Chronic Pain Syndromes: Neck Pain

7

George Deng

Introduction

Neck pain is a common source of pain with an overall prevalence of up to 86.6% and a mean of 23.1% [1]. Neck pain was identified as the main cause in 20.4% of chronic pain patients [2]. There are several risk factors for neck pain including female gender, high-income countries, urban location, age, occupation, and previous musculoskeletal pain [1, 3].

The cervical spine is composed of seven vertebrae and eight cervical nerve roots. Each vertebra is connected to the adjacent level via the facet joints, uncinate process, and the intervertebral disc except for the atlantooccipital (C0–C1) articulations and the atlantoaxial (C1–C2) articulation.

Pain referral can pose another challenge in the assessment of neck pain. This phenomenon is attributed to the convergence theory of pain [4]. Neck pain not only refers pain distally but can also refer pain cranially causing cervicogenic headaches [5] via the cervicotrigeminal convergence [6].

Etiology

The differential diagnosis for neck pain can be either categorized from an anatomical perspective or from a disease perspective (Table 7.1). Anatomically, innervated structures include the bones, intervertebral discs, facet joint, ligaments, muscles, and nerves can be a source of pain.

G. Deng (✉)
Section of Physical Medicine and Rehabilitation, Department of Clinical Neuroscience, University of Calgary, Calgary, AB, Canada

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Table 7.1 Differential diagnosis for neck pain

Mechanical	• Osteoarthritis • Cervical strain and sprain • Adjacent level arthritis post-spinal fusion • Radiculopathy and radiculitis • Superficial cervical plexopathy
Inflammatory	• Seronegative spondyloarthropathy • Connective tissue disease • Rheumatoid arthritis (atlantoaxial) • Diffuse idiopathic skeletal hyperostosis • Longus colli tendinitis
Infectious	• Vertebral osteomyelitis • Diskitis • Cervical Pott's disease from tuberculosis • Granulomatous process • Epidural, intradural, and subdural abscesses • Retropharyngeal abscess
Tumors	• Benign osseus tumors • Malignant tumors • Metastasis • Intradural and extradural tumors
Congenital	• Down's syndrome • Ehrler's Danlos syndrome • Chiari malformation
Syndromes	• Myofascial pain syndrome • Fibromyalgia and widespread pain syndrome • Hypermobility syndrome

Clinical Evaluation

History

The evaluation for neck pain includes a thorough history and physical examination. The history should include details about the pain. Aggravating or alleviating features that are not activity related or positional should prompt the physician to consider nonmechanical sources of pain. Associated features such as headaches or dizziness are commonly reported and would necessities further characterization of these symptoms. Red flags should be elicited to rule out potentially devastating etiologies of pain which includes neurologic compromise, vertebrobasilar insufficiency, craniovertebral ligament instability, infections, and malignancy.

There is a bidirectional effect of pain with mood [7] and sleep [8]. Identification and treatment of these concurrent issues are important in helping a patient with pain. Additionally, many of the pain-modulating medications can also affect mood and sleep.

Certain medical conditions may be pertinent in the patient with neck pain. For example, cervical instability may be present in patients with Down's syndrome [9], Rheumatoid Arthritis [10], and among others [11–16] and patients with

hypermobility syndrome [17] or fibromyalgia may present with generalized pain include pain in the cervical region. There are several inherited conditions that may predispose a patient to neck pain. These include rheumatological [10, 12, 14], hypermobility [16–18], and cervical dystonia [15] to name a few. Lastly, a history of bleeding diathesis and anticoagulation use may limit neuroaxial interventional options [19].

One must be mindful of drug–drug interactions (see Pharmacology chapter). Although commonly used for pain management, cannabis is only recommended for use in specific pain conditions [20, 21]. Antidepressants and gabapentinoids used for pain modulation can also increase the risks of suicidality.

Previous neck surgeries may provide a clue to current neck pain. A history of cervical spinal surgery may lead to acceleration of adjacent level spondylosis and pain [22]. Additionally, previous anterior neck dissections may predispose a patient to superficial cervical plexus neuropathic pain [23].

Approaching chronic pain from the psychosocial perspective is important. Components of the social history include occupation, living situation, and ongoing litigation and worker's compensation. It is also important to elicit a history of alcohol, smoking, and illicit drug use. A functional history includes how the pain is affecting their activities of daily living, instrumental activities of daily living, vocational demands, and avocational pursuits. Treatment of pain can also lead to improvement of function which can be a more objective measure of improvement than a pain numeric rating scale.

Outcome Measures

Outcome measures can use to help the physician better characterize and communicate the patient's symptoms and severity in a more objective and validated manner. Common outcome measures include the brief pain inventory, Patient Reported Outcome Measurement Information System, Numeric Pain Rating Scale, Neck Disability Index, and the Neck Pain and Disability scale.

Physical Examination

The goal of the physical examination is to determine the main structural source of the pain, rule out neurologic deficits, and to help guide treatment. The components of a physical examination would include both musculoskeletal and neurologic maneuvers.

