Systematic Review

# Cervical Facet Joint Pain and Cervicogenic Headache Treated With Radiofrequency Ablation: A Systematic Review

Michael Suer, MD[1], Sayed Emal Wahezi, MD[2], Alaa Abd-Elsayed, MD[3], and Nalini Sehgal, MD[1]

From: [1]Department of Orthopedics and Rehabilitation, University of Wisconsin School of Medicine and Public Health, Madison, WI; [2]Department of Rehabilitation Medicine, Montefiore Medical Center, SUNY-Buffalo, Buffalo, NY; [3]Department of Anesthesia, University of Wisconsin School of Medicine and Public Health, Madison, WI

Address Correspondence:
Michael Suer, MD
Department of Orthopedics and Rehabilitation, University of Wisconsin School of Medicine and Public Health, Madison, WI
1685 Highland Ave
Madison, WI, 53705
E-mail: suer@rehab.wisc.edu

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**Background:** Chronic neck pain is often multifactorial and is a leading cause of pain and disability. Cervical facet joint pain is a common cause of neck pain and, in addition to more conservative modalities, can be treated with radiofrequency ablation (RFA) of the respective medial branch nerves. Cervicogenic headaches are a frequent complaint in pain clinics in the United States and can be targeted via a similar procedural approach.

**Objectives:** We evaluated randomized controlled trials of cervical facet joint pain and cervicogenic headaches with the goal of establishing a current level of evidence for treating these etiologies of pain with RFA.

**Study Design:** Systematic review.

**Methods:** Database search, from inception through July 2021, was performed identifying randomized controlled trials for cervical medial branch RFA. Two reviewers independently evaluated the studies to identify those meeting criteria. Primary outcome measures included pain relief and duration of pain relief. Secondary outcome measures included function, sleep, mood, return to work, additional treatments, and complications.

**Results:** Four randomized controlled studies met inclusion criteria and were selected for this review, each demonstrated low risk of bias. Of these studies, 3 were unique with the fourth being a subgroup analysis. Primary outcome measures of pain relief and duration of relief were variable with successful relief ranging from 30% to 50% and median duration of pain relief also demonstrating a wide variety. Function and psychological distress were also variably reported and found variable relief to treatment with no difference between groups in 2 of the studies.

**Limitations:** Primary limitations of the review are the paucity of randomized controlled trials and the variability in measured outcome measures.

**Conclusions:** Based on this systematic review, efficacy of cervical facet RFA in treatment of chronic neck pain has Level II evidence.

**Key words:** Cervicalgia, neck pain, radiofrequency ablation, RFA, cervicogenic headache, cervical facet

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Chronic neck pain is a leading cause of disability in the United States, and contributes to poor quality of life and productivity (1,2). Neck pain is multifactorial; the pain can originate from cervical spine structures or can be referred from other sites/structures. In the cervical spine, potential sources of pain include neck muscles, spinal ligaments, facet joints, intervertebral discs, spinal nerve roots, spinal cord, dura, and vertebrae. Facet joints are an important and common cause of chronic neck pain (1).

The prevalence of cervical facet joint pain has been described to vary from 20% to 35% in the general population (2). The prevalence is higher in the elderly population, increasing with advancing age, and reaching a prevalence of 60% to 70% at C6-C7 by age of 40 years (2). Risk factors for cervical facet joint pain include age, trauma (whiplash), postural abnormalities, instability, spinal surgery, osteoarthritis, and inflammatory arthropathy (1).

Cervical facet joint pain is axial, nonradiating, located in the posterior neck and shoulder area, exacerbated by neck movements, and without radicular or neurologic upper extremity symptoms. There is pain-limited neck mobility and posterior neck tenderness on examination. Physical examination and imaging studies are unreliable in diagnosing facet joint pain (3-5). Pain diagrams (6,7) can provide a clue to the symptomatic facet joint(s). Local anesthetic blocks of facet joint nerves, called medial branch blocks (MBBs), are an accepted method for diagnosing facet joint pain, distinguishing facet joint pain from other causes of neck pain, selecting patients for facet radiofrequency ablation (RFA), and prognosticating treatment responses (3,4). Recent studies (8,9) have questioned these assumptions.

Cervical facet joints are innervated by medial branches of dorsal rami of cervical spinal nerves (10,11). Each facet joint, except the C2-C3 facet joint, is supplied by branches from 2 spinal nerves, located above and below the joint. The C2-C3 facet is innervated by a single nerve called the superficial branch of the C3 dorsal ramus (11,12). Variability in facet joint innervation occurs in the form of additional nerve supply from spinal nerves 2 or 3 levels distant from the facet joint or from contralateral spinal nerves (13). Theoretically, this variability may contribute to suboptimal treatment outcomes after facet RFA (14).

Recommended practice for diagnosing facet joint pain is to perform double-controlled MBBs with 2 different local anesthetics of different onset and duration of action. The idea behind double-controlled blocks is to decrease the likelihood of a false-positive result (4,13). A positive analgesic response is defined as complete or near complete (i.e., 80% to 100%) relief of pain at symptomatic level(s) with onset and duration of pain relief concordant with the type of local anesthetic used for the block. It is suggested that lidocaine, a short onset and duration local anesthetic, will produce an analgesic effect of shorter onset and duration compared to bupivacaine, which has a relatively longer onset and duration of action (3,13). In practice, cutoffs for percentage pain relief, separating positive from negative analgesic responses, vary widely and range between 50% to 100% (8,13,14). Triple-controlled MBBs with a short- and long-acting local anesthetic and saline injections in random order, recommended to exclude placebo responses, are impractical and have not been adopted into routine practice (9,13).

