

Axial neck pain: a surgeon's perspective

Neck pain is a common and difficult patient complaint. In the majority of cases, conservative treatment, including the use of pain medication, anti-inflammatories, rest, physical therapy and select injections provide the best relief of chronic pain. By elucidating the primary pain generator clinicians may be guided towards the best treatment options. Surgical treatment of axial neck pain is controversial and reported outcomes are not encouraging, with the exception of a select group of patients. This article is intended to provide the general clinician with an understanding of neck pain from a surgeon's standpoint so that the treating physician can guide their patient's expectations in advance of a surgical consultation. We have performed an extensive review of the English language literature discussing axial neck pain with a special focus on surgical treatment options. In addition, we give our opinion regarding both the conservative and surgical treatment of these challenging patients based on our own experience.

KEYWORDS: axial neck pain • surgical management

Understanding and treating axial neck pain is both challenging and controversial. Axial neck pain is confined to the cervical, occipital or posterior scapular areas [1]. While axial neck pain typically does not radiate into the upper extremities, some patients may experience a component of referred pain to the proximal upper extremities. This should be distinguished from radicular pain, which typically extends distally down the upper extremity in a dermatomal distribution. Axial neck pain may also be associated with severe headaches with holocephalic radiation [1]. While most cases of neck pain resolve within 6 weeks with conservative treatment alone, population-based studies indicate that 10–34% of the general population have persistent chronic neck pain, with 50% complaining of occipital radiation [2–4].

In most patients, unless neck pain is accompanied by spinal instability, neurologic compromise, or severe deformity, surgical intervention has traditionally been avoided [5,6]. More recently, some authors report a benefit with surgery in a select cohort [7–9]. For the best outcome, clinicians should perform appropriate investigations to elucidate the pathophysiologic basis for pain, and base treatment decisions on this. An understanding of surgical indications and potential complications in these patients is also important. This article details the main causes of axial neck pain, including appropriate diagnostic work-up and potential interventions.

Prevalence & natural history

Neck pain is very common, with one population-based study reporting a 66% lifetime incidence [10]. A best evidence synthesis of the existing literature revealed a 30–50% annual prevalence of neck pain with a 1.7–11.5% annual prevalence of activity-limiting pain. Neck pain occurs more frequently in women, with a peak in middle age. Tobacco exposure and poor psychologic health also increase risk. Known disc degeneration is not a risk factor [11].

Although frustrating, axial neck pain is usually self-limited and will improve with time, conservative care and patience [5,6,12]. Unfortunately, in some cases, pain relief is incomplete and patients may suffer residual symptoms that are disabling. In patients completing 3 months of medical treatment, approximately 22–32% of patients had persistent pain [5,6,13]. Psychosocial factors are the strongest predictor associated with persistent neck pain [14].

Pathophysiology

The cervical spine is a biomechanically complex structure in which bone, disc, joint, muscle and ligament interact to provide head stability and motion. Thus, the clinician's greatest challenge is determining which components of the cervical spine constitutes the primary pain generator for a particular patient. Secondary pain generators may confound the issue. For instance, instability of the craniocervical junction may result in neck

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muscle pain and stiffness, as these muscles 'compensate' for the instability [15]. Unfortunately, there is a complete lack of Class 1 data that conclusively demonstrates the pathophysiologic basis of neck pain in any subset of patients; thus, much of what is discussed is theoretical or based on small patient series and anecdotal evidence.

■ Radiculopathy/myelopathy

Neurologic injury must be ruled out in any patient suffering from axial neck pain. As a natural part of aging, the majority of adults develop degenerative changes throughout their spine [16]. If this results in spinal canal narrowing and cord compression, patients may develop myelopathy. This is usually a painless process; however, in some cases patients describe Lhermitte's phenomenon, or an intermittent sharp shooting pain down the spine. Most patients describe painless, bilateral hand clumsiness and gait difficulty or fatigue [17]. However, this is slowly progressive and may lead to severe neurologic impairment, bowel and bladder incontinence, and paralysis. If detected, even in the early stages, surgical referral is appropriate as recent studies have demonstrated that early decompression may result in more favorable outcomes [18]. In our practice, we will typically approach this problem with either an anterior or posterior operation, with or without fusion, depending on the causative pathology and overall condition of the spine. It should be noted, however, that both an anterior and posterior operation is required in select patients. We inform patients with myelopathy that the goal of surgery is to stop further progression of myelopathic symptoms, rather than to eliminate them, so they have realistic expectations. In those patients who choose expectant treatment, serial neurologic examinations are appropriate to detect subtle progression.

