

A best practice guide to management of recent onset cervical radiculopathy in people presenting to primary care

LOUISE KEATING SMISCP MPhtySt (Manip)

Clinical Specialist

During the World Health Organisation's (WHO) bone and joint decade 2000-10, the taskforce on neck pain highlighted the existence of a gap in the research for the optimal management of cervical radiculopathy (CR) despite the high levels of pain and disability associated with this condition. With a prevalence less than half that seen for lumbar radiculopathy, the research gap for CR is most evident for the first 12 weeks of the condition, making evidence-based clinical decision-making a challenge for primary carers. Informed by recent primary and secondary research in CR and neuropathic pain, a best practice management guide is outlined for the physiotherapist in private practice and could assist them in the QAP process.



LEARNING OUTCOMES

TO SUPPORT PHYSIO FIRST QAP

- 1 To describe and contrast the definition and diagnostic criteria currently in use for recent onset CR.
- 2 To explore the diagnostic accuracy of physical tests.
- 3 To establish the best evidence guide to assessment and non-invasive management of people with recent onset CR.

Introduction

The current evidence base for the management of people with recent onset (less than 12 weeks) CR is small in comparison to that available for axial neck pain or lumbar radiculopathy, which poses a challenge for the physiotherapist in private practice. As people with CR often experience high levels of pain and disability (Haldeman *et al* 2008), they present to primary carers seeking diagnosis, reassurance and treatment aimed at speedy symptom resolution, for a condition thought to have a favourable natural history of recovery over weeks and months (Blanpied *et al* 2017). A composite guide is outlined to assist

clinical decision making, based on CR and neuropathic pain clinical guidelines, systematic reviews, and emerging clinical trials.

Background

A lack of agreement on the definition and diagnostic criteria of CR is the first challenge evident in current research (Thoomes *et al* 2012). The IASP Taxonomy Working Group (2011) defines radiculopathy as the objective loss of sensory and / or motor function as a result of conduction block in axons of a spinal nerve or its roots, which can occur in isolation or in association with radicular pain (typically lancinating), referred pain, or spinal pain (IASP 2011). In contrast, the North American Spine Society (NASS) appears to limit its definition exclusively to painful radiculopathy as “pain in a radicular pattern in one or both upper extremities related to compression and / or irritation of one or more cervical nerve roots”, and reports that “frequent signs and symptoms include varying degrees of sensory, motor and reflex changes as well as dysesthesias and paresthesias related to nerve root(s) without evidence of cord compression (myelopathy)” (Bono *et al* 2011).

This definition highlights that mechanical compression and / or chemical irritation that results in neuroinflammation can insult the nerve root (Kuijper *et al* 2009b; Schmid *et al* 2013). It is now thought that neuroinflammation, with or without root compression, is the main driver of clinical symptoms, which helps to explain the tendency for spontaneous resolution in the majority of people, particularly in CR caused by soft disc prolapse (Kuijper *et al* 2009b).

Radicular symptoms can demonstrate an extra-territorial spread due to neuroinflammation at the dorsal root ganglion, expansion in size of dorsal horn receptive fields, and changes in sub-cortical and cortical regions, leading to cortical reorganisation (Schmid *et al* 2013). The inclusion of symptom aggravation by neck posture or movement in any CR definition has been suggested (Thoomes *et al* 2012), which makes good clinical sense for the differentiation of CR from shoulder pain and other peripheral neuropathies, e.g. carpal tunnel syndrome.

Aetiology is most commonly spondylotic change affecting the capacity of the intervertebral foramen, followed by

“ IT IS THOUGHT THAT NEUROINFLAMMATION IS THE MAIN DRIVER OF THE CLINICAL SYMPTOMS OF CLINICAL RADICULOPATHY ”

disc prolapse (Radhakrishnan *et al* 1994) which drives peak incidence to the fifth and sixth decades of life. The most common root levels involved are C7 and C6, followed by C5 and C8 (Radhakrishnan *et al* 1994; Kim *et al* 2016), leading to characteristic neck and / or periscapular pain, and dermatomal arm symptoms (Bono *et al* 2011). The localising value of dermatomal arm pain alone is considered to be less than that of paraesthesiae, when they are present (Kuijper *et al* 2009a).