Musculoskeletal examination includes observation, range of motion, palpation, and special tests. The examination should include not only the cervical spine but also the joint above and below, which includes the temporomandibular joint and the shoulder joint.

Special testing of the neck includes cervical flexion rotation test (while patient is supine, the head is supported by the examiner and the cervical spine is rotated to end range with the cervical spine passively fully flexed) and Spurling's test (axial load

with neck in extension, rotation, and lateral flexion). Cervical flexion rotation test is considered positive for C1–C2 involvement with reduction of rotation range and pain provocation. Spurling's test is considered positive for cervical nerve root involvement with reproduction of radicular arm pain.

Neurologic examination includes the cranial nerve evaluation, Horner's syndrome, as well as assessing for tone, bulk, power, deep tendon reflexes, Hoffman's, plantar response, and sensation in the limbs.

Laboratory Studies

Laboratory studies ordered should be guided by the patient's history and physical examination. The goal of laboratory studies is to rule out systemic causes of pain. For example, a patient presenting with systemic features of malignancy or infection would benefit from a complete blood count with differential and C-reactive protein/erythrocyte sedimentation rate. Prolonged morning stiffness, polyarthralgias, and rashes may warrant a rheumatologic workup.

Imaging Studies

Although imaging studies are commonly ordered for the evaluation of neck pain, one must be mindful of its poor sensitivity and specificity. There is good evidence that the location and degree of degenerative changes seen on imaging does not always correlate with the patient's symptoms [24].

When traumatic fractures, osteoporotic fracture, infection, or malignancy is suspected, a plain radiograph can be a helpful initial modality. Additional flexion and extension view helpful in identifying ligamentous injuries or segmental instability.

CTs or MRIs can be helpful in further evaluation of the cervical spine to assess for alternative reasons for neck pain other than spondylosis. Additionally, bone scan can be helpful in identifying pathological fractures, and inflammatory sources of pain.

Common Disorders

Chronic Primary Cervical Pain

The International Association For the Study of Pain published the new ICD 11 classification in 2019 [25]. Previously, chronic primary cervical pain was known as nonspecific neck pain or mechanical neck pain. This new language in labeling attempts to be inclusive of the pain regardless of its complex biopsychosocial origins.

From a biomechanical approach, there are many structures in the neck that are innervated by nociceptive neurons and can be implicated in pain. Cervical facet mediated pain is the most implicated anatomical structure in neck pain with an estimated prevalence of 60% [26]. The most common levels implicated is the C2–3 level, followed by C5–C7 [27]. There are no pathognomonic features on history that can help the clinician differentiate facet joint pain from other sources of pain [28]. Clinically, there may be restrictions in range and pain provocation. Palpable tenderness over the suspected facet joint levels can be as diagnostically accurate as local anesthetic blocks [29]. Imaging studies can rule out other serious sources of pain.

Another structure that is implicated in primary cervical pain is the cervical disks. This structure typically refer pain to the posterior neck in the midline with pain radiation into a wider area [30]. Physical exam signs are similar to those of cervical facet-mediated pain. As most interventional pain procedures are targeted at the facet joint due to safety, local anesthetic blockade of the facet joint without any pain relief likely points to involvement of the disc. Similar to facet-mediated pain, imaging modalities are used to rule out more serious pathology rather than to rule in the disc as a pain generator as imaging changes can occur in asymptomatic population [24].

Management of primary neck pain must be approached systematically and involve the patient's own preferences to maximize success. Management options can be divided into conservative, pharmacologic, and interventional options.

Conservative options for chronic primary cervical pain are associated with limited side effects and risks. Allied health providers including physiotherapy, occupational therapy, and pain psychology can be enlisted to help. There is heterogeneity in the literature which limits the level of evidence for rehabilitation [31]. Activity modification, pacing, and ergonomic adjustments are basic first steps. Modalities and passive treatments include, thermotherapy or cryotherapy [32–36], various manual therapies [37–41], transcutaneous electrical nerve stimulation [42–45], therapeutic ultrasound [43, 46–48], and needle intramuscular stimulation [49–51] can be helpful for short-term pain management. However, current management paradigms prefer a focus on active based rehabilitation and self-management options [52–54]. This can include, but is not limited to, pain neuroscience education [55–58], various exercise therapies [31, 59–62], and mind-body exercises (e.g., yoga, tai-chi, and qi gong) [25, 31, 63–66]. There is also evidence for the use of psychological therapies in the management of chronic neck pain [67–74].

Pharmacologic options include simple analgesics such as acetaminophen or nonsteroidal anti-inflammatory drugs (NSAIDs). One must be careful about underlying health conditions that may preclude the use of these medications. Escalation to opioids is rarely needed and often contraindicated due to the potential for dependency and the social implications of such. Pain modulating medications, although not well studied, can also provide longer duration of relief. These pain modulating medications include serotonin norepinephrine reuptake inhibitor (SNRI's), tricyclic antidepressants (TCAs), or gabapentinoids. Additionally, cannabis products may provide relief in certain patients. This includes nabilone, Sativex, or other plant-based products. Lastly, topical compounded options may serve a middle ground for patients who want to decrease their pill burden. There is limited evidence of such, but some

patients do report relief. Many medications can be compounded into a topical formulation, including diclofenac, ketoprofen, cyclobenzaprine, gabapentin, lidocaine, and amitriptyline to name a few.

