Radiology guided treatment for spinal pain

Dr Paul O’Connell
Image guided treatment for back pain

- Management of
  - Acute radicular pain
  - Chronic low back pain
    - Facetal
    - Sacro-iliac joint
  - Cervicogenic headaches
  - Osteoporotic crush fracture
  - Hypotension headaches
Acute radicular pain

• pain radiating into the limb in dermatome
  – lancinating, burning, stabbing, or electric quality

• limitation of straight-leg-raise to $<30^\circ$

• CT or MRI to assess for disc herniation
  – at segmental level consistent with clinical features
Acute radicular pain
Disc protrusion
Subarticular (posterolateral)
Transforaminal nerve root block

Perineural injection L5

Perineural injection S1
Lumbar epidural steroid

Indications – radicular pain with

• Lumbosacral disk herniation (if transforaminal not possible)

• Spinal stenosis

• Facetal cyst

• Compression fracture lumbar spine

Contraindication

• Acute spinal cord compression
Peripheral nerve fibre types

Pain

• Type A & B
  – Myelinated

• Type C
  – Unmyelinated
Local anaesthetic

- Sodium channel blocker
- Affects
  - Unmyelinated fibres generally
  - Myelinated nerves at the nodes of Ranvier
Local anaesthetic

The nodes of Ranvier span from 1–2 µm

The internode distances varies with nerve type & size:
- Pain: smallest
- Sensory: intermediate
- Motor: largest
Local anaesthetic needs to cover $\geq 3$ nodes of Ranvier
Disc Protrusion

- Acute disc protrusion
  → annular nerve ending pain - stretch
- Mechanical compression / stretch of spinal root
  → weakness and numbness
  • uninflamed nerve compressed will stop functioning
- 2° inflammation
  → radicular pain

Radiculopathy usually recovers 2-6 weeks but disc resorption takes months
Surgical decompression does not always relieve radiculopathy

McLain et al
Cleveland Clinic J Medicine 71:12 Dec 2004
Steroid effect

- Inhibits neural transmission in nociceptive C fibers

- ↓ Phospholipase A2
- ↓ Arachidonic acid

- ↓ capillary permeability and endothelial reaction
  - ↓ Acute polymorphonuclear leukocyte (PML) inflammatory response
  - ↓ Endothelial cytokine release
  - ↓ Late monocyte and macrophage
  - ↓ Capillary and fibroblast proliferation scar collagen
Inflammatory cascade

- Injury
  - Phospholipase A$_2$
    - Arachidonic acid
      - Cyclooxygenase
        - Hyperalgaesic Prostaglandins & thromboxanes
      - Lipooxygenase
        - Hyperalgaesic leukotrienes

- NSAID
- STEROID

Inflammation & pain
Steroid injection
Contraindications

• Systemic infection or local infection at site
• Bleeding disorder or fully anticoagulated
• History of significant allergic reactions to injectates
• Patient refusal
Steroid injection
Relative contraindications

• Pregnancy
  – to avoid exposing the fetus to ionizing radiation

• Poorly controlled diabetes
  – may transiently, but significantly, ↑ blood glucose

• Immunosuppression
  – may require additional precautions

• Congestive heart failure
  – potential for steroid-induced fluid retention (Not Celestone)
Celestone chronodose

- Betamethasone sodium phosphate and acetate
- Does not precipitate with local anaesthetic
- Does not cause water retention
- Crosses placenta
- *Particulate*
Cause of cord infarcts

- *Particle embolisation*
- Benzyl alcohol
- Needle induced vasospasm
- Disruption of artery
- Haematoma compressing artery

- *Infarcts have only been reported with particulates*

Particulate versus non-particulate steroids for lumbar transforaminal or interlaminar epidural steroid injections: an update
Skeletal Radiology, Nov 2014
Tobias J. Dietrich, Reto Sutter, Johannes M. Froehlich, Christian W. A. Pfirrmann
Dexamethasone

- Not particulate
  - No recorded spinal cord arterial embolic event
  - Preservative benzyl alcohol – particles $\frac{1}{10}$ size RBC
Dexamethasone

• High solubility and negligible particle size
  – Particles significantly smaller than red blood cells
  – Least tendency to aggregation
  – Lowest density
Time to reconsider steroid injections in the spine?

Steroid injections to the spine provide no advantage over placebo, but do carry risks of harm

Gluco- corticoids (often simply called “steroid”) injections into the spine, a procedure frequently performed by specialist radiologists using imaging for localisation, are increasingly being used to treat non-specific low back pain or leg (radicular) pain due to disc herniation or spinal stenosis. A report from the United States shows a 70% increase in Medicare expenditure for epidural steroid injections in the 7 years up to 2001. Similarly, an increased number of spinal steroid injections are being given each year in Australia. For example, the number of procedures that have been performed under the Medicare Benefits Schedule item 39038, which includes injection into one or more facet joints under image intensification, has more than doubled in the 10 years to 2011, with over 21,500 provided in 2011 and over 35,000 in 2012.