Figure 1 illustrates the dermatomal pattern of radicular arm. When such pain is present, it should also be considered as a form of peripheral neuropathic pain, defined by the IASP as pain caused by a lesion or disease of the peripheral somatosensory nervous system (Jensen *et al* 2011). A combination of nociceptive and neuropathic pain mechanisms can be expected in the radiculopathy patient, due to the potential for co-existing axial neck pain, somatic referred,

and radicular arm pain (Kjaer *et al* 2017). Clinical guidelines for the management of neuropathic pain can therefore be of benefit to the primary carer.

Diagnosis

Reflecting the practitioner’s clinical reasoning approach, a cluster of tests are recommended to maximise diagnostic accuracy (Bono *et al* 2011; Thoomes *et al* 2017; Rubinstein *et al* 2007). A recent review of diagnostic accuracy of physical tests (Thoomes *et al* 2017) using a reference standard of imaging or surgical findings, recommends the combined use of Spurling’s test, supine axial traction test (<https://www.youtube.com/watch?v=QKc1BV-BERs>), and the recently described arm squeeze test (<https://www.youtube.com/watch?v=rROAZDrAYUk>) for diagnosis of CR in the presence of a consistent patient history. Based on the occurrence of neuromechanosensitivity, the arm squeeze test distinguishes between



FIGURE 2: Arm squeeze test for diagnosis of CR

radicular pain and shoulder pain with high levels (0.96) of sensitivity and (0.91-1.0) of specificity (Gumina *et al* 2013). A positive arm squeeze test occurs when the patient reports three points or higher on VAS when pressure is applied to the circumference of the middle third of the upper arm (figure 2), when compared with pressure on the acromioclavicular and anterolateral subacromial areas.

A combination of negative upper limb neural tension (ULNT) tests and the arm squeeze test are recommended by Thoomes *et al* (2017) to rule out CR.

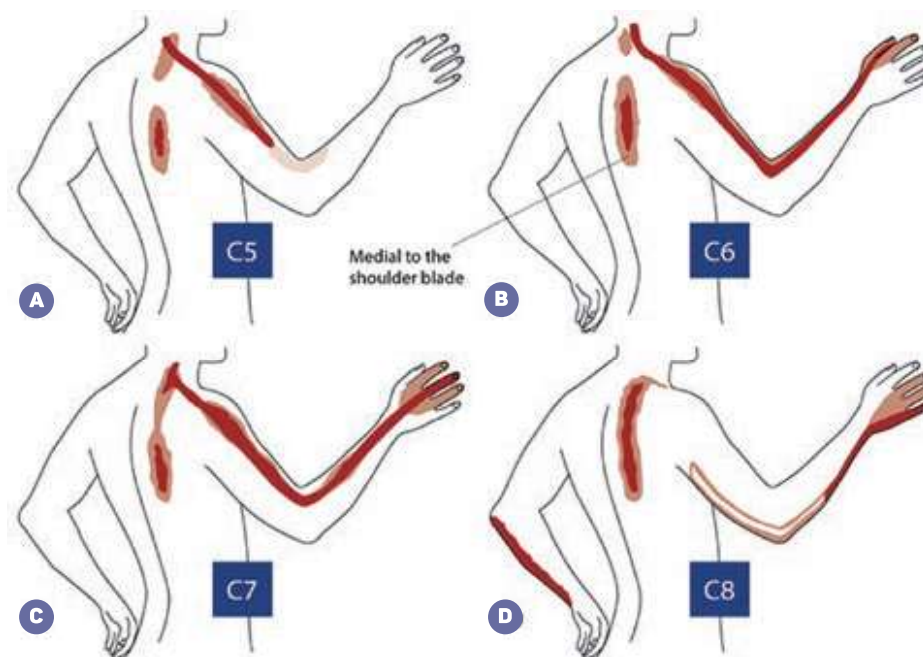


FIGURE 1: Dermatomal pain patterns in CR: www.differencebetween.net/science/health/differences-between-myelopathy-and-radiculopathy