There has been a dramatic increase in interventional options in the management of pain [75]. Although, steroid injections are commonly used, the evidence supporting its use is limited [76, 77] and has risks [78, 79]. Radiofrequency ablation has the strongest interventional evidence in patients with neck predominant pain [80, 81]. This involves cauterization of the medial branch of the dorsal rami that innervates the facet joints. The main potential risk of this procedure is pain aggravation as well as, very rarely post radiofrequency neuritis [81, 82]. Lastly, there is interest in the use of platelet rich plasma therapy in the management of facet mediated pain in the lumbar spine [83–85] but evidence in the neck does not exist. This procedure involves centrifuging the patient's own platelets to concentrate the various growth factors and signaling proteins and injecting it into the putative painful facet joint. Lastly, one must be careful with maintaining a patient's expectation after interventional procedures as these procedures can potentially cause complications such as pain aggravation, failure for pain relief, hematoma formation, nerve injury, and theoretically stroke and death.

Neuromodulation is a growing field that involves either chemical or electrical modulation of the central or peripheral nervous system. One option is spinal cord stimulators which has evidence in neuropathic pain [86] and persistent postoperative spinal surgery axial or radicular pain [87, 88]. It does have a high initial cost to the healthcare system but economic studies do indicate that they are beneficial when accounting for the overall reduced healthcare utilization [89].

Lastly, there is some evidence that surgery can be used for recalcitrant axial cervical pain thought to be discogenic in origin [90–92]. If pursued, typically provocative discography is used to demonstrate that the targeted level is the main pain generator [91].

Cervical Radiculopathy

Cervical radiculopathy is a pathology of the cervical nerve roots. Symptoms are typically radicular in a dermatomal pattern and can be associated with a somatic referral pattern in the neck and in the periscapular regions. Patients may report neuropathic quality of pain associated with a myotomal distribution of weakness. Physical examination may identify the pattern of weakness following a myotome, but rarely sensory abnormalities are found due to the overlap of dermatomes. Deep tendon reflexes can be helpful if the nerve root pathology involves the C5, C6, or C7 nerve roots which are tested with biceps, brachioradialis, and triceps deep tendon reflexes. One must also rule out any upper motor neuron findings in both the upper and lower limbs which can be suggestive of spinal cord involvement. This includes spasticity, hyperreflexia, clonus, Hoffmann's, and plantar response. Spurling's maneuver and Bakody's hyperabduction signs are other physical examination maneuvers useful in identifying cervical radiculopathy. Bakody's hyperabduction sign is positive for cervical radiculitis if the radicular pain is improved with the ipsilateral hand placed over the patient's own head.

Cervical spine X-rays can identify potential areas of neural foraminal stenosis due to bony spondylosis. However, MRIs are better suited at defining the structures surrounding the nerve root and to rule out underlying cervical myelopathy. Electrodiagnostic evaluation with nerve conduction studies and electromyography can also localize nerve injuries to the root and help with clarifying prognosis.

The typical natural history of cervical radiculopathy is gradual resolution of symptoms with conservative care [93]. Education and reassurance are important part of the management. Activity modification and ergonomic adjustments can be helpful in avoiding re-aggravation of the nerve root. Modalities used in primary neck pain can also be used but evidence of such is lacking. Thermotherapy is often used to help with pain [94] but one study indicates that its use in cervical radiculopathy is associated with poorer outcomes [95]. A number of studies have shown that traction is helpful temporarily [95–103].

Additionally, neuropathic medications can be helpful in controlling some of the neuropathic radicular pain [20]. As mentioned in the previous section, the choice of medication should take into account a patient's expectations, medical history, and concomitant medications. Occasionally, the pain from radiculopathy can be so severe that opioids may be needed.

Surgery is indicated for patients with severe symptoms, neurologic deficits, progressive symptoms, or after failing conservative care. Decompression surgery has satisfactory results in up to 96% of patients [92, 104–106]. There is an estimated complication rate of around 10% with a less than 1% risk of clinical worsening [107–110].

Conclusion

Axial cervical pain is a very common complaint that all physicians may encounter in their clinical practice. The biomechanical source of axial cervical pain is broad with cervical facets and disks being most studied in the literature. One must also consider the patient as a whole and consider the biopsychosocial factors to best help the patient in achieving their goals and meeting their expectations.