However, systematic reviews that have investigated the benefits of these procedures for different indications have, at best, drawn uncertain conclusions. A 2008 Cochrane review that included 18 randomised trials (1 179 participants) of epidural, facet joint or “trigger point” injections for subacute or chronic low back pain found no strong evidence for or against the use of any type of injection therapy and, specifically, found no evidence of benefit of steroid injections compared with placebo. Other reviews of spinal steroid injections for back pain or radiculopathy (including less rigorous trials) concluded that, at best, spinal steroid injections may provide short-term benefits (possibly 2-6 weeks), although the evidence of effectiveness is weak, and the effect is independent of the method of administration (interlaminar, caudal, foraminl). Studies in which local anaesthetic was used in the placebo injection (local anaesthetic is usually used with steroid injections) have shown no difference between treatment groups for disc herniation or spinal stenosis.

The injection of steroid in and around the spine is generally considered a safe procedure. In nine of the 18 trials included in the 2008 Cochrane review, adverse effects such as headache, dizziness, transient local pain, paraesthesia and numbness were reported in a small number of patients undergoing steroid spine injection. While reports of death are rare, serious adverse events such as cauda equina syndrome, septic arthritis, discitis, paraspinal abscesses, arachnoiditis, epidural and paraspinal haematomas and neuropathy and paralysis have been reported. While injection of steroid into the spine has also been associated with systemic effects such as adrenal suppression, and with subsequent vertebral fracture.

Recent reports of meningitis and associated deaths after spinal steroid injections due to fungal contamination of steroid prepared in the USA force us to re-examine the risk-benefit ratio for spinal steroid injections, and the rationale for their continued use. The continued and increasing use of steroid injections is likely explained by doctors’ observing that the condition of most patients improves after injection, and by patient preference. However, the fact that high-quality blinded and controlled trials have been unable to show any significant benefits of steroid over placebo (alone or local anaesthetics) indicates that the steroids themselves have no direct therapeutic effect. As well as the placebo effect, other factors such as regression to the mean and a favourable natural history may also explain the observed improvements.

Given the lack of evidence for a clinically important benefit over placebo, a small but insignificant risk of harm, and the rising costs associated with their increasing use, is there a justification for continued use of spinal steroid injections for low back pain or radicular symptoms? In our opinion, placebo treatment that has a risk of harm is not justified outside an experimental framework. Unless declared, the use of such a placebo is deceitful and potentially harmful. Furthermore, the use of placebo treatments in medicine reinforces a false belief in their effectiveness, and leads to a lack of distinction between mainstream medicine and the numerous forms of alternative medicine, many of which rely on the placebo effect.

Based on systematic reviews of best available evidence, 2009 recommendations from the United Kingdom National Institute for Health and Clinical Excellence (NICE) advised against offering any injections of therapeutic substances (including steroid) into the back for persistent low back pain. In our opinion, withdrawal of public funding for spinal steroid injections for low back pain and/or radiculopathy in Australia should be considered on the basis of our knowledge of the placebo nature of the treatment, the costs and, not least, because of the likelihood of harm.

Competing interests: No relevant disclosures.

Provenance: Not commissioned; externally peer reviewed.

Sciatica from disc herniation - conservative versus surgery

• Outcomes at 1 and 2 years were similar for 283 patients
• No clinically significant difference 8 wks & 6 months’ follow-up
• 56% of patients did not require surgery for recovery

• Early surgery roughly doubled the speed of recovery
• Delayed surgery might result in some extra weeks of discomfort
• Major advantage of early surgery
  – more rapid relief of pain
  – reassurance about recovery
  – earlier return to normal activities

Sciatica caused by lumbar disc herniation conservative care versus early surgery
2 year results of a randomised controlled trial
BMJ; June 2008
Department of Neurosurgery, Leiden University Netherlands.
150 patients randomised into test groups

54% relief at 1 month (>50% reduction of pain)

25% relief at 1 year (after 1 injection)

Acute & chronic radiculopathy

**Transforaminal injection of steroids a viable alternative to surgery for lumbar radicular pain due to disc herniation.**

Transforaminal Steroid Injection for Lumbar Radicular Pain Superior to Placebo

*Pain Medicine* August 2010 Bogduk et al
Image guided treatment for back / neck pain

