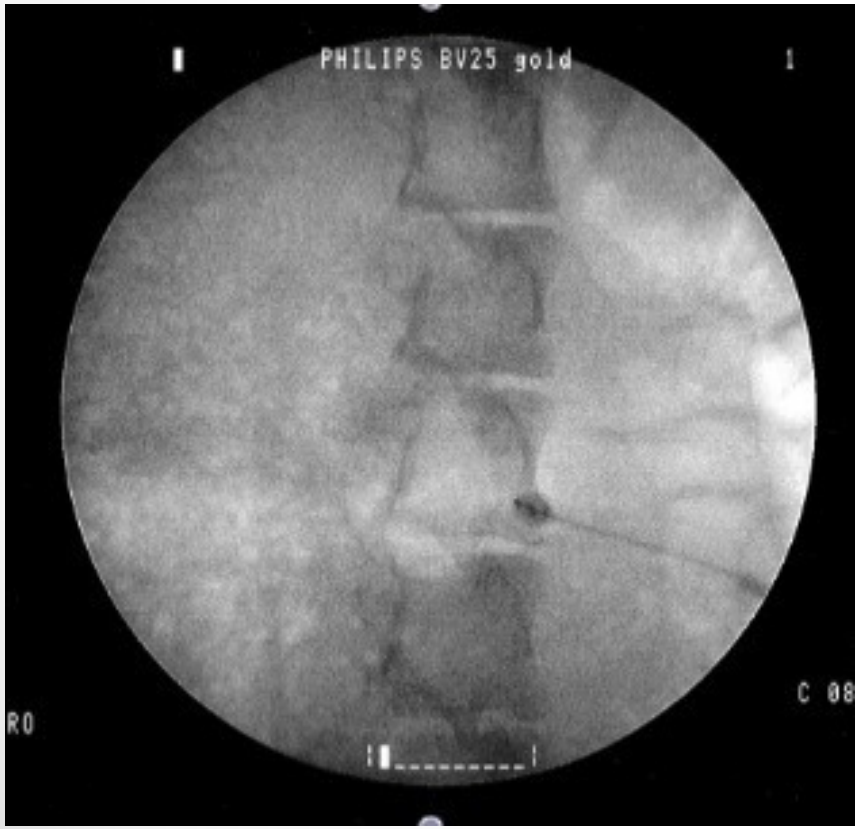
- Low invasive character
- Target selective approach
- Possibility of outpatient treatment
- Safety

Aim of our study

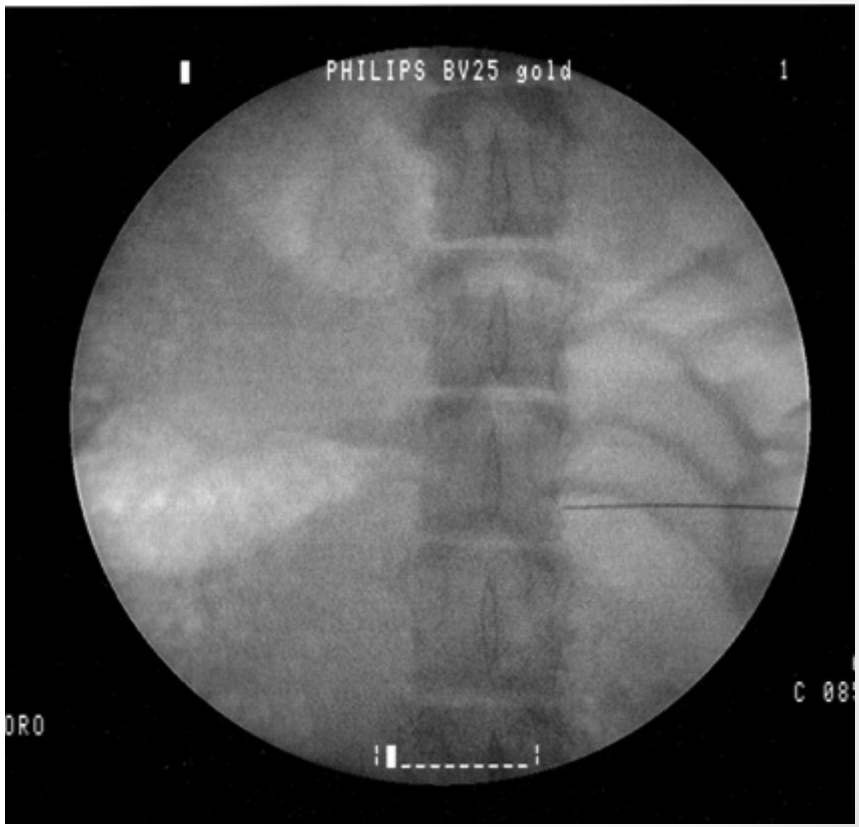
- To analyze histologic effects of PRF on the home pig lumbar ganglion and evaluate biomarkers expression in gangliar cells