The revised clinical guidelines on neck pain from the American Physical Therapy Association (APTA) continue to recommend the use of Wainner’s clinical prediction rule (CPR), as well as the Valsalva test (<https://www.youtube.com/watch?v=k5o26XwpCt4>), for making a diagnosis of CR in the presence of radicular pain (Blanpied *et al* 2017). Wainner’s CPR was developed using needle electromyography (EMG) and nerve conduction studies as a reference (Wainner *et al* 2003), an approach that has been criticised (Thoomes *et al* 2017). The CPR includes Spurling’s test, supine axial traction tests, limitation of ipsilateral rotation to 60 degrees or less, and a positive ULNT. When three of these tests are positive, the CPR has a specificity of 94% (95% CI; 0.88-1.0) (29)

"THE USE OF MRI OR CT IMAGING IS NOT IMMEDIATELY RECOMMENDED IN RECENT ONSET CERVICAL RADICULOPATHY"

and a positive likelihood ratio of 6.1 (95% CI; 2.0-18.6). When all four tests are positive, specificity improves to 100% (95% CI; 0.97-1.0), and the positive likelihood ratio is 30.3 (95% CI; 1.7-538.2) (Wainner *et al* 2003). The NASS clinical guidelines recommend use of the shoulder abduction test for arm pain relief (https://www.youtube.com/watch?v=8_AHkiiPYS8), and Spurling's test to aid diagnosis (Bono *et al* 2011).

The use of MRI or CT imaging is not immediately recommended in recent onset CR, unless in the context of significant myotomal paresis after traumatic injury (Leveque *et al* 2015). Imaging, to confirm root level and aetiology prior to consideration of surgical intervention is recommended by NASS (Bono *et al* 2011). The exact timing of imaging is not stipulated in that guideline but those recently published by the Ontario Protocol for Traffic Injury Management (OPTIMa) recommend referral to a physician for investigation and management at three months post symptom onset, if neurological symptoms and disability remain (Cote *et al* 2016).

Best evidence guide for assessment

Assessment of a person with recent onset CR should be undertaken in consideration of their unique biopsychosocial experience of pain, and encapsulate dimensions of disability, health and psychosocial functioning (Salt *et al* 2009; Blanpied *et al* 2017).

The Neuropathic Pain Special Interest Group (NeuPSIG) of the IASP has recommended, in its guidelines for the assessment of chronic neuropathic pain in primary care, that labelling the pain mechanism(s) present is advantageous

to clinical care (Haanpaa *et al* 2009).

This can be applied to the recent onset CR patient, particularly as they near 12 weeks of symptom duration. NeuPSIG also highlighted the importance of sensory tests and recommends that thermal and vibration sensitivity be routinely tested, along with light touch and pinprick tests, as patients frequently have reduced response to one modality, while experiencing pain from another. This is in part due to the overlap evident between areas of sensory loss and maximal pain. Primary carers should also consider that lack of response to nociceptive analgesics, e.g. NSAIDs, indicates the likelihood of neuropathic pain being the primary mechanism (Haanpaa *et al* 2009).

Neuropathic pain can be identified by using screening questionnaires and both the S-LANSS (Bennett *et al* 2005) and PainDETECT (Freyhagen *et al* 2006) have been used in CR, but a systematic review of screening tools (Mathieson *et al* 2015) has promoted the Neuropathic Pain Questionnaire (Krause & Backonja 2003).

Clinical guidelines recommend monitoring to track clinical course and guide decisions during treatment (Kjaer *et al* 2017), as well as gain an understanding of the biopsychosocial experience of the patient. Use of VAS by the Neck Disability Index (NDI) is recommended by NASS (Bono *et al* 2011). The APTA recommends use of cervical ROM and the Patient-Specific Functional Scale (PSFS) ahead of the NDI owing to the stronger psychometric properties, i.e. greater reliability, seen with PSFS in a CR cohort (Blanpied *et al* 2017).

The revised APTA guidelines also now suggest the use of algometric assessment of pressure pain threshold (PPT) for monitoring changing

somatosensory profiles. Chien *et al* (2008) have identified widespread mechanosensitivity in chronic CR in comparison to painfree controls, but no research has yet examined PPT in recent onset CR.