Facet joint pain is treated by RFA of corresponding medial branches of spinal segmental nerves. The underlying principle being interruption of the transmission of pain signals from the facet joint to the spinal dorsal horn, thereby eliminating perception of pain originating from targeted facet joint(s). Due to the precise ablation of selected nerves, this procedure mitigates pain from the denervated facet joint(s) only and has no effect on pain arising from other pain generators, such as adjacent facet joints, discs, ligaments, etc. Besides operator skill and experience, technical factors that determine treatment outcomes include choice of RFA technique and RFA equipment. Fluoroscopic guidance is required for precise probe positioning and 2 different conventional RFA techniques have been described. The technique originally described by Shealy (15) consists of RFA probe placement perpendicular to the target nerve/site and a single RF lesion at 80°C for 65 seconds. The technique described by Bogduk et al (13) and recommended by the Spinal Society (SIS) requires RF probe placement parallel to target nerves/site, using parasagittal and oblique approaches and creating multiple overlapping RF lesions (16). This technique is believed to target larger segments of the medial branches, and by creating multiple lesions compensates for the variable course of the nerves (13). Despite its professed superiority, the SIS technique has not been widely adopted as it is laborious, requires multiple needle passes, increases procedure time, and radiation exposure. Lord et al (17) quoted RFA procedure time of 3 hours in their study. Variations on this technique consist of using larger diameter probes and/or electrodes with 2 tips to create larger lesions or 2 simultaneous lesions.

A new RFA technology, cooled RFA (18), overcomes the disadvantages of conventional RFA. In this technique, 17-G water-cooled probes are placed at target sites to create a large lesion of spherical configuration over 150 seconds (19,20). It is claimed that the lesion size is 5 times the size of the lesion created by conventional RFA, and the lesion extends distal to the probe tip in a spherical shape. The size and shape of the RFA lesion obviates the need for parallel electrode place-

ment and creation of multiple lesions by 2 separate approaches (18-20). A single parasagittal approach at each level suffices to create a lesion covering the posterior and middle third of the articular pillar, thereby significantly reducing procedure time and radiation exposure. A major limitation in widespread adoption of this technology is the overall cost/expenses incurred. In addition to the cost of the RFA generator unit, there are ongoing expenses of disposable equipment. Except for the RFA generator, all of the items used for cooled RFA are disposable (18).

There is an ongoing debate regarding the efficacy of cervical RFA. Previous reviews (21,22) have reported Level 2A or 2B evidence for cervical RFA for cervicogenic headaches and chronic neck pain, and discussed utility and effectiveness of cervical facet interventions in chronic neck pain. Prospective and retrospective studies (14,23,24) have demonstrated cervical facet joint RFA is an effective treatment for facet joint pain. This systematic review will review literature for randomized controlled trials (RCTs) on cervical RFA and provide an update on cervical facet RFA efficacy.

## Methods

### Search Strategy

A computerized database search (inception to July 2021) of PubMed, Scopus, Web of Science, and Cochrane Reviews & Cochrane Central Register of Controlled Trials was performed. The search included manual searches of bibliographies of systematic and narrative reviews and cross references to the reviews. Key words used in the search were spinal pain (neck and cervical), facet joint pain, facet dysfunction, facet arthritis, degenerative spondylosis, post-laminectomy syndrome, spinal fusion, heat coagulation, radiofrequency nerve ablation, radiofrequency neurotomy.

### Inclusion Criteria

RCTs on cervical RFA in patients with chronic cervical facet joint pain of > 3 months duration were included for review. Studies were included if the procedures were fluoroscopically guided and controlled for false-positive responses (i.e., used comparative control or placebo control blocks). Both conventional RF and cooled RF techniques were included. Primary outcome measures included pain relief and duration of pain relief. Secondary outcome measures included function, sleep, mood, return to work, additional treatments (i.e., opioid use, injections, surgery), and complications.

### Exclusion Criteria

Articles excluded from review were retrospective studies, nonrandomized prospective studies, cadaver studies, studies describing injection technique, ultrasound-guided injections, case reports/series, reviews, guidelines, letters, and expert opinions. Studies on therapeutic facet joint procedures, such as intraarticular steroid injections and therapeutic MBBs, were excluded.

## Results

### Study Selection

Figure 1 shows flow diagram of the study selection using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses process. Titles obtained from computerized database searches were initially screened via title alone followed by abstract review for exclusion criteria and inclusion criteria. Initial search revealed 2,447 titles of which 67 abstracts were reviewed by 2 physician reviewers (MS and SW) independently for exclusion and inclusion criteria resulting in 4 RCTs for further evaluation.