Radicular symptoms are often accompanied by reactive axial neck pain. Compression of an exiting nerve root, often by a degenerative disc or osteophyte, results in pain, weakness and sensory disturbances in the distribution of the nerve. With increasing severity, patients describe dermatomal tingling, a sharp shooting pain radiating down the arm and myotomal weakness [19]. Often, patients complain of neck stiffness and aching due to associated muscle spasm; however, this should be considered secondary to the primary complaint of nerve root irritation. In most cases, radicular symptoms improve with conservative management, including nonsteroidal anti-inflammatories, rest, physical therapy and targeted injections [20]. If symptoms persist or are severe, surgical referral

is appropriate for the consideration of nerve root decompression. In our experience, if a disc protrusion or osteophyte is more centrally located and causing the radiculopathy, or if there is also evidence of cervical myelopathy, an anterior discectomy with fusion is typically performed. If a disc protrusion causing radiculopathy is located more laterally and there is no evidence of myelopathy, we often perform a posterior cervical foraminotomy and microdiscectomy without fusion. Patients will often have immediate improvement in pain control, with motor and sensory symptoms improving over time.

■ Cervical strain/soft tissue injury

The most common source of axial neck pain is regional soft tissue [1]. In patients with acute or subacute symptoms, this is likely a result of a cervical strain or 'whiplash'-type injury. This is the most common cause of axial cervical pain and is often frustratingly persistent. In many cases, symptoms occur following an acceleration-deceleration trauma. In the vast majority of cases, symptoms resolve within 6 weeks with conservative treatment alone [21]. Thus, early in the course of axial pain, it is reasonable to treat patients with rest, analgesics, muscle relaxants and physical therapy.

Unfortunately, chronic axial neck pain persists in 10–34% of patients [2–4]. It is unclear what the true basis of this pain is, but it may be related to sensitization of free mechanonociceptive nerve endings in the muscle [12]. In some cases, there is no antecedent trauma, but insidious axial pain. Unless a true soft tissue injury has occurred, such as a cervical strain, this is more likely to be a secondary pain generator caused by chronic soft tissue stress related to poor posture, unstable biomechanics or another chronic stressor.

There are rarely obvious pathognomonic features on radiographs that correlate with chronic cervical strain. Thus, the true pain generator is speculative and likely multifactorial; biomechanical, psychosocial and behavioral factors likely play a role [22–24]. Some feel that soft tissue damage, either at the time of injury or due to 'wear-and-tear', results in small hematomas, fibrosis, strictures and atrophy within the muscle tissue, ultimately leading to spasm and pain [1,25–30]. Others feel that the facet, injured at the time of an acceleration-deceleration injury, is the anatomic site of pain. Injury to the articular surface may prevent the joint from gliding smoothly [31], or facet capsular stretch may cause pain [32–35]. Finally, others feel that it is the disc

itself that is the pain generator [36]. This may be direct due to small tears of the annulus, or indirect as microinstability leads to altered biomechanics and pain via facet or muscle.

In our surgical practice, we typically do not offer surgical intervention in patients thought to have cervical strain or soft tissue injury as the primary cause of their neck pain. We recommend conservative treatment with analgesics, physical therapy and possibly consultation with a pain specialist.

■ Facet pain

Another cause of pain may be the zygapophyseal or posterior facet joints [37]. These are the diarthrodial synovial joints between the superior and inferior articular processes of adjacent vertebrae, which prevent excess anterior translation. In a series of normal volunteers, Dwyer *et al.* performed provocative facet injections and derived a segmental cutaneous map of pain patterns involving the head, neck, and shoulder [10,38]. In the upper cervical spine, there are no facet joints; however, similar, reproducible pain patterns can be seen by injection into the atlanto-occipital and atlantoaxial joints [8,9,39,40]. These particular pain patterns are reversible with anesthetic injections to the facet or the dorsal primary rami innervating the facet, suggesting this is a reproducible pain generator in the neck [32]. However, when performed for diagnostic purposes, these injections are associated with a very high false-positive rate, reported between 27 and 38% [41,42]. Thus, it is recommended that a control facet joint injection should be used in these patients when performed for diagnostic purposes [37]. A randomized controlled trial comparing 2-year outcomes of therapeutic cervical medial branch blocks with local anesthetic with or without steroids in patients with chronic neck pain of facet joint origin was recently published [43]. This study found that 85% of patients with anesthetic alone and 93% of patients with both anesthetic and steroids experienced significant pain relief at 2 years after an average of 5.7 treatments over that duration, thus demonstrating the overall effectiveness of this treatment.