Best evidence guide for conservative management

Several clinical guidelines now exist for the management of CR, these include the Danish National clinical guidelines for recent onset CR (Kjaer *et al* 2017) and NASS clinical guidelines for CR from degenerative disorders (Bono *et al* 2011). Other broader, neck pain guidelines, such as the APTA Revised Neck Pain clinical guidelines (Blanpied *et al* 2017) and the Canadian OPTIMa clinical guidelines (Cote *et al* 2016) also include CR and, where inconsistency between them occurs, it is most often due to the variation in methodology and length of follow-up (Kjaer *et al* 2017).

The most recently published Danish Guidelines (Kjaer *et al* 2017), based on low-quality evidence and consensus, recommend management strategies for short duration CR, i.e. days or weeks, should focus primarily on providing the patient with information about favourable prognosis, pain mechanism, pain management, warning signs, and individualised physical activity advice. Advice should be tailored to minimise symptom provocation while maintaining physical function and promoting health. It should take into account patient preference, and additional management strategies should be applied in proportion to their effectiveness versus the duration of the symptoms and how bothersome the patient finds them, all of

"IT IS RECOMMENDED THAT THERMAL AND VIBRATION SENSITIVITY BE ROUTINELY TESTED"

“ADVICE SHOULD BE TAILORED TO MINIMISE SYMPTOM PROVOCATION, WHILE MAINTAINING PHYSICAL FUNCTION AND PROMOTING HEALTH”

which should be closely monitored and lead to adjustments as appropriate. A multi-modal approach, including pharmacological management, low intensity manual therapy techniques, non-provocative motor control exercise (DNFs), and directional exercise to reduce arm pain, is recommended. Inconsistent trial results led to a recommendation that manual or mechanical traction could be tried, but should be quickly discontinued if it leads to no improvement or even symptom provocation (Kjaer *et al* 2017). Massage and acupuncture can also be used for pain relief, if other treatments are ineffective or provocative (Kjaer *et al* 2017).

For recent onset CR, including grade III whiplash associated disorders (WAD), the OPTIMa collaboration recommends structured patient education, reassurance, and supervised graded strengthening exercise over a six-week period. It is the view of the OPTIMa authors that, owing to evidence of its ineffectiveness, clinicians should not use education alone, instead the use of a collar, low-level laser therapy or traction should also be considered (Cote *et al* 2016).

The revised APTA guidelines (Blanpied *et al* 2017) also recommend low-level laser therapy and possible short-term use of a cervical collar for patients with acute neck and radiating arm pain, as well as the option of clinicians providing mobilising and stabilising exercises.

Mechanical intermittent cervical traction, combined with other interventions such

as stretching and strengthening exercise, and cervical and thoracic mobilisation / manipulation, is reserved for chronic presentations. Clinicians are further recommended to monitor symptom irritability and, when applying manual therapy and exercise interventions for patients with radicular pain, to adjust treatment accordingly. Short-term use of a semi-rigid collar can be considered for those who don't respond to other treatments, but their use should be restricted to a limited time due to concerns of potential negative effects (Blanpied *et al* 2017). The Dutch trial upon which this recommendation is based, advised the use of a collar during the day for three weeks, with weaning taking place over the next six weeks. However, trial participants actually wore the collar on average for two thirds of the recommended time (Kuijper *et al* 2009a).

The NASS clinical guidelines recommend that conservative management strategies such as ozone injections, cervical halter traction, medication, physical therapy / exercise, or a combination of all these approaches, can be considered in the case of no natural improvement (Bono *et al* 2011).

It has been demonstrated in a review on cervicobrachial pain, defined as both somatic and radicular pain, and that included CR, that there is inconclusive evidence for the effectiveness of non-invasive management, and that there is a clear need for high-quality trials (Salt *et al* 2011; Gross *et al* 2015b; Fouyas 2010). Multi-modal physiotherapy has not yet been well researched for recent onset CR (Thoomes *et al* 2012), but it may prove clinically significant (Huriwitz *et al* 2008).