### Methodologic Quality and Risk of Bias Assessment

Table 1 shows risk of bias and Table 2 shows methodologic quality assessment. Two reviewers (MS and SW) evaluated and graded articles meeting inclusion criteria for risk of bias, methodologic quality, and grading evidence. Risk of bias of individual studies by Cochrane criteria (25) was completed with disagreements settled by discussion by the 2 reviewers. Quality of study was graded based on Interventional Pain Management Techniques-Quality Appraisal of Reliability and Risk of Bias Assessment (IPM-QRB) for randomized trials with disagreements between the 2 reviewers settled through discussion (26).

### Level of Evidence

Evidence level was determined using the American Society of Interventional Pain Physicians (ASIPP) Grading of Evidence criteria (32) (Table 3). Evidence based on 5 levels of evidence was determined independently by 2 review authors (MS and SW). Disagreements, if any, were resolved by a third author (NS). None of the reviewers had any conflicts of interest. For the purpose of grading of evidence, high quality is determined as score of 32 to 48 on IPM-QRB and 8 or more on Cochrane criteria; moderate-quality evidence is score of 20 to 31 on IPM-QRB and 4 to 7 on Cochrane criteria;

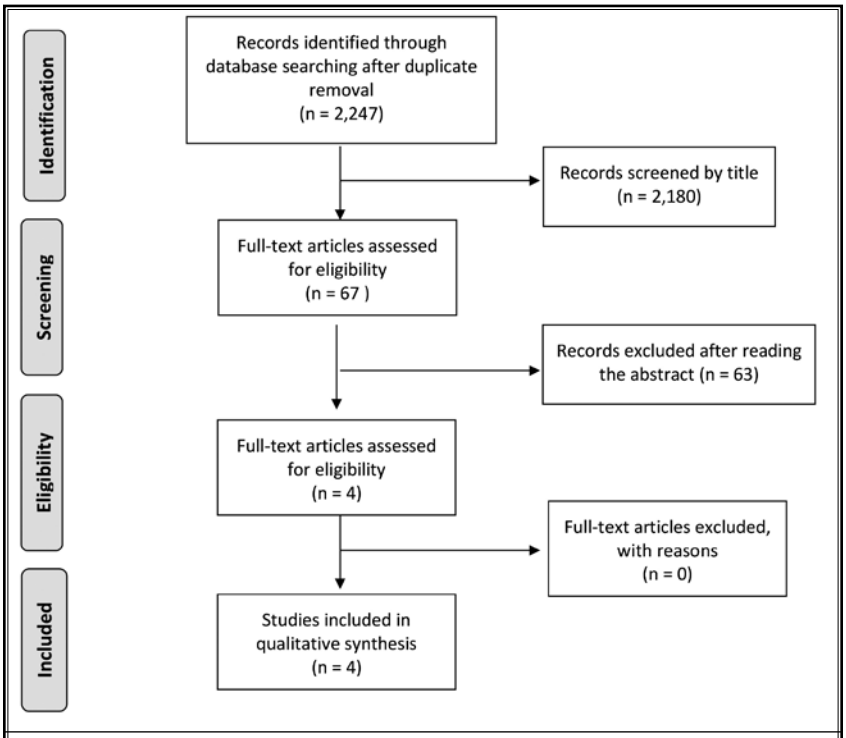


Fig. 1. *PNS in pain management: PRISMA 2009 flow diagram*

Table 1. *Risk of bias.*

| Bias Domain | Haspeslagh | Stovner | Wallis | Lord |
|---|---|---|---|---|
| Selection (Random sequence generation) | Low | Low | Low | Low |
| Selection (Allocation concealment) | Low | Low | Low | Low |
| Selection (Groups similar at baseline) | Low | High | Low | Low |
| Performance (Patient blinding) | High | Low | Low | Low |
| Performance (Care provider blinding) | High | Low | Low | Low |
| Performance (Co-interventions avoided or similar) | High | Low | Low | Low |
| Performance (Compliance acceptable in all groups) | Low | Low | Low | Low |
| Detection (Outcome assessor blinding) | Low | Low | Low | Low |
| Detection (Timing of outcome assessment similar) | Low | Low | Low | Low |
| Attrition (Dropout rate described & acceptable) | Low | Low | Low | Low |
| Attrition (Patients analyzed in the allocated group) | Low | Low | Low | Low |
| Reporting (Selective outcome reporting) | Low | Low | Low | Low |
| Other (Other sources of potential bias) | Low | Low | Low | Low |

and low-quality evidence is score of < 20 on IPM-QRB and < 4 on Cochrane criteria (25,26,32).

## Study Characteristics

Four randomized controlled studies met inclusion criteria and were selected for this review. The study by Wallis et al (27) is a subanalysis of Lord et al (17) and described the effect of cervical RFA on psychological distress.

## Percutaneous Radiofrequency Neurotomy for Chronic Cervical Zygapophyseal Joint Pain (Cochrane 13/13; IPM-QRB 37)

Lord et al (17) described treatment response to percutaneous cervical RFA in 24 chronic neck pain/whiplash patients in a randomized, sham-controlled, operator-blinded trial. Diagnoses of facet joint pain was based on complete pain relief after MBBs with lidocaine and bupivacaine and no pain relief with saline in 24/54 patients. The RFA technique consisted of 2 to 3 RF lesions at 80°C for 90 seconds at each level using parasagittal and oblique approaches. The sham technique was similar to the RFA technique, except probe temperature was maintained at 37°C for 90 seconds. At 3-months follow-up, active treatment was offered to all patients with ongoing pain in the control and treatment groups.