Another reported treatment of facet joint pain is radiofrequency ablation of the medial branches of the dorsal rami innervating the facets. In a retrospective study performed by Mikeladze *et al.*, 68 of 118 patients had some temporary relief of pain with this technique, but 40 of the patients had no response to the treatment [44]. Thus, results of this intervention are less encouraging than facet joint injection results.

In our practice we do not offer surgery to patients thought to have neck pain of facet origin and instead refer them to pain specialists for conservative therapy and injection therapy when indicated.

■ Cervical degenerative disc disease

Cervical discs may also be a source of pain [37]. Unfortunately, diagnosing the cervical disc as a pain generator is complicated by the normal aging process. Age-related changes include dehydration of the nucleus pulposus, loss of disc height and decreased annular competence. Changes in endplate stresses can result in osteophyte formation, endplate sclerosis, uncovertebral and facet joint hypertrophy and loss of lordosis. This occurs most rapidly at levels under the highest biomechanical stress and those in previously injured. In most patients, these changes are asymptomatic; in the majority of cases, degenerative changes on cervical imaging are not the smoking gun in neck pain patients [45].

However, there is a subset of patients in whom degenerative discs are indeed a source of pain. Pure discogenic pain is unique; patients feel they can not get comfortable and frequently readjust their position and 'squirm' during office visits. Pathophysiologically, the pain may arise from annular incompetence. The annulus is innervated by a branch of the ventral nerve root, the sinuvertebral nerve, and the sympathetic plexus [46], which may be irritated by associated microinstability. This is an extremely difficult entity to accurately diagnose, and in our experience the success of surgery in even the most appropriate candidates is poor.

■ Peripheral nerve pain

Compression of peripheral nerves may cause pain. The occipital nerve is formed by the dorsal rami of C2, C3 and C4, and can cause occipital headache when irritated. Commonly, atlantoaxial instability causes compression of the C2 root within the foramen causing symptoms [47]. Patients with atlantoaxial degenerative osteoarthritis who complain of upper cervical and occipital pain secondary to involvement of the C2 nerve root can be successfully treated with C1–2 posterior arthrodesis [12]. In our practice, we tend to favor the C1–2 Harms technique or transarticular fixation for bony fusion.

A C4 radiculopathy is important to distinguish from true axial neck pain. Unlike most cervical radiculopathies in which pain radiates down the arm to some degree, the C4 dermatome

involves the proximal trapezius and posterior scapula, mimicking axial pain [48]. However, in most cases, radicular symptoms are unilateral as opposed to bilateral axial pain. Paresthesias and sensory examination should be performed, however there is no motor unit associated with this root. In this patient population, we offer surgical intervention given the presence of a radiographic abnormality supporting the diagnosis and failure of conservative management. As with more common radiculopathies, this can be addressed with either an anterior or posterior surgery based on the pathology and patient characteristics.

■ Tumor/trauma/infectious process

In some cases, axial neck pain may result from a more serious pathologic process. Often, antecedent histories of injury, systemic symptoms, or exposure are the 'red flags' that should prompt an expedited work-up. The clinician must rule out overt instability or active process that could result in spinal cord injury.

Tumors frequently metastasize to the vertebral body and can cause a number of symptoms that can be mistaken for axial neck pain [49]. It is theorized that tumor growth causing periosteal stretching can cause an unrelenting pain, varying from persistent aching to sharp, stabbing pains. Tumor infiltration can also result in vertebral body collapse with resulting mechanical pain due to resultant instability. This pain worsens with movement but may abate with rest. Often, neural element compression from tumor or pathologic fracture fragments results in an associated neurologic deficit. Immediate work-up and emergent surgical consultation is warranted in these cases.

Similar to tumor pathology, infectious problems can result in axial pain symptoms [50]. In most cases, the nidus of the infectious process is the disc space, although osteomyelitis and epidural collections occur. Again, destruction of bone and disc spaces are the pain generators of this process. Spinal instability, direct compression by the infectious process and indirect spinal cord compromise can result in neurologic deficit, so immediate surgical and infectious disease consultation is warranted [1].

■ Shoulder pathology/rotator-cuff disease

All