A recent Cochrane Review (Gross *et al* 2015a) on exercise for mechanical neck disorders (MND) including CR, concluded that there was a slight beneficial effect on pain when using static and dynamic cervical, scapulothoracic, and upper extremity stretching and strengthening immediately post treatment, but not at intermediate term follow-up, when there was little, or no difference in function. The clinician's challenge in recent onset CR is to determine how useful exercises are in providing symptom relief, and additionally in considering what they offer in long-term benefit as secondary prevention.

Little is yet known about CR recurrence rates with only one study demonstrating a recurrence likelihood of 12.5% (Honet & Puri 1976) and, as a result, trials have not yet focused on secondary prevention. Axioscapular muscle imbalance and scapular dyskinesis are known to exist in axial neck pain but patterns in CR, once overt neuromechanosensitivity has settled, remain unknown.

When deciding which manual technique to choose, the strongest evidence is found for lateral glide (Coppieters *et al* 2003; Nee *et al* 2012; Langevin *et al* 2015), but the clinician should discontinue its use as soon as it becomes clinically apparent that this technique is not producing a positive effect, as not all trials, albeit in a more heterogeneous group of patients with cervicobrachial pain, have demonstrated benefit (Salt *et al* 2016).

Neural tissue management, including education, lateral glide, and neural tissue

“THE STRONGEST EVIDENCE IS FOUND FOR THE LATERAL GLIDE TECHNIQUE, BUT SHOULD BE DISCONTINUED AS SOON AS IT IS APPARENT THAT IT IS NOT PRODUCING A POSITIVE EFFECT”

mobilisation exercise, has demonstrated a clinically meaningful reduction in neck and arm symptoms and disability (Nee *et al* 2012), but there is only a sub-group of CR patients for whom this approach is likely to be effective. In their trial, Nee *et al* (2012) included patients with over four weeks of symptoms, who showed a positive ULNT test and only one neurological sign, excluding those with two or more signs.

Clinical trials for conservative management in recent onset CR require appropriate control groups, such as Kuijpers *et al* (2009a), to fully establish natural history (Fouyas 2010) which is most often reported as favourable over variable time periods (Radhakrishnan *et al* 1994; Alentado *et al* 2014; Bono *et al* 2011). While Radhakrishnan *et al* (1994) found that 75% of patients spontaneously improved after five years, relatively little is known about the natural history of CR in the first 12 weeks. In one of the few trials of patients with less than one month of symptoms, a wait-and-see control group demonstrated reduction from VAS 7 to 5 at six weeks and full resolution at six months, albeit with low levels of residual neck pain (Kuijper *et al* 2009a). Patients presenting to private practitioners may do so because they may consider this relatively slow improvement unacceptable.

Physiotherapists in private practice, including those who are non-prescribers,

must be aware of pharmacological recommendations, particularly in the context of direct patient access and referral to our prescribing colleagues.

The NICE guidelines for the pharmacological management of neuropathic pain in non-specialist settings (NICE 2014) requires primary carers to consider the patient's global experience of pain, including its impact on sleep, and on daily physical and emotional functioning, and recommend a choice of Amitriptyline, Duloxetine, Gabapentin or Pregabalin as the first line for pain control. Where lack of effectiveness or intolerable side effects arise, progress to second or third line drugs should only be considered after all options in this first line group have been tried. Tramadol should only be considered as acute rescue therapy for short periods.

The Danish clinical guidelines recommend the preferential use of oral NSAIDs over Tramadol, based on a determination that the addiction risk outweighs its stronger, analgesic effect (Kjaer *et al* 2017). Anti-depressants and anti-convulsant medication was not included in this review.

Predictors of clinical outcome

Not surprisingly, given the small evidence base for conservative management of CR, little is known about predictors of good clinical

outcome. Cleland *et al* (2007) identified a four-variable model that detected participants who were most likely to demonstrate short-term, i.e. after one month, improvement with conservative treatment. This model included participants who were older than 54 years, whose dominant arm was not affected, whose symptoms were not aggravated by cervical flexion and who received multi-modal physiotherapy made up of manual therapy, cervical traction and deep neck flexor strengthening for at least half of their visits to the clinic. When all four variables were present, the positive likelihood ratio was 8.3 (95% CI = 1.9-63.9) (Cleland *et al* 2007).