Primary treatment outcomes were measured by the Visual Analog Scale (VAS) and the McGill Pain Questionnaire (MPQ) at 3-5 days, 2-3 weeks, and 3 months. Secondary outcomes were activities of daily living (ADLs), residual pain, and need for ongoing treatment. Success was defined as pain of 0 to 5 on the 0-100 VAS, word count < 3/20 on the MPQ, restoration of 4 self-identified ADLs, "absence of usual pain," and no further/additional treatment for the "same" pain. Median time to return of 50% of pre-RFA pain level was estimated. Treatment failures were defined as no pain relief or pain return to at least 50% of preoperative level.

Table 2. *Assessment of methodologic quality of randomized trials of interventional techniques: Item checklist for assessment of RCTs of IPM techniques utilizing IPM-QRB.*

| | | Scoring | Author Haspelagh | Author Stovner | Author Wallis | Author Lord |
|---|---|---|---|---|---|---|
| I. | CONSORT OR SPIRIT | | | | | |
| 1. | Trial Design Guidance and Reporting | | | | | |
| | Trial designed without any guidance | 0 | | | | |
| | Trial designed utilizing other than CONSORT or SPIRIT criteria | 1 | 1 | 1 | 1 | 1 |
| | Trial implies it was based on CONSORT or SPIRIT without clear description | 2 | | | | |
| | Explicit use of CONSORT or SPIRIT with identification of criteria | 3 | | | | |
| II. | DESIGN FACTORS | | | | | |
| 2. | Trial Design and Type of Control | | | | | |
| | Poorly designed control group (quasi-selection, convenient sampling) | 0 | | | | |
| | Proper active-control or sham procedure with injection of active agent | 2 | 2 | | | |
| | Proper placebo control (no active solutions into active structures) | 3 | | 3 | 3 | 3 |
| 3. | Setting/Physician | | | | | |
| | General setting with no specialty affiliation and general physician | 0 | | | | |
| | Specialty of anesthesia/PMR/neurology, etc | 1 | 1 | 1 | | |
| | Interventional pain management with interventional pain management physician | 2 | | | 2 | 2 |
| 4. | Imaging | | | | | |
| | Blind procedures | 0 | | | | |
| | Ultrasound | 1 | | | | |
| | CT | 2 | | | | |
| | Fluoro | 3 | 3 | 3 | 3 | 3 |
| 5. | Sample Size | | | | | |
| | < 50 patients in the study without appropriate sample size determination | 0 | | | | |
| | Sample size calculation with < 25 patients in each group | 1 | 1 | 1 | 1 | 1 |
| | Appropriate sample size calculation with at least 25 patients in each group | 2 | | | | |
| | Appropriate sample size calculation with 50 patients in each group | 3 | | | | |
| 6. | Statistical Methodology | | | | | |
| | None or inappropriate | 0 | | | | |
| | Appropriate | 1 | 1 | 1 | 1 | 1 |
| III. | PATIENT FACTORS | | | | | |
| 7. | Inclusiveness of Population | | | | | |
| 7a. | For epidural procedures: | | | | | |
| | Poorly identified mixed population | 0 | | | | |
| | Clearly identified mixed population | 1 | | | | |
| | Disorders specific trials (ie, well-defined spinal stenosis and disc herniation, disorder specific, disc herniation or spinal stenosis, or post-surgery syndrome) | 2 | | | | |

Table 2 (cont.). Assessment of methodologic quality of randomized trials of interventional techniques: Item checklist for assessment of RCTs of IPM techniques utilizing IPM-QRB.