References

1. Hoy DG, Protani M, De R, Buchbinder R. The epidemiology of neck pain. Best Pract Res Clin Rheumatol. Bailliere Tindall Ltd. 2010;24:783–92.
2. Schopflocher D, Taenzer P, Jovey R. The prevalence of chronic pain in Canada. Pain Res Manag. 2011;16(6):445–50.
3. Côté P, van der Velde G, Cassidy JD, Carroll LJ, Hogg-Johnson S, Holm LW, et al. The burden and determinants of neck pain in workers. Results of the bone and joint decade 2000-2010 task force on neck pain and its associated disorders. J Manip Physiol Ther. 2009;32(2 SUPPL)
4. Bogduk N. The anatomy and pathophysiology of neck pain. Vol. 14, physical medicine and rehabilitation clinics of North America. W.B. Saunders; 2003. p. 455–72.
5. Olesen J, Bes A, Kunkel R, Lance JW, Nappi G, Pfaffenrath V, et al. The international classification of headache disorders, 3rd edition (beta version). Cephalalgia. 2013;33(9):629–808.
6. Piovesan EJ, Kowacs PA, Oshinsky ML. Convergence of cervical and trigeminal sensory afferents. Curr Pain Headache Rep. Current Medicine Group LLC 1. 2003;7:377–83.

7. Lumley MA, Cohen JL, Borszcz GS, Cano A, Radcliffe AM, Porter LS, et al. Pain and emotion: a biopsychosocial review of recent research. J Clin Psychol. 2011;67:942–68. NIH Public Access
8. Finan PH, Goodin BR, Smith MT. The association of sleep and pain: an update and a path forward. J Pain. NIH Public Access. 2013;14:1539–52.
9. Tredwell SJ, Newman DE, Lockitch G. Instability of the upper cervical spine in down syndrome. J Pediatr Orthop. 1990;10(5):602–6.
10. Da Côrte FC, Neves N. Cervical spine instability in rheumatoid arthritis. Eur J Orthop Surg Traumatol. Springer-Verlag France. 2014;24
11. Isu T, Miyasaka K, Abe H, Ito T, Iwasaki Y, Tsuru M, et al. Atlantoaxial dislocation associated with neurofibromatosis: report of three cases. J Neurosurg. 1983;58(3):451–3.
12. Liu J, Zhu L, Jiang E, Zou S, Xu G. Ankylosing spondylitis manifested by extensive cervical erosions with spontaneous anterior atlantoaxial subluxation. World Neurosurg. 2019;122:583–9.
13. Shunmugam M, Poonnoose S. Spontaneous atlantoaxial subluxation associated with tonsillitis. Asian J Neurosurg. 2015;10(2):139.
14. Elgafy H, Liu X, Herron J. Spinal gout: a review with case illustration. World J Orthop. 2016;7:766–75. Baishideng Publishing Group Co
15. Charles PD, Adler CH, Stacy M, Comella C, Jankovic J, Manack Adams A, et al. Cervical dystonia and pain: characteristics and treatment patterns from CD PROBE (cervical dystonia patient registry for observation of OnabotulinumtoxinA efficacy). J Neurol. 2014;261(7):1309–19.
16. Levander B, Mellström A, Grepe A. Atlantoaxial instability in marfans syndrome. Diagnosis and treatment—a case report. Neuroradiology. 1981;21(1):43–6.
17. Tobias JH, Deere K, Palmer S, Clark EM, Clinch J. Joint hypermobility is a risk factor for musculoskeletal pain during adolescence: findings of a prospective cohort study. Arthritis Rheum. 2013;65(4):1107–15.
18. Castori M, Morlino S, Ghibellini G, Celletti C, Camerota F, Grammatico P. Connective tissue, Ehlers-Danlos syndrome(s), and head and cervical pain. Am J Med Genet Part C Semin Med Genet. 2015;169(1):84–96.
19. Narouze S, Benzon HT, Provenzano D, Buvanendran A, De Andres J, Deer T, et al. Interventional spine and pain procedures in patients on antiplatelet and anticoagulant medications (Second Edition): Guidelines from the American Society of Regional Anesthesia and Pain Medicine, the European Society of Regional Anaesthesia and Pain Therapy, the American Academy of Pain Medicine, the International Neuromodulation Society, the North American Neuromodulation Society, and the World Institute of Pain. Reg Anesthesia Pain Med. Lippincott Williams and Wilkins. 2018;43:225–62.
20. De Moulin D, Boulanger A, Clark AJ, Clarke H, Dao T, Finley GA, et al. Pharmacological management of chronic neuropathic pain: revised consensus statement from the Canadian Pain Society. Pain Res Manag. 2014;19(6):328–35.
21. Allan GM, Ramji J, Perry D, Ton J, Beahm NP, Crisp N, et al. Simplified guideline for prescribing medical cannabinoids in primary care. Can Fam Physician. 2018;64(2):111.
22. Alhashash M, Shousha M, Boehm H. Adjacent segment disease after cervical spine fusion. Spine (Phila Pa 1976). 2018;43(9):605–9.
23. Sist T, Miner M, Lema M. Characteristics of postradical neck pain syndrome: a report of 25 cases. J Pain Symptom Manag. 1999;18(2):95–102.
24. Kato F, Yukawa Y, Suda K, Yamagata M, Ueta T. Normal morphology, age-related changes and abnormal findings of the cervical spine. Part II: magnetic resonance imaging of over 1,200 asymptomatic subjects. Eur Spine J. 2012;21(8):1499–507.
25. Nicholas M, Vlaeyen JWS, Rief W, Barke A, Aziz Q, Benoliel R, et al. The IASP classification of chronic pain for ICD-11: chronic primary pain. Pain. 2019;160:28–37. Lippincott Williams and Wilkins
26. Manchikanti L, Singh V, Rivera J, Pampati V. ## M. prevalence of cervical facet joint pain in chronic neck pain. Pain Physician. 5(3):243–9.