X-RAY

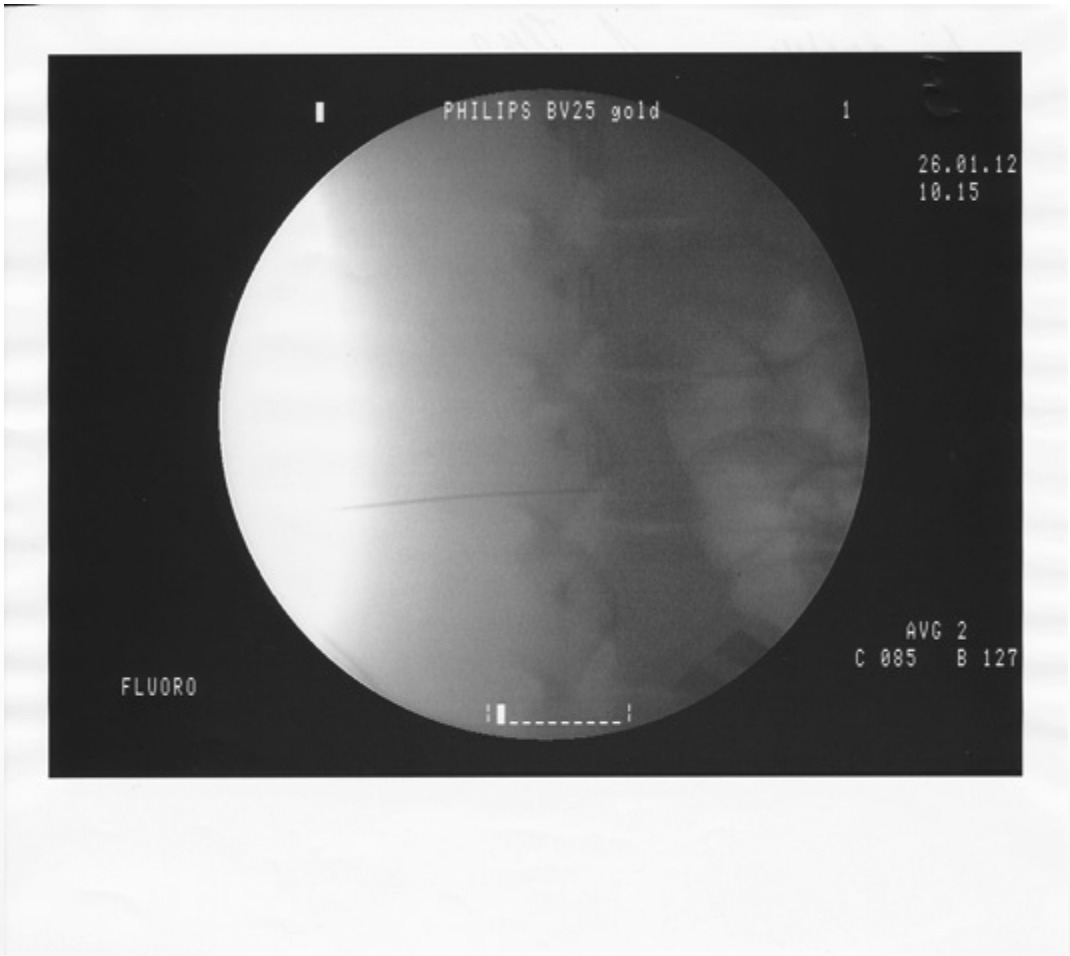
Oblique view



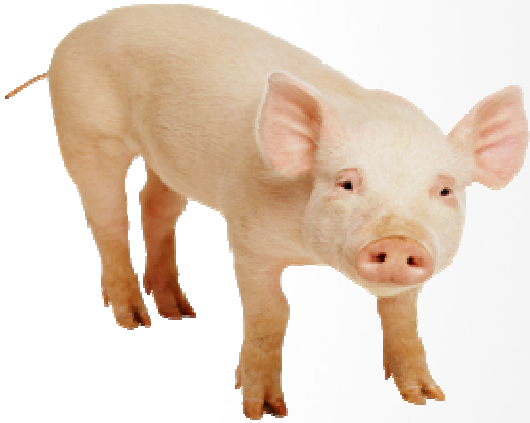
AP view



X-RAY (Lateral view)



Thank You for Your attention.



From left to right: dr.E.Vasiļevskis, dr.I.Evansa, dr.I.Paņihins, prof.M.Pilmane, prof. A.Auzāns, dr.M.Arons.