| | | Scoring | Author Haspelagh | Author Stovner | Author Wallis | Author Lord |
|---|---|---|---|---|---|---|
| 7b. | For facet or sacroiliac joint interventions: | | | | | |
| | No diagnostic blocks | 0 | 0 | 0 | | |
| | Selection with single diagnostic blocks | 1 | | | | |
| | Selection with placebo or dual diagnostic blocks | 2 | | | 2 | 2 |
| 8. | Duration of Pain (at least 80% of Patients) | | | | | |
| | < 3 months | 0 | 0 | 0 | 0 | 0 |
| | 3 to 6 months | 1 | | | | |
| | > 6 months | 2 | 2 | 2 | 2 | 2 |
| 9. | Previous Treatments | | | | | |
| | Conservative management, including drug therapy, exercise therapy, physical therapy, etc | | | | | |
| | Were not utilized in a structured fashion | 0 | 0 | 0 | 0 | 0 |
| | Were utilized sporadically in a structured fashion | 1 | | | | |
| | Were utilized in a structured fashion | 2 | | | | |
| 10. | Duration of Follow-up with Appropriate Interventions | | | | | |
| | Three months or less for epidural or facet joint procedures, etc and 6 months for intradiscal procedures and implantables | 0 | | | 0 | 0 |
| | Six months for epidural or facet joint procedures, etc, or one year for intradiscal procedures or implantables | 1 | 1 | | 1 | 1 |
| | One year for epidurals or facet joint procedures, etc, and 2 years or longer for discal procedures and implantables | 2 | | | | |
| | Two years or longer for epidurals and facet joint procedures, etc, or 5 years or longer for discal procedures and implantables | 3 | | 3 | | |
| IV. | OUTCOMES | | | | | |
| 11. | Outcomes Assessment | | | | | |
| | No significant descriptions of outcomes or < 20% change | 0 | | | | |
| | Pain rating with decrease of 2 points or > 20% reduction | 1 | 1 | | | |
| | Functional status improvement of 20% | 1 | | | | |
| | Pain rating and functional status improvement with decrease of > 20% | 2 | | 2 | | |
| | Pain rating with decrease of 50% or decrease of 3 points | 2 | | | | |
| | Functional status improvement with 50% or 40% reduction in disability scores | 2 | | | | |
| | Significant improvement with pain and function ≥ 50% or 3 points and 40% reduction | 4 | | | 4 | 4 |
| 12. | Analysis of All Randomized Patients in the Group | | | | | |
| | Not performed | 0 | | | | |
| | Performed without intent-to-treat analysis without inclusion of all randomized patients | 1 | 1 | 1 | 1 | 1 |
| | All patients included with or without intent-to-treat analysis | 2 | | | | |
| 13. | Description of Dropout Rate | | | | | |
| | No description | 0 | | | | |
| | < 20% withdrawal in one year in any group | 1 | | | | |
| | < 30% withdrawal at 2 years in any group | 2 | 2 | 1 | 1 | 1 |

Table 2 (cont.). Assessment of methodologic quality of randomized trials of interventional techniques: Item checklist for assessment of RCTs of IPM techniques utilizing IPM-QRB.

| | | Scoring | Author Haspelagh | Author Stovner | Author Wallis | Author Lord |
|---|---|---|---|---|---|---|
| 14. | Similarity of Groups at Baseline for Important Prognostic Indicators | | | | | |
| | Groups dissimilar with influence on outcomes | 0 | | | | |
| | Groups dissimilar without influence on outcomes | 1 | | | | |
| | Groups similar | 2 | 2 | 2 | 2 | 2 |
| 15. | Role of Co-Interventions | | | | | |
| | Dissimilar co-interventions | 0 | 0 | | | |
| | No co-interventions or similar co-interventions | 1 | | 1 | 1 | 1 |
| V. | RANDOMIZATION | | | | | |
| 16. | Method of Randomization | | | | | |
| | Quasi-randomized or poorly randomized or not described | 0 | 0 | 0 | | |
| | Adequate randomization (coin toss, drawing of balls of different colors, drawing of ballots) | 1 | | | | |
| | High-quality randomization (Computer generated random sequence, preordered sealed envelopes, sequentially ordered vials, telephone call, preordered list of treatment assignments, etc) | 2 | | | 2 | 2 |
| VI. | ALLOCATION CONCEALMENT | | | | | |
| 17. | Concealed Treatment Allocation | | | | | |
| | Poor concealment of allocation (open enrollment) | 0 | 0 | | | |
| | Adequate concealment of allocation with potential for identification | 1 | | | | |
| | High-quality concealment with strict controls (independent assignment without influence on the assignment sequence) | 2 | | 2 | 2 | 2 |
| VII. | BLINDING | | | | | |
| 18. | Patient Blinding | | | | | |
| | Patients not blinded | 0 | 0 | 0 | | |
| | Patients blinded adequately | 1 | | | 1 | 1 |
| 19. | Care Provider Blinding | | | | | |
| | Not blinded | 0 | 0 | 0 | | |
| | Blinded | 1 | | | 1 | 1 |
| 20. | Outcome Assessor Blinding | | | | | |
| | Not blinded | 0 | | | | |
| | Blinded performed by independent assessor | 1 | 1 | 1 | 1 | 1 |
| VIII. | CONFLICTS OF INTEREST | | | | | |
| 21. | Funding and Sponsorship | | | | | |
| | Trial included industry employees | -3 | | | | |
| | Industry employees involved; high levels of funding with remunerations by industry or an organization funded with conflicts | -3 | | | | |
| | Industry or organizational funding with reimbursement of expenses with some involvement | 0 | | | | |
| | Industry or organization funding of expenses without involvement | 1 | | | | |
| | Funding by internal resources only | 2 | 2 | 2 | 2 | 2 |
| | Governmental funding without conflict, such as NIH, NHS, AHRQ | 3 | | | | |

Table 2 (cont.). Assessment of methodologic quality of randomized trials of interventional techniques: Item checklist for assessment of RCTs of IPM techniques utilizing IPM-QRB.

| | | Scoring | Author Haspelagh | Author Stovner | Author Wallis | Author Lord |
|---|---|---|---|---|---|---|
| 22. | Conflicts of Interest | | | | | |
| | None described or disclosed or implied conflict | 0 | | | | |
| | Marginally disclosed | 1 | | | | |
| | Well-described or implied with minor conflicts | 2 | | | | |
| | Well-disclosed or implied with no conflicts | 3 | 3 | 3 | 3 | 3 |
| | Hidden | –1 | | | | |
| | Misleading | –2 | | | | |
| | Major impact related to conflicts | –3 | | | | |
| TOTAL MAXIMUM | | 50 | 24 | 30 | 37 | 37 |

Abbreviations: RCTs, randomized controlled trials; CONSORT, Consolidated Standards of Reporting Trials; SPIRIT, Standard Protocol Items: Recommendations for Interventional Trials; PMR, polymyalgia rheumatic; CT, computed tomography; Fluoro, fluoroscopy; NIH, National Institute of Health; NHS, National Health Service; AHRQ, Agency for Healthcare Research and Quality.