27. Cooper G, Bailey B, Bogduk N. Cervical zygapophysial joint pain maps. Pain Med. 2007;8(4):344–53.
28. Bogduk N, Marsland A. The cervical zygapophysiai joints as a source of neck pain. Spine (Phila Pa 1976). 1988;13(6):610–7.
29. Jull G, Bogduk N, Marsland A. The accuracy of manual diagnosis for cervical zygapophysial joint pain syndromes. Med J Aust. 1988;148(5):233–6.
30. Slipman CW, Plastaras C, Patel R, Isaac Z, Chow D, Garvan C, et al. Provocative cervical discography symptom mapping. Spine J. 2005;5(4):381–8.
31. Gross A, Kay TM, Paquin JP, Blanchette S, Lalonde P, Christie T, et al. Exercises for mechanical neck disorders. Cochrane Database Syst Rev. 2015;2017. John Wiley and Sons Ltd
32. Garra G, Singer AJ, Leno R, Taira BR, Gupta N, Mathaikutty B, et al. Heat or cold packs for neck and back strain: a randomized controlled trial of efficacy. Acad Emerg Med. 2010;17(5):484–9.
33. Lizis P, Kobza W, Manko G, Jaszczur-Nowicki J, Perlinski J, Para B. Cryotherapy with mobilization versus cryotherapy with mobilization reinforced with home stretching exercises in treatment of chronic neck pain: a randomized trial. J Manip Physiol Ther. 2020;43(3):197–205.
34. Cramer H, Baumgarten C, Choi KE, Lauche R, Saha FJ, Musial F, et al. Thermotherapy self-treatment for neck pain relief-a randomized controlled trial. Eur J Integr Med. 2012;4(4):e371–8.
35. Petrofsky JS, Laymon M, Alshammari F, Khowailed IA, Lee H. Use of low level of continuous heat and ibuprofen as an adjunct to physical therapy improves pain relief, range of motion and the compliance for home exercise in patients with nonspecific neck pain: a randomized controlled trial. J Back Musculoskelet Rehabil. 2017;30(4):889–96.
36. Shin HJ, Kim SH, Hahm SC, Cho HY. Thermotherapy plus neck stabilization exercise for chronic nonspecific neck pain in elderly: a single-blinded randomized controlled trial. Int J Environ Res Public Health. 2020;17(15):1–12.
37. Kim JH, Lee HS, Park SW. Effects of the active release technique on pain and range of motion of patients with chronic neck pain. J Phys Ther Sci. 2015;27(8):2461–4.
38. Hidalgo B, Hall T, Bossert J, Dugeny A, Cagnie B, Pitance L. The efficacy of manual therapy and exercise for treating non-specific neck pain: a systematic review. J Back Musculoskelet Rehabil. 2017;30:1149–69. IOS Press
39. Costello M, Puentedura E, Louie J, Cleland J, Ciccone CD. The immediate effects of soft tissue mobilization versus therapeutic ultrasound for patients with neck and arm pain with evidence of neural mechanosensitivity: a randomized clinical trial. J Man Manip Ther. 2016;24(3):128–40.
40. Sasso RC, Smucker JD, Hacker RJ, Heller JG. Artificial disc versus fusion: a prospective, randomized study with 2-year follow-up on 99 patients. Spine (Phila Pa 1976). 2007;32(26):2933–40.
41. D'Sylva J, Miller J, Gross A, Burnie SJ, Goldsmith CH, Graham N, et al. Manual therapy with or without physical medicine modalities for neck pain: a systematic review. Man Ther. 2010;15:415–33.
42. Martimbianco ALC, Porfírio GJM, Pacheco RL, Torloni MR, Riera R. Transcutaneous electrical nerve stimulation (TENS) for chronic neck pain. Cochrane Database Syst Rev. 2019;2019. John Wiley and Sons Ltd
43. Sayilir S. The short-term effects of TENS plus therapeutic ultrasound combinations in chronic neck pain. Complement Ther Clin Pract. 2018;31:278–81.
44. Chiu TTW, Hui-Chan CWY, Cheing G. A randomized clinical trial of TENS and exercise for patients with chronic neck pain. Clin Rehabil. 2005;19(8):850–60.
45. Maayah M. Evaluation of transcutaneous electrical nerve stimulation as a treatment of neck pain due to musculoskeletal disorders. J Clin Med Res. 2010;2(3):127.
46. Noori SA, Rasheed A, Aiyer R, Jung B, Bansal N, Chang KV, et al. Therapeutic ultrasound for pain management in chronic low back pain and chronic neck pain: a systematic review. Pain Medicine (United States). 2020;21:1482–93. Oxford University Press