Conclusion

It has yet to be comprehensively established whether patients who present in primary care with recent onset CR improve because of time, conservative treatment or a combination of both, but current clinical guidelines suggest that it is reasonable to adopt a non-provocative multi-modal approach, particularly in the absence of natural improvement. Clinical guidelines are mostly based on low-quality evidence and consensus opinion, and highlight the need for higher quality trials with adequate control groups and follow-up.

In response to this, the PACeR trial (registered at clinicaltrials.gov (NCT02449200)) is currently under way in Dublin, investigating the effectiveness of multimodal physiotherapy on recent onset CR in comparison to an advice control, with interventions such as upper limb neural unloading tape (figures 3 and 4), non-provocative manual therapy and mobilising, and axioscapular strengthening exercise on pain and disability in recent onset CR.

About the author

Louise Keating is a Lecturer at the School of Physiotherapy, Royal College of Surgeons in Ireland and a practising Clinical Specialist in musculoskeletal therapy in private practice in Dublin. A physiotherapist for 25 years, Louise has been involved in undergraduate



FIGURE 3: Upper limb neural unloading tape based on McConnell (2004)



FIGURE 4: Upper limb neural unloading tape based on McConnell (2004)

CONTACT DETAILS

lkeating@rcsi.ie
@LKeating_RCSI or @PACeR_Trial
+353 1 402 2259

and postgraduate musculoskeletal physiotherapy education in Ireland for more than 15 years, following attainment of her master's degree from the University of Queensland, and she is currently pursuing a PhD. Louise is also the principal investigator for the EuroSpine-funded PACeR trial – a randomised controlled trial of multimodal physiotherapy for patients with acute or sub-acute cervical radiculopathy (www.rcsi.ie/pacertrial).