Table 3. *ASIPP grading of evidence.*

| | |
|---|---|
| Level I | Evidence obtained from multiple relevant high-quality randomized controlled trials<br>OR<br>Evidence obtained from multiple high-quality diagnostic accuracy studies |
| Level II | Evidence obtained from at least one relevant high-quality randomized controlled trial or multiple relevant moderate- or low-quality randomized controlled trials<br>OR<br>Evidence obtained from at least one high-quality diagnostic accuracy study or multiple moderate- or low-quality diagnostic accuracy studies |
| Level III | Evidence obtained from at least one relevant moderate- or low-quality randomized controlled trial study<br>OR<br>Evidence obtained from at least one relevant high-quality nonrandomized trial or observational study with multiple moderate- or low-quality observational studies<br>OR<br>Evidence obtained from at least one moderate-quality diagnostic accuracy study in addition to low-quality studies |
| Level IV | Evidence obtained from multiple moderate- or low-quality relevant observational studies<br>OR<br>Evidence obtained from multiple relevant low-quality diagnostic accuracy studies |
| Level V | Opinion or consensus of large group of clinicians and/or scientists |

Abbreviation: ASIPP, American Society of Interventional Pain Physicians.

## Resolution of Psychological Distress of Whiplash Patients Following Treatment by Radiofrequency Neurotomy: A Randomized, Double-blind, Placebo-Controlled Trial (Cochrane 13/13; IPM-QRB 37)

Wallis et al (27) described effects of RFA on psychological distress in a subgroup of patients from Lord et al (17). Of the 24 patients in Lord et al (17), 7 patients with concurrent pain from untreated facet joints were excluded. Seventeen patients, 9 pain free (6 in active group and 3 in control group) and 8 with ongoing pain (3 in active and 5 in control group) at 3 months were included in the subgroup analyses. Patients were evaluated for pain and psychological status at baseline and 3 months after RFA by psychologist blinded to treatment groups. Resolution of psychological distress was defined as return to normal for all previously elevated scores on

The Symptom Checklist-90-Revised (SCL-90-R) or decrease in somatization and at least 7 of the 8 subscales of SCL-90-R in normal range.

### Radiofrequency Denervation of Facet Joints C2-C6 in Cervicogenic Headache: A Randomized, Double-blind, Sham-Controlled Study (Cochrane 12/13, IPM-QRB 30)

Stovner et al (28) randomized 12 patients with unilateral chronic cervicogenic headaches, diagnosed by Sjaastad et al clinical criteria (29) (Table 4), to receive RFA or control/sham treatment. RFA of C2-C3 to C6-C7 facet joints consisted of 3 to 4 RF lesions at 85°C for 60 seconds by posterolateral approach. The procedure for control/sham group was similar to treatment group, except no RF lesions were created. Operator was not blinded, but patients and assessors were blinded to treatment allocation.

Patients were followed up at 1, 3, 6, 12, 18, and 24 months after RFA. Primary outcome was number of days with moderate-severe pain, pain reduction of at least 30% was considered as clinically significant on a 14-day pain log. Secondary outcomes were pain severity on categorical pain scale (no pain = 0, mild pain = 1, moderate pain = 2, severe pain = 3), duration of pain, analgesic use, cervical range of motion (ROM), and pressure thresholds at follow-up.

### Randomized Controlled Trial of Cervical Radiofrequency Lesions as a Treatment for Cervicogenic Headache (Cochrane 10/13, IPM-QRB 24)

Haspeslagh et al (30) performed RFA in patients with cervicogenic headaches. Thirty patients, fulfilling Sjaastad et al criteria (29) (Table 4), were randomized to RFA or local injection groups. Each group was offered treatment in a 3-step process, based on response to previous treatment. RFA group was treated with RFA of C3-C6 medial branches (step 1). At 8 weeks, nonresponders underwent diagnostic segmental nerve blocks at tender levels. Those with 50% pain reduction to segmental nerve bocks were treated with RFA of the dorsal root ganglion (DRG) (step 2). Nonresponders to step 2 at 8 weeks were treated with transcutaneous electrical nerve stimulation (TENS) (step 3). The RFA technique consisted of a single lesion at 67°C for 60 seconds at each level with fluoroscopic guidance.

The control group received local anesthetic block of greater occipital nerve (GON) (step 1), and repeated at 8 weeks in nonresponders (step 2). Nonresponders to step 2 at 8 weeks were treated with TENS unit (step 3). GON block was performed 2 cm lateral and 2 cm inferior to the external occipital protuberance with 2 mL of 0.5% bupivacaine.