47. Matijević-Mikelić V, Crnković M, Matijević M, Leović D, Demarin V. The effectiveness of the therapeutic ultrasound on the psycho-physiological functioning in patients who presented with neck pain. Coll Antropol. 2012;36(3):921–8.
48. Qing W, Shi X, Zhang Q, Peng L, He C, Wei Q. Effect of therapeutic ultrasound for neck pain: a systematic review and meta-analysis. Arch Phys Med Rehabil. 2021;
49. Lee SH, Chen CC, Lee CS, Lin TC, Chan RC. Effects of needle electrical intramuscular stimulation on shoulder and cervical myofascial pain syndrome and microcirculation. J Chin Med Assoc. 2008;71(4):200–6.
50. Karakurum B, Karaalin O, Coskun Ö, Dora B, Üçler S, Inan L. The 'dry-needle technique': intramuscular stimulation in tension-type headache. Cephalalgia. 2001;21(8):813–7.
51. Navarro-Santana MJ, Sanchez-Infante J, Fernández-de-las-Peñas C, Cleland JA, Martín-Casas P, Plaza-Manzano G. Effectiveness of dry needling for myofascial trigger points associated with neck pain symptoms: an updated systematic review and meta-analysis. J Clin Med. 2020;9(10):3300.
52. Gustavsson C, von Koch L. A 9-year follow-up of a self-management group intervention for persistent neck pain in primary health care: a randomized controlled trial. J Pain Res. 2016;10:53–64.
53. Gustavsson C, Denison E, Von Koch L. Self-management of persistent neck pain: two-year follow-up of a randomized controlled trial of a multicomponent group intervention in primary health care. Spine (Phila Pa 1976). 2011;36(25):2105–15.
54. Escolar-Reina P, Medina-Mirapeix F, Gascón-Cánovas JJ, Montilla-Herrador J, Valera-Garrido JF, Collins SM. Self-Management of Chronic Neck and low Back Pain and relevance of information provided during clinical encounters: an observational study. Arch Phys Med Rehabil. 2009;90(10):1734–9.
55. Andias R, Neto M, Silva AG. The effects of pain neuroscience education and exercise on pain, muscle endurance, catastrophizing and anxiety in adolescents with chronic idiopathic neck pain: a school-based pilot, randomized and controlled study. Physiother Theory Pract. 2018;34(9):682–91.
56. Willaert W, Malfliet A, Coppieters I, Lenoir D, De Pauw R, Danneels L, et al. Does pain neuroscience education and cognition-targeted motor control training improve cervical motor output? Secondary analysis of a randomized clinical trial. Pain Pract. 2020;20(6):600–14.
57. Malfliet A, Kregel J, Coppieters I, De Pauw R, Meeus M, Roussel N, et al. Effect of pain neuroscience education combined with cognition-targeted motor control training on chronic spinal pain a randomized clinical trial. JAMA Neurol. 2018;75(7):808–17.
58. Brage K, Ris I, Falla D, Søgaard K, Juul-Kristensen B. Pain education combined with neck- and aerobic training is more effective at relieving chronic neck pain than pain education alone—a preliminary randomized controlled trial. Man Ther. 2015;20(5):686–93.
59. Fredin K, Lorås H. Manual therapy, exercise therapy or combined treatment in the management of adult neck pain—a systematic review and meta-analysis. Musculoskelet Sci Pract. Elsevier Ltd. 2017;31:62–71.
60. Louw S, Makwela S, Manas L, Meyer L, Terblanche D, Brink Y. Effectiveness of exercise in office workers with neck pain: a systematic review and meta-analysis. South African J Physiother. 2017;73:1.
61. Martin-Gomez C, Sestelo-Diaz R, Carrillo-Sanjuan V, Navarro-Santana MJ, Bardon-Romero J, Plaza-Manzano G. Motor control using cranio-cervical flexion exercises versus other treatments for non-specific chronic neck pain: a systematic review and meta-analysis. Musculoskelet Sci Pract. 2019;42:52–9.
62. Chen X, Coombes BK, Sjøgaard G, Jun D, O'Leary S, Johnston V. Workplace-based interventions for neck pain in office workers: systematic review and meta-analysis. Phys Ther. Oxford University Press. 2018;98:40–62.
63. Lauche R, Stumpe C, Fehr J, Cramer H, Cheng YW, Wayne PM, et al. The effects of tai chi and Neck exercises in the treatment of chronic nonspecific Neck pain: a randomized controlled trial. J Pain. 2016;17(9):1013–27.

