Pulsed Radiofrequency Ablation: A Review of the Evidence

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Objectives

- Participants will be able to state the difference in mechanism of action for pulsed radiofrequency ablation versus continuous radiofrequency ablation.
- Participants will be able to identify indications and contraindications for pulsed radiofrequency ablation.
- Participants will be able to describe potential complications/benefits of spinal pain procedures.
- Review the extant literature on pulsed radiofrequency ablation.

What is Radiofrequency (RF)?

- The use of a radiofrequency lesion generator which heats tissue to a selected temperature making a discrete lesion near a nerve
- “Frictional heat is generated by molecular movement in a field of alternating current at radio wave frequency.”

How does RF work? (mechanism of action)

- Continuous Radiofrequency Ablation (CRFA) uses high frequency alternating current to induce coagulative necrosis at the target tissue.

- Pulsed Radiofrequency (PRF) uses radiofrequency current in short, high-voltage bursts.


How does CRFA work? (mechanism of action)

- Continuous RF results in the selective destruction of pain-carrying nerve fibers (A-delta and C fibers, not the A-beta fibers).

- Thermocoagulation

How does Pulsed RF work? (mechanism of action)

- Unclear

- May involved temperature-independent pathway mediated by a rapidly changing electrical field.

Vatansever et al.  
Difference in Continuous RF and Pulsed RF and sham—cellular changes

- Research in rats
- No obvious motor or sensory deficit in any mode
- Sham
  - Electrode placement but no current applied
  - Some damage of myelin configuration, lamellous separation myelin protrusion, neurofilament and neurotubulous accumulation in myelinated axons, and endoneural edema were seen.

Continuous RF—40°C

- Increased damage of myelin configuration, lamellous separation myelin protrusion, neurofilament and neurotubulous accumulation in myelinated axons, and endoneurial edema were seen.
- Endoneurial edema

Continuous RF—40°C (cont)

- Severe damage to transverse myelin fibers, configurations and protrusions.
- Edema in endoneurium and perineurium.
- Separations in axoplasm.
Continuous RF—80°C
- Significant endoneural edema
- Blood cells adhering to endothelium.
- Early indications of Wallerian degeneration—degeneration of the axon distal to the site of damage
- Epineurium structure disrupted
- Epineurium significantly thickened.

Continuous RF 80°C (cont)
- Lamellous separation, lysis, intra-axonal vacuoles, damage in the basal lamina of Schwann cells
- Increased endoplasmic reticulum with granules
- Cytoplasmic degeneration
- Intracytoplasmic lipid accumulation
- Axonal degeneration

Changes similar to CRF40
- Severity of the lesions is low in all
- Damage in morphologic structure was progressively increased in Sham, PRF, CRF40 through CRF80
Differences in CRFA and PRF
--temperature and time

- Continuous RF
  - Temperatures 60-90°C (140-176°F)
  - 60-90 seconds

- Pulsed RF
  - 40-42°C (104-107.8°F)
  - 120 seconds* to 8 minutes

Indications for Continuous RFA
- Typically considered last therapeutic option
- Axial Back/Neck Pain
- Knee pain unresponsive to other injections
- SI Joint pain

Indications for Pulsed RFA
- Axial Back/Neck pain
- Radicular neck/back pain
- Trigeminal neuralgia
- Occipital neuralgia
- Inguinal pain/orchalgia
- SI joint pain
- Suprascapular pain
- Post surgical thoracic pain
Contraindications

- Coagulopathies
- Infection
- Inability to tolerate positioning

Other considerations

- Most insurance companies require two diagnostic injections with local anesthetic from which the patient gains complete pain relief before approval is given for RF

Other clinical considerations

Anticoagulation

- May anticoagulation be stopped?
  - Recent cardiac and vascular stents may preclude being able to do the procedure
- Know how far in advance of the procedure anticoagulation meds must be held
  - Warfarin—5 day
  - Clopidogrel—7 days
  - Ticlopidogrel—14 days
  - Other anticoagulants—specific to the drug
- Pacemaker or ICD, get cardiology involved
How is RF done?

- IV +/-
- Positioning
  - Lumbar: Prone, pillow beneath abdomen (unless protuberant abdomen)
  - Cervical: head on pillow, pillow beneath shoulders (breathing room)
- Mild sedation (analgesia)
- C-Arm fluoroscopy to locate sites and visualize needle placement
- Nerve stimulator to assist with needle placement
- Apply RF

Lumbar medial branch
Radiofrequency Ablation

Cervical
Radiofrequency Ablation
Advantages of RFA over other Neurolytic Techniques

- Pinpoint the nerve using nerve stimulation
- Temperature is controlled
  - Minimizes tissue destruction and tissue overheating
- Makes a discrete lesion
- Repeatable—nerve regenerates
- Reports of increased pain after nerve regrowth is less than other neurodestructive techniques

Advantages of PRF over CRFA

- Less neurodestructive
- Need less local anesthetic during procedure
- Fewer flares in pain
- May treat different sites where continuous RF may not be used
- Possibly less scarring over time
Monitoring/ Nursing care during and after procedure

- Conscious sedation monitoring
  - BP, P, R, Oxygen sats, ECG, verbal contact
- Maintain sterility
- Keep patient informed
- “Second eye”
  - Fluoro
  - RF machine functioning
- Distraction/humor
- Education

Potential complications/ side effects

- Pain flare
- Infection
- Hematoma/epidural or local
- Reaction to meds
- Tingling/numbness of legs (local anesthetic)
- Extremity weakness/paralysis (rare)

Patient Education

- What is the procedure?
- How is it done? When, where, how, monitoring, pain control during
- Post-procedure care
- What can it do/not do?
- What can be expected of the procedure?
- How long does it last?
- Can it be repeated?
- How often can it be repeated?
- Can it be done the same time as other procedures?
Patient education (cont)

- When to restart anticoagulation
- Self care—ice/heat
- s/s complications
- How to contact providers
- How to access emergency care
- If you want them to call you between visits, when and how

Patient follow-up

- Office f/u: Clinician specific
- We will repeat every 6 months
- ?? Insurance constraints??