• Management of
  – Acute radicular pain
  – Chronic low back pain
    • Facetal
    • Sacro-iliac joint
  – Cervicogenic headaches
  – Osteoporotic crush fracture
  – Hypotension headaches
Chronic spinal pain
non radicular

• Low back pain
  – Facet pain 40%
  – Disc pain 40%
  – Sacro-iliac pain 20%

• Chronic cervical pain
  – Facet pain (zygo-apophyseal pain) 60%

• Malignant pain
  – Tumours and infection <1%
Facet Syndrome

• LBP with
  – Buttock pain
  – Pseudo-radiculopathy to inguinal or posterior thigh
  – Paravertebral tenderness
  – Transitional movement aggravation (from sitting)
Facet pain

• Animal studies show *nociceptors* in joint capsule & adjacent muscles and tendons.

• Joint capsule pain may be from pinching, compression, stretching or strain.

Facet pain

Unlike elsewhere in the body a **normal** appearing facet joint may be a pain generator

- **Plain Xrays & CT**
- Nuclear medicine
- Facet joint injection
- Medial branch block
SPECT nuclear medicine
Facet injection
Medial Branch Block
Radiofrequency Ablation
Medial Branch

Lumbar

• Junction of the superior articular process and transverse process
  – under the mamilloaccessory ligament of the vertebra below
  – L3 medial branch lies on the L4 vertebra

• EXCEPTION over S1
  • L5 posterior 1\textsuperscript{st} ramus sited junction sacral ala and the S1 superior articular process

• Each facet joint innervated by 2 medial branches
Mamillo-accessory ligament (MAL)

- Mamillary process of sup. art. process
- Accessory tubercle of transverse process
- Encloses the medial branch in fibro-osseous tunnel.
- Reliable course relative to bone.
- Ossified in over 10%
- May be site of entrapment causing low-back pain.

RF technique

• Preceding MBB with >50% relief
  – Small volume (1/2 ml Marcaine 0.5%)

• Pre RF stimulation
  – 50 Hz to ensure proximity of electrode to sensory fibers threshold 0.3 - 0.9 V
  – 2 Hz stimulation to detect muscle contractions in the multifidus muscle
    threshold within 1.5 times of sensory stimulation.
  – Ensure not stimulating anterior ramus

• ≥ 20 G needle  (curved tip)
Radiofrequency ablation

• Thermal radiofrequency
  – Oscillating electrical pulse at microwave frequency
  – Causes tissue heating (70-85°)
  – Denatures protein, disrupting nerves

• Pulsed radiofrequency
  – Electromagnetic pulses
  – Does not exceed 42°
  – No definable lesion
Complications

- No pain relief
- Anaesthesia
- Multifidus wasting
- Charcot joint

*Presented at SMISS 2013 Annual Conference By Farhan Siddiqi MD et al*
Complications

• No pain relief
• Anaesthesia
• Multifidus wasting
• Charcot joint
Complications

- No pain relief
- Anaesthesia
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- Charcot joint
Multifidus wasting

• Case study single patient post lumbar RF
• Pain decreased by 60% at 2 weeks, 92% by 4 weeks
• Immediate and sustained ↓ EMG activity over the multifidus and erector spinae muscles
• Gradual positive changes in gait kinematics across all sessions

Changes in gait kinematics and lower back muscle activity post RF denervation of the zygapophyssial joint: a case study.

Stegemöller EL¹, Roper J, Hass CJ, Kennedy DJ.
doi: 10.1016/j.spinee.2013.06.061. [Epub ahead of print]
Multifidus wasting

Retrospective study 27 patients

No statistical difference in size or morphology of Multifidus

↑Disc degeneration following RF (14.9% vs 4.6%)

Morphologic changes in the lumbar spine after lumbar medial branch radiofrequency neurotomy: a quantitative radiological study.

Smuck M¹, Crisostomo RA, Demirjian R, Fitch DS, Kennedy DJ, Geisser ME.

Complications

• No pain relief
• Anaesthesia
• Multifidus wasting
• Charcot joint

No published reports directly attributed to RF
Sacro–iliac joint injection
Sacroiliac joint RF denervation
Sacroiliac joint RF denervation

- L5 posterior 1\(^{\circ}\) ramus
- S1 lateral branch
- S2 lateral branch
- S3 lateral branch
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Facet injection - cervical
Whiplash injuries pain generators are facet joints. Facet joints in the cervical spine are more sensitive than lumbar. Probably overstretched joint capsule.

Cervical RF of 53 chronic whiplash patients: significant early (within 1 month) and sustained (3 months) improvements in pain, disability, local and widespread hyperalgesia.