64. Zhang F. Tai chi as a potentially effective treatment for neck pain. J Formos Med Assoc. Elsevier Ltd. 2014;113:199–200.
65. Li Y, Li S, Jiang J, Yuan S. Effects of yoga on patients with chronic nonspecific neck pain; a PRISMA systematic review and meta-analysis. Medicine (United States). Lippincott Williams and Wilkins. 2019;98
66. Kim SD. Effects of yoga on chronic neck pain: a systematic review of randomized controlled trials. J Phys Ther Sci. Society of Physical Therapy Science (Rigaku Ryoho Kagakugakkai). 2016;28:2171–4.
67. Guerrero AVS, Maujean A, Campbell L, Sterling M. A systematic review and meta-analysis of the effectiveness of psychological interventions delivered by physiotherapists on pain, disability and psychological outcomes in musculoskeletal pain conditions. Clin J Pain. Lippincott Williams and Wilkins. 2018;34:838–57.
68. Sterling M, Smeets R, Keijzers G, Warren J, Kenardy J. Physiotherapist-delivered stress inoculation training integrated with exercise versus physiotherapy exercise alone for acute whiplash-associated disorder (StressModex): a randomised controlled trial of a combined psychological/physical intervention. Br J Sports Med. 2019;53:19.
69. Monticone M, Cedraschi C, Ambrosini E, Rocca B, Fiorentini R, Restelli M, et al. Cognitive-behavioural treatment for subacute and chronic neck pain, Cochrane Database Syst Rev. John Wiley and Sons Ltd; 2015 2015.
70. Jeitler M, Brunnhuber S, Meier L, Lüdtke R, Büssing A, Kessler C, et al. Effectiveness of Jyoti meditation for patients with chronic neck pain and psychological distress—a randomized controlled clinical trial. J Pain. 2015;16(1):77–86.
71. Rosenzweig S, Greeson JM, Reibel DK, Green JS, Jasser SA, Beasley D. Mindfulness-based stress reduction for chronic pain conditions: variation in treatment outcomes and role of home meditation practice. J Psychosom Res. 2010;68(1):29–36.
72. Vowles KE, Fink BC, Cohen LL. Acceptance and commitment therapy for chronic pain: a diary study of treatment process in relation to reliable change in disability. J Context Behav Sci. 2014;3(2):74–80.
73. McCracken LM, Sato A, Taylor GJ. A trial of a brief group-based form of acceptance and commitment therapy (ACT) for chronic pain in general practice: pilot outcome and process results. J Pain. 2013;14(11):1398–406.
74. Probst T, Baumeister H, McCracken L, Lin J. Baseline psychological inflexibility moderates the outcome pain interference in a randomized controlled trial on internet-based acceptance and commitment therapy for chronic pain. J Clin Med. 2018;8(1):24.
75. Manchikanti L, Pampati V, Hirsch JA. Utilization of interventional techniques in managing chronic pain in Medicare population from 2000 to 2014: an analysis of patterns of utilization. Pain Physician. 2016;19(4):E531–46.
76. Barnsley L, Lord SM, Wallis BJ, Bogduk N. Lack of effect of intraarticular corticosteroids for chronic pain in the cervical zygapophyseal joints. N Engl J Med. 1994;330(15):1047–50.
77. Falco FJE, Manchikanti L, Datta S, Wargo BW, Geffert S, Bryce DA, et al. Systematic review of the therapeutic effectiveness of cervical facet joint interventions: an update. Pain Physician. 2012;15
78. Habib GS. Systemic effects of intra-articular corticosteroids. Clin Rheumatol. 2009;28:749–56.
79. Stout A, Friedly J, Standaert CJ. Systemic absorption and side effects of locally injected glucocorticoids, vol. 11. PM and R. John Wiley and Sons Inc.; 2019. p. 409–19.
80. Burnham T, Conger A, Salazar F, Petersen R, Kendall R, Cunningham S, et al. The effectiveness of cervical medial branch radiofrequency ablation for chronic facet joint syndrome in patients selected by a practical medial branch block paradigm. Pain Med (United States). 2020;21(10):2071–6.
81. Engel AJ, Rappard G, King W, Kennedy DJ. The effectiveness and risks of fluoroscopically-guided cervical medial branch thermal radiofrequency neurotomy: a systematic review with comprehensive analysis of the published data. Pain Med (United States). Oxford University Press. 2016;17:658–69.