Procedure outcomes

- Some have immediate relief
- Some don’t note the full effect for up to a month
- 17-82% benefit
- Continuous RF
  - Lumbar medial branch—4+ months, 4-6 most common, up to 2 years reported
  - Cervical medial branch—6-18 months
**Mikeladze PRF**
- Cervical and lumbar PRF
- Retrospective
- N = 114
- 42°C, 120 seconds
- 68 (60%) patients > 50% pain relief for 4 months

**Lindner PRF**
- Lumbar
- Retrospective
- N = 48
- 42°C, 120 seconds
- 21 of 29 without back surgery, > 60% pain relief at 4 months
- 5 of 19 with back surgery, > 60% pain relief at 4 months

**Misaggi, et al**
- Lumbar facet
- Retrospective
- N = 32
- Previous RFA
- Temp—unstated, 180 seconds
- 75% “marked improvement in VAS”
- 3 cases post-procedure neuralgia**
- 21% (5) with flare in symptoms**
- F/U 6-12 months in this 75%
- 2 pts requested repeat procedure
Knoll et al
- Lumbar facet
- N = 50
- 26 pts f/u—13 CRF, 13 PRF
- CRF—80° C, 75 seconds
- PRF—42° C, 120 seconds
- No significant difference in VAS
- No significant difference in function

Tekin et al
- Lumbar facet
- Randomized, double-blind
- PRF vs sham and CRF
- N = 20 in each group
- PRF—42° C, 120 seconds
- CRF—80° C, 90 seconds
- PRF and CRF of longer duration than sham
- CRF lasted longer

Shabat et al
- “Neuropathic spinal pain”
- Prospective
- N = 28
- 42° C, 120 seconds
- Dorsal root ganglia
- 1 month—24/28 complete, moderate or good pain relief
- 3 month—23/28; 6 month—20/28 and 12 month 19/28 “some degree of pain relief”
Chao, et al

- Cervical and lumbar radicular pain
- Retrospective
- N = 154---49 cervical, 116 lumbar
- 2-4 levels
- 42° C, 120 seconds
- 1 week to 1 year
- F/U
- 53.06% cervical and 44.93% lumbar with > 50% pain relief at 3 months

van Zundert et al

- Chronic cervical radicular pain
- N = 23
- Double-blind, sham-controlled, randomized
- 42° C, 120 seconds
- Sham--Needle placement and testing, but no current applied
- 3 months
- VAS and perceived effect better with PRF
- No difference in analgesic intake

van Zundert et al

- Trigeminal neuralgia
- N = 5
- 42° C, 120 seconds
- 3 of 5 with relief 10-20 months
- 1 with 90% pain relief at 22 months
- 1 with 75% at 1 month but opted for surgical microvascular decompression
Navani et al
- Occipital Neuralgia
- Case study
- N = 1
- 42 year of suboccipital pain
- 42°C, 120 seconds
- C1 & C2 dorsal rami
- 4 month f/u—60-70% pain relief

Rozen & Ahn
- Chronic ilioinguinal neuralgia after inguinal herniorrhaphy
- N = 5
- + response to selective nerve root blocks
- 42°C, 120 seconds
- T12, L1, and L2 sensory ganglia
- “Significant pain relief” at 4 - 9 months in 4 patients

Cohen & Foster
- Groin pain ororchaglia
- N = 3
- 42°C, 120 seconds
- Ilioinguinal or genitofemoral nerve
- Complete pain resolution at 6 months
Vallejo et al
- SI Joint
- N = 22
- 42°C, 120 seconds
- Done x 2
- L4, L5 medial branches and L1 and S2 lateral branches
- VAS down at 6 months
- Physical well-being and function up at 6 months

Shah & Racz
- Glenohumeral osteoarthritis and adhesive capsulitis
- Case report
- Suprascapular nerve
- 42°C, 120 seconds
- 4-5 months pain relief, improved function

Kane et al
- Suprascapular nerve for painful cuff tear
  - Prospective
  - N = 12
  - RA 1 pt, OA 11 pts
  - No benefit from steroids, local or analgesics
  - Poor surgical candidates
  - 42°C, 120 seconds “2 or 3 times”
  - Statistically significant improvement in VAS at 3 and 6 months compared to baseline
  - Decreased function in 6 pts
  - Wearing off by 6 months
Phillip et al

- Meralgia paresthetica
- Case study
- Previous temporary relief with steroids
- PRF—42° C, 120 seconds
- 1 ml 0.5% bupivacaine and 4 mg dexamethasone post procedure
- Complete pain relief maintained after 9 months

Cohen et al

- Retrospective
- N = 46
- Post-surgical thoracic pain
- Compared PRF of dorsal root ganglion vs pharmacologic rx vs PRF intercostal nerves
- No difference at 6 weeks
- PRF of DRG better than other therapy

References:

References (cont)