Primary outcomes were mean VAS over one week and global perceived effect (GPE). Secondary outcomes were days with headache, intensity of headache, and quality of life. Outcomes were assessed 4 weeks before treatment and posttreatment at 8 weeks and 4, 6, 8, 10, and 12 months after initial treatment by a blinded investigator. Successful treatment was defined as 20-mm

Table 4. *Sjaastad criteria for cervicogenic headache.*

| Criteria | Definition |
|---|---|
| Major Signs and Symptoms (Obligatory for Diagnosis) | Unilaterality of the head pain, without side shift<br>Provocation of the attack<br>Pain triggered by neck movement and/or sustained head positioning<br>Pain elicited by external pressure over the ipsilateral upper, posterior neck region, or occipital region<br>Ipsilateral neck, shoulder, and arm pain that is nonradicular<br>Reduced ROM of the cervical spine |
| Pain Characteristics | Nonclustering pain episodes<br>Pain episodes of varying duration or fluctuating continuous pain<br>Moderate, nonexcruciating pain, usually of nonthrobbing nature<br>Pain starting in the neck, eventually spreading to oculo-fronto-temporal areas, where maximum pain is often located |
| Other Important Criteria | Anesthetic blockade of the major occipital nerve and/or C2 nerve root on the symptomatic side abolishes pain transiently<br>Female gender<br>History of head and/or neck trauma (whiplash) |
| Minor, Rare, Nonobligatory Signs or Symptoms | Autonomic signs and symptoms<br>Nausea<br>Vomiting<br>Ipsilateral edema, flushing (mostly periocular)<br>Dizziness<br>Phono- and photophobia<br>Ipsilateral blurred vision to the pain<br>Difficulties swallowing |

Abbreviation: ROM, range of motion.

mean VAS over a period of one week and GPE of +2 or +3 on a 7-point scale (-3 to +3).

### Pain Relief and Duration of Relief

In Lord et al (17), 7 out of 12 in active (RFA) group vs 1 out of 12 in control (sham) group were pain free at 27 weeks. Median time to return of 50% preoperative pain level was 263 days in the active group and 8 days in the control group. No pain relief was reported in 3 out of 12 RFA patients and 6 out of 12 control patients. Flow charts detailing both treatment groups and treatment responses with follow-up were not provided. Loss to follow-ups were not reported.

In Stovner et al (28), 4 out of 6 patients in the RFA group and 2 out of 6 in the control group obtained > 30% improvement at 3 months. Outcomes were similar in both treatment groups at 6 months and subsequent follow-ups. Control group performed better on most variables at 24 months. One patient died and there was missing information for others at follow-up.

Haspeslagh et al (30) reported the VAS improved and number of headaches decreased at all follow-up time points for both active treatment and control patients without statistically significant differences. Follow-up was complete in 11/15 in the RF group and 10/15 in the control group.

### Function

Lord et al (17) asked patients to select 4 ADLs most limited by pain. Response to treatment was reported as successful or unsuccessful in the study and specific return to function was not explicitly addressed. Stovner et al (28) measured cervical ROM and reported no significant difference between the groups at any time point.

### Global Perceived Effect and Quality of Life

GPE was reported by Haspeslagh et al (30) and Stovner et al (28). Both studies showed improved global perceived effect in RFA and control groups without statistically significant difference between groups.

### Psychological Function

One study described changes in SCL-90-R in RFA and control group (Wallis and Lord [27]). Complete resolution of psychological distress was observed on SCL-90-R in all 9 patients who were pain free at 3 months (6 from active and 3 from control). One patient with continued pain after RFA also obtained resolution of psychological symptoms. There was no improvement in SCL-90-R scores in 8 patients with continued pain (3 in active and 5 in control). Similarly, in the escape therapy group, all pain-free patients had resolution of psychological distress. There was a strong association between complete pain relief and resolution of psychological test (Fisher's exact test $P < 0.001$).

### Analgesic Use

Stovner et al (28) found no significant difference in analgesic use between the treatment and control groups. One patient in the control group developed acute rheumatoid arthritis and markedly increased analgesic use with no change in neck pain or headaches.

### Adverse Outcomes

Increased neck pain after RFA was reported by Lord et al (17) and Stovner et al (28). The duration of increased pain reported after RFA was 1-2 days in Stovner et al (28) and 13.5 days in Lord et al (17). Lord et al (17) described numbness and/or dysesthesias in 5 patients after RFA. One patient developed a psoriatic rash (Kobner's phenomenon) one week after RFA (Lord [17]).

## Discussion

We noted a dearth of RCTs on cervical facet RF neurotomy, 3 RCTs (17,28,30) were published between 1996 to 2006, 2 studies in patients with cervicogenic headaches, and one in post-traumatic neck pain after a motor vehicle accident. The fourth study by Wallis et al (27) is a subanalysis of Lord et al (17), describing improvement in psychological distress after RFA and is accordingly grouped with Lord et al (17). Two studies were sham controlled: Lord et al (17) on post-traumatic neck pain and Stovner et al (28) on cervicogenic headaches. Cochrane risk of bias criteria (25) were applied and showed low risk of bias for all 3 studies, Lord et al (17) (score of 13/13) and Stovner et al (28) (score of 12/13) as compared to Haspeslagh et al (30) (score of 10/13), where patients and operators were not blinded to treatment allocation. An IPM-QRB score of 32-48 is high, 20 to 31 is moderate, and < 20 is low on methodologic quality assessment. IPM-QRB scores were 37 for Lord (17) and Wallis's (27) studies, 30 for Stovner et al (28), and 24 for Haspelagh et al (30). A major limitation of these studies was the small number, 24 patients enrolled in Lord et al (17), 30 in Haspelagh et al (30), and Stovner et al (28) fell short of the target number of 24, enrolling 12 patients over 2.9 years, at which time further enrollment was terminated and post hoc analy-

ses performed. This speaks to the challenge and cost of recruiting patients for sham-controlled randomized interventional studies.