82. Gazelka HM, Knievel S, Mauck WD, Moeschler SM, Pingree MJ, Rho RH, et al. Incidence of neuropathic pain after radiofrequency denervation of the third occipital nerve. J Pain Res. 2014;7:195.
83. Navani A, Manchikanti L, Albers SL, Latchaw RE, Sanapati J, Kaye AD, et al. Responsible, safe, and effective use of biologics in the Management of low Back Pain: American Society of Interventional Pain Physicians (ASIPP) guidelines. Pain Physician. 2019;22(1S):S1–74.
84. Wu J, Du Z, Lv Y, Zhang J, Xiong W, Wang R, et al. A new technique for the treatment of lumbar facet joint syndrome using intra-articular injection with autologous platelet rich plasma. Pain Physician. 2016;19(8):617–25.
85. Wu J, Zhou J, Liu C, Zhang J, Xiong W, Lv Y, et al. A prospective study comparing platelet-rich plasma and local Anesthetic (LA)/corticosteroid in intra-articular injection for the treatment of lumbar facet joint syndrome. Pain Pract. 2017;17(7):914–24.
86. Wolter T, Kieselbach K. Cervical spinal cord stimulation: an analysis of 23 patients with long-term follow-up. Pain Physician. 15(3):203–12.
87. Vallejo R, Kramer J, Benyamin R. Neuromodulation of the cervical spinal cord in the treatment of chronic intractable neck and upper extremity pain: a case series and review of the literature. Pain Physician. 2007;10(2):305–11.
88. Hunter CW, Carlson J, Yang A, Deer T. Spinal cord stimulation for the treatment of failed neck surgery syndrome: outcome of a prospective case series. Neuromodulation. 2018;21(5):495–503.
89. Deer TR, Skaribas IM, Haider N, Salmon J, Kim C, Nelson C, et al. Effectiveness of cervical spinal cord stimulation for the management of chronic pain. Neuromodulation. 2014;17(3):265–71.
90. Palit M, Schofferman J, Goldthwaite N, Reynolds J, Kerner M, Keaney D, et al. Anterior discectomy and fusion for the management of neck pain. Spine (Phila Pa 1976). 1999;24(21):2224–8.
91. Whitecloud TS, Seago RA. Cervical discogenic syndrome. Results of operative intervention in patients with positive discography. Spine (Phila Pa 1976). 1987;12(4):313–6.
92. Gore DR, Sepic SB. Anterior cervical fusion for degenerated or protruded discs-a review of one hundred forty-six patients. Spine (Phila Pa 1976). 1984;9(7):667–71.
93. Heckmann JG, Lang CJ, Zöbelein I, Laumer R, Druschky A, Neundörfer B. Herniated cervical intervertebral discs with radiculopathy: an outcome study of conservatively or surgically treated patients. J Spinal Disord. 1999;12(5):396–401.
94. Malanga GA, Yan N, Stark J. Mechanisms and efficacy of heat and cold therapies for musculoskeletal injury. Postgrad Med. Taylor and Francis Inc. 2015;127:57–65.
95. Jette DU, Jette AM. Physical therapy and health outcomes in patients with spinal impairments. Phys Ther. 1996;76(9):930–45.
96. Swezey RL, Swezey AM, Warner K. Efficacy of home cervical traction therapy. Am J Phys Med Rehabil. 1999;78(1):30–2.
97. Valtonen EJ, Kiuru E. Cervical traction as a therapeutic tool. A clinical analysis based on 212 patients. Scand J Rehabil Med. 1970;2(1):29–36.
98. Van der Heijden GJMG, Beurskens AJHM, Koes BW, Assendelft WJJ, De Vet HCW, Bouter LM. The efficacy of traction for back and neck pain: a systematic, blinded review of randomized clinical trial methods. Phys Ther. 1995;75(2):93–104.
99. Wong AMK, Lee MY, Chang WH, Tang FT. Clinical trial of a cervical traction modality with electromyographic biofeedback. Am J Phys Med Rehabil. 1997;76(1):19–25.
100. Romeo A, Vanti C, Boldrini V, Ruggeri M, Guccione AA, Pillastrini P, et al. Cervical radiculopathy: effectiveness of adding traction to physical therapy-a systematic review and meta-analysis of randomized controlled trials. Phys Ther. Oxford University Press. 2018;98:231–42.
101. Constantoyannis C, Konstantinou D, Kourtopoulos H, Papadakis N. Intermittent cervical traction for cervical radiculopathy caused by large-volume herniated disks. J Manip Physiol Ther. 2002;25(3):188–92.
102. Jellad A, Ben Salah Z, Boudokhane S, Migaou H, Bahri I, Rejeb N. The value of intermittent cervical traction in recent cervical radiculopathy. Ann Phys Rehabil Med. 2009;52(9):638–52.

103. Garg P. Home care neck traction for a patient with neck pain and cervical radiculopathy symptoms: a case report. J Chiropr Med. 2019;18(2):127–30.
104. Aldrich F. Posterolateral microdiscectomy for cervical monoradiculopathy caused by posterolateral soft cervical disc sequestration. J Neurosurg. 1990;72(3):370–7.
105. Herkowitz HN, Kurz LT, Overholt DP. Surgical management of cervical soft disc herniation: a comparison between the anterior and posterior approach. Spine (Phila Pa 1976). 1990;15(10):1026–30.
106. Klein GR, Vaccaro AR, Albert TJ. Health outcome assessment before and after anterior cervical discectomy and fusion for radiculopathy: a prospective analysis. Spine (Phila Pa 1976). 2000;25(7):801–3.
107. Tasiou A, Giannis T, Brotis AG, Siasios I, Georgiadis I, Gatos H, et al. Anterior cervical spine surgery-associated complications in a retrospective case-control study. J Spine Surg. 2017;3(3):444–59.
108. Cheung JPY, Luk KDK. Complications of anterior and posterior cervical spine surgery. Asian Spine J. 2016;10:385–400. Korean Society of Spine Surgery
109. Bernstein DN, Thirukumaran C, Saleh A, Molinari RW, Mesfin A. Complications and readmission after cervical spine surgery in elderly patients: an analysis of 1786 patients. World Neurosurg. 2017;103:859–68.e8
110. Yee TJ, Swong K, Park P. Complications of anterior cervical spine surgery: a systematic review of the literature. J Spine Surg. AME Publishing Company. 2020;6:302–22.