References

- Alentado VH, Lubelski D, Steinmetz MP, Benzel EC, Mroz TE. Optimal duration of conservative management prior to surgery for cervical and lumbar radiculopathy: a literature review. *Global Spine* 2014;4:279-286
- Bennett MI, Smith BH, Torrance N, Potter J. The S-LANSS score for identifying pain of predominantly neuropathic origin: validation for use in clinical and postal research. *Pain* 2005;6:149-58
- Blanpied PR, Gross AR, Elliott JM, Devaney LL, Clewley D, Walton DM, Sparks C, Robertson EK. Neck pain. *Orthopaedic and Sports Physical Therapy* 2017;47:A1-A83
- Bono CM, Ghiselli G, Gilbert TJ, Kreiner DS, Reitman C, Summers JT, Baisden JL, Easa J, Fernand R, Lamer T, Matz PG, Mazanec DJ, Resnick DK, Shaffer WO, Sharma AK, Timmons RB, Toton JF. An evidence-based clinical guideline for the diagnosis and treatment of cervical radiculopathy from degenerative disorders. *Spine* 2011;11:64-72
- Chien A, Eliav E, Sterling M. Whiplash (Grade II) and cervical radiculopathy share a similar sensory presentation: an investigation using quantitative sensory testing. *Clinical Journal of Pain* 2008;24:7:595-603
- Cleland JA, Fritz JM, Whitman JM, Heath R. Predictors of short-term outcome in people with a clinical diagnosis of cervical radiculopathy. *Physical Therapy* 2007;87:1619-1632
- Coppieters MW, Staapaerts KH, Wouters LL, Janessens K. The immediate effects of a cervical lateral glide treatment technique in patients with neurogenic cervicobrachial pain. *Orthopaedic and Sports Physical Therapy* 2003;33:369-378
- Cote P, Wong J, Sutton D, Shearer H, Mior S, Randhawa K, Ameis A, Carroll L, Nordin M, Yu H, Lindsay G, Southerst D, Varatharajan S, Jacobs C, Stupar M, Taylor-Vaisey A, Van der Velde G, Gross D, Brison R, Paulden M, Ammendolia C, Cassidy D, Loisel P, Marshall S, Bohay R, Stapleton J, Lacerte M, Krahn M, Salhany R. Management of neck pain and associated disorders: a clinical practice guideline from the Ontario Protocol for Traffic Injury Management (OPTIMA) collaboration. *European Spine* 2016;25:22
- Fouyas I, Sandercock P, Statham P, Nikolaidis I. How beneficial is surgery for cervical radiculopathy and myelopathy? *British Medical Journal* 2010;341
- Freyenhagen R, Baron R, Gockel U, Tolle TR 2006. painDETECT: a new screening questionnaire to identify neuropathic components in patients with back pain. *Current Medical Research Opinion* 2006;22:1911-1920
- Gross A, Kay T, Paquin J, Blanchette S, Lalonde P, Christie T, Dupont G, Graham N, Burnie S, Gellay G, Goldsmith C, Forget M, Hoving J, Brønfort G, Santaguida P, Group CO 2015a. Exercises for mechanical neck disorders. *Cochrane Database of Systematic Reviews* 2015a
- Gross A, Langevin P, Burnie S, Bedard-Brochu M, Empey B, Dugas E, Faber-Dobrescu M, Andres C, Graham N, Goldsmith C, Brønfort G, Hoving JL, LeBlanc F. Manipulation and mobilisation for neck pain contrasted against an inactive control or another active treatment (Review). *Cochrane Database of Systematic Reviews* 2015b
- Gumina S, Carbone S, Albino P, Gurzi M, Postaccini F. Arm squeeze test: a new clinical test to distinguish neck from shoulder pain. *European Spine* 2013;22:1558-1563
- Haanpää ML, Backonja MM, Bennett MI, Bouhassira D, Crucco G, Hansson PT, Jensen TS, Kauppila T, Rice AS, Smith BH, Treede RD, Baron R. Assessment of neuropathic pain in primary care. *American Journal of Medicine* 2009; 122:S13-21
- Haldeman S, Carroll L, Cassidy J, Schubert J, Nygren A. The bone and joint decade 2000–2010 task force on neck pain and its associated disorders – executive summary. *Spine* 2008;33:S5-57
- Honet J, Puri K. Cervical radiculitis: treatment and results in 82 patients. *Archives of Physical Medicine and Rehabilitation* 1976;57:5
- Huriwicz EL, Carragee EJ, Velde G, Carroll LJ, Nordin M, Guzman J, Peloso PM, Holm LW, Cote P, Hogg-Johnson S, Cassidy JD, Haldeman S. Treatment of neck pain: non-invasive interventions. *European Spine Journal* 2008;17:123-152
- International Association for the Study of Pain (IASP). IASP Taxonomy PART I-C. Spinal Pain, Section 1: Spinal and Radicular Pain Syndromes (Online). 2011; https://www.iasp-pain.org/files/Content/ContentFolders/Publications2/ClassificationofChronicPain/PART_I-C.pdf (Accessed 21/09/2017)
- Jensen TS, Baron R, Haanpää M, Kalso E, Loesser JD, Rice ASC, Treede R-D. A new definition of neuropathic pain. *Pain* 2011;152:2204-2205
- Kim H, Nemani V, Piyaskulkaew C, Vargas S, Riew K. 2016. Cervical radiculopathy: incidence and treatment of 1,420 consecutive cases. *Asian Spine* 2016;10:6
- Kjaer P, Kongsted A, Hartvigsen J, Isenberg-Jorgensen A, Schiøtz-Christensen B, Soborg B, Krog C, Møller CM, Halling CMB, Lauridsen HH, Hansen IR, Norregaard J, Jorgensen KJ, Hansen LV, Jakobsen M, Jensen MB, Melbye M, Duel P, Christensen SW, Povlsen TM. National clinical guidelines for non-surgical treatment of patients with recent onset neck pain or cervical radiculopathy. *European Spine* 2017; Epub ahead of print
- Krause S, Backonja M. Development of a neuropathic pain questionnaire. *Clinical Journal of Pain* 2003;19:8
- Kuijper B, Tans JT, Beelen A, Nolle F, De Visser M. Cervical collar or physiotherapy versus wait and see policy for recent onset cervical radiculopathy: randomised trial. *British Medical Journal* 2009a;339:b3883
- Kuijper B, Tans JT, Schimsheimer RJ, Van der Kallen BF, Beelen A, Nolle F, De Visser M. Degenerative cervical radiculopathy: diagnosis and conservative treatment. A review. *European Neurology* 2009b;16:15-20
- Langevin P, Desmeules F, Lamothe M, Robitaille S, Roy JS. Comparison of 2 manual therapy and exercise protocols for cervical radiculopathy: a randomized clinical trial evaluating short-term effects. *Orthopaedic and Sports Physical Therapy* 2015;45:4-17
- Leveque JC, Marong-Ceesay B, Cooper T, Howe CR. Diagnosis and treatment of cervical radiculopathy and myelopathy. *Archives of Physical Medicine and Rehabilitation* 2015;26:491-511