*Cervical radiofrequency neurotomy reduces central hyperexcitability and improves neck movement in individuals with chronic whiplash.*


Medial Branch
Cervical

• Waist of the articular pillars
  – C3–T1
  – eg C5 & C6 medial branches → C5/6 facet

EXCEPTION
  – C0-C2 joints by C1 & C2 ventral rami
  – C2/3 facet by TON
On the concept of third occipital headache
NIKOLAI BOGDUK, ANTHONY MARSLAND
Journal of Neurology, Neurosurgery, and Psychiatry 1986;49:775-780
Radiofrequency ablation C2/3 & C3/4
Medial Branch Block / Radiofrequency ablation
Third occipital nerve (TON) RF complications

- Numbness
  - larger area & more constant than other cervical MBB

- Head neck proprioception sense (HPNS)
  - Semispinalis capitus
  - temporary

- Neuritis
Radiofrequency neuritis

- Pain (burning) and hypersensitivity (2-4 weeks)
- Highest incidence C2/3 & C3/4

Greater occipital nerve
Lesser occipital nerve
Third occipital nerve
Greater occipital nerve block
Greater occipital nerve block

Ultrasound

CT
• All facet joint interventions ↑ 308%
  – Lumbosacral facet blocks ↑ 228% (990,449)
  – Lumbosacral RF ↑ 662% (406,378)
  – Cerv. & thoracic facet blocks ↑ 359% (317,220)
  – Cervical & thoracic RF ↑ 836% (97,526)

Assessment of the escalating growth of facet joint interventions in the medicare population in the United States from 2000 to 2011.
Evidence based medicine

Pain Physician. 2013 Apr;16(2 Suppl):S49-283.

An update of comprehensive evidence-based guidelines for interventional techniques in chronic spinal pain.

Part II: guidance and recommendations.


OBJECTIVE:

To develop evidence-based clinical practice guidelines for interventional techniques in the diagnosis and treatment of chronic spinal pain.

METHODOLOGY:

Systematic assessment of the literature.
<table>
<thead>
<tr>
<th>Evidence Grade</th>
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</thead>
<tbody>
<tr>
<td>Good</td>
<td>Lumbar CRF*</td>
<td>Lumbar MBB (therapeutic)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fair</td>
<td>Cervical CRF*</td>
<td>Cervical MBB (therapeutic)</td>
<td>Thoracic MBB (therapeutic)</td>
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<tr>
<td>Limited or Poor</td>
<td>Thoracic CRF</td>
<td>PRF all medial branches</td>
<td>Facet blocks</td>
<td>Diagnostic lumbar nerve root block</td>
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* Preceded by successful MBB
2011 RF / MBB audit
Brisbane Private Imaging

• 5 month audit - 82 patients

• 50% MBB’s did not proceed to RF (30/58)

• 75% improvement if +ve MBB (21/28) - all regions*

• 50% improvement if no preceding MBB (12/24)
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  - Hypotension headaches
Osteoporotic crush fractures
Vertebroplasty
Persisting vertebral body fracture (Kummell’s disease)
Vertebroplasty

- Osteoporotic crush fractures
- Trans pedicular approach
- Polymethylmethacrylate (PMMA) + barium
- Internally fixates fracture
- Heats to 82-86\(^0\) during polymerization
Vertebroplasty


- 2 studies found no benefit for compression fractures compared to sham procedure

  - Kallimes University of Washington
    - multicenter, prospective double-blinded randomized trial
    - 131 participants
    - vertebroplasty had no detectable benefit from sham procedures.

  - Buchbinder trial
    - funded by the Australian government and Cook Medical Inc
    - Multicenter, randomized, double-blind, placebo-controlled trial
    - 78 participants with osteoporotic vertebral compression fractures
    - vertebroplasty and sham procedures nearly identical pain relief
Vertebroplasty
Medicare response to NEJM articles

• USA 20/6/2011 in order to be reimbursable
  – 1) detailed medical record showing pain caused by fracture
  – 2) radiographic confirmation of a fracture
  – 3) other treatment plans attempted for a reasonable time
  – 4) procedure not performed in the emergency department
  – 5) that at least 1 year of follow-up

• Australia 1st November 2011
  – Removes vertebroplasty from MBS
Vertebroplasty

Medical Journal of Australia 2010 – reply Clarke et al

- Osteoporotic crush fractures usually heal 6-12 weeks
- Suggest perform vertebroplasty < 6 weeks
  - Or if fracture / fluid filled cleft persists > 6 weeks
- Buchbinder study
  - trial average 9.5 weeks (up to 12 months)
  - MRI oedema = fracture (may persist for months after union)
- Kallimes study
  - 18 weeks average
  - No MRI or nuclear medicine required
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CSF Hypotension Headache

Pachymeningeal enhancement
CSF Hypotension Headache