Strengths of Lord et al (17) include stringent patient selection criteria, multiple RF lesions, sham controls, masking of patients, operator and assessors, use of validated outcomes instruments (i.e., VAS, MPQ, SCL-90 R), and describing durability of pain relief. Limitations of the study are small numbers, lack of flow diagram accounting for all of the patients in the study, short follow-up interval of 3 months, active treatment to sham controls, and treatment failures at 3-month follow-up confounding long-term analysis, lack of validated function scale, failure to report on analgesic use pre- and post-RF, or assess cervical mobility on objective testing. Success was characterized by "absence of usual pain" and no further/additional treatment for "same" pain at 3 months follow-up. Does this imply that there were other areas of untreated neck pain, which could limit ADLs and require ongoing treatment?

Stovner et al (28) studied therapeutic efficacy of cervical facet RFA in unilateral cervicogenic headaches. Study strengths included sham controls, multiple RF lesions, masking patients and assessors to treatment groups, follow-ups at multiple intervals up to 24 months, including in outcomes assessment analgesic usage, GPE, cervical mobility, and pressure thresholds. Major limitations of this study include not enrolling patients with chronic neck pain, lack of diagnostic MBBs to identify symptomatic facet levels, extensive unilateral C2-C3 to C6-C7 facet joint denervation potentially causing unilateral cervical paraspinous muscle weakness, small numbers, post hoc analyses, and use of categorical pain scale instead of VAS or numeric rating scale.

Haspelagh et al (30) randomized patients with cervicogenic headaches to receive cervical RFA or GON blocks and concluded treatment outcomes of RFA of cervical facet joint and DRG are not superior to GON blocks. Limitations of this study include performing cervical facet RFA without establishing facet joint pain with diagnostic MBBs, multiple step procedure at 8-week intervals confounding outcomes assessment, and unclear reasons for cervical DRG RFA.

While all 3 studies used fluoroscopic guidance to perform RFA, only Lord et al (17) enrolled patients with chronic facet joint neck pain, with diagnoses established on bases of diagnostic MBBs. Stovner et al (28) and Haspelagh et al (30) did not enroll patients with chronic neck pain, and enrolled patients with cervicogenic headache based on Saajsted et al (29) criteria. Thus, the results of these 2 studies cannot be applied to cervical facet mediated chronic neck pain. Based on this review and applying ASIPP Grading of Evidence criteria (Table 3), the net benefit of cervical facet RFA treatment for chronic neck pain is moderate to substantial; and, therefore, gets a Level II grade. The strength of evidence is strong based on Cochrane and IPM-QRB criteria.

These trials demonstrate the challenge of designing adequately powered randomized controlled clinical trials of interventional techniques. RCTs with sham controls are costly, and it is difficult to enroll sufficient number of patients and follow-up long term in sham-controlled trials. Effectively masking patients to RFA is also problematic making RCTs with sham controls ethically challenging and less desirable. There is, however, a need for well-designed prospective controlled studies, including comparative effectiveness studies on cervical facet RFA in chronic neck pain patients. None of the studies enrolled patients with nontraumatic chronic neck pain. In order to overcome limitations of current studies and to provide a strong evidence base for cervical facet RFA in chronic pain, future studies need to enroll patients with nontraumatic chronic neck pain selected on the basis of stringent diagnostic blocks; enroll adequate number of patients based on sample size calculations; ensure adequate long-term follow-up; employ validated and standardized outcome instruments for pain relief, function, analgesic use, and durability of treatment effect; and describe short-term and long-term complications. Additionally, RFA technique, technical skill, and expertise of the operator are critical to successful outcomes. It is suggested that studies include detailed description of RFA techniques with fluoroscopic images of probe placement in 2 different views. Comparative efficacy of cooled RFA vs conventional RFA for chronic neck pain is lacking. McCormick et al (31) compared cooled RF to conventional RFA for lumbar facet joint pain and reported that although the success rate was greater with cooled RFA, the difference in primary and secondary outcomes did not reach statistical significance. Future studies should study the cost-effectiveness of cervical facet RFA as compared to conservative medical management and surgical treatments.

## Conclusions

Based on this systematic review, efficacy of cervical facet RFA in treatment of chronic neck pain has Level II evidence. Paucity of adequately powered RCTs, several

limitations of studies as described above, variability in patient population, heterogeneous treatment outcomes, and follow-up intervals do not allow for meta-analyses. There remain many questions going forward in relation to cervical RFA that highlight the need for further research into this treatment for chronic neck pain.

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