- Mathieson S, Maher CG, Terwee CB, Folly de Campos T, Lin CW. Neuropathic pain screening questionnaires have limited measurement properties. A systematic review. *Clinical Epidemiology* 2015;68:957-966
- McConnell J. The use of taping for pain relief in the management of spinal pain. In: Boyling J, Jull G, Twomey L (eds.) *Grieve's Modern Manual Therapy* (3rd edn). Elsevier Churchill Livingstone 2004
- National Institute for Health and Care Excellence (NICE). The pharmacological management of neuropathic pain in adults in non-specialist settings. NICE Clinical Guidelines 2014;173:neuropathic pain – pharmacological management NHS England. *Trauma Programme of Care Pathfinder Project – Low Back Pain and Radicular Pain Report of the Clinical Group, National Pathway of Care for Low Back and Radicular Pain* [Online]. 2014; (Accessed 20/09/17)
- Nee RJ, Vicenzino B, Jull GA, Cleland JA, Coppieters MW. Neural tissue management provides immediate clinically relevant benefits without harmful effects for patients with nerve-related neck and arm pain: a randomised trial. *Physiotherapy* 2012;58:23-31
- Radhakrishnan K, Litchy WJ, O'Fallon WM, Kurland LT. Epidemiology of cervical radiculopathy. A population-based study from Rochester, Minnesota, 1976 through 1990. *Brain* 1994;117:325-335
- Rubinstein SM, Pool JJ, Van Tulder MW, Riphagen II, De Vet HC. A systematic review of the diagnostic accuracy of provocative tests of the neck for diagnosing cervical radiculopathy. *European Spine* 2007;16:307-319
- Salt E, Kelly S, Soundy A. Randomised controlled trial for the efficacy of cervical lateral glide mobilisation in the management of cervicobrachial pain. *Open Journal of Therapy and Rehabilitation* 2016;04:132-145
- Salt E, Kelly S, Wright C. A pilot study: effectiveness of a lateral glide cervical spine mobilisation on cervicobrachial (neck and arm) pain. 3rd International Conference on Movement Dysfunction 2009 Edinburgh. *Manual therapy* 2009;S42
- Salt E, Wright C, Kelly S, Dean A. A systematic literature review on the effectiveness of non-invasive therapy for cervicobrachial pain. *Manual Therapy* 2011;16:53-65
- Schmid AB, Nee RJ, Coppieters MW. Reappraising entrapment neuropathies – mechanisms, diagnosis and management. *Manual Therapy* 2013;18:449-457
- Thoomes EJ, Scholten-Peeters GG, De Boer AJ, Olsthoorn RA, Verkerk K, Lin C, Verhagen AP. Lack of uniform diagnostic criteria for cervical radiculopathy in conservative intervention studies: a systematic review. *European Spine* 2012;21:1459-1470
- Thoomes EJ, Van Geest S, Van der Windt DA, Falla D, Verhagen AP, Koes BW, Thoomes-de Graaf M, Kuijper B, Scholten-Peeters WG, Vleggeert-Lankamp CL. Value of physical tests in diagnosing cervical radiculopathy: a systematic review. *Spine* 2017; in press
- Wainner RS, Fritz JM, Irrgang JJ, Boninger ML, Delitto A, Allison S. Reliability and diagnostic accuracy of the clinical examination and patient self-report measures for cervical radiculopathy. *Spine* 2003;28:52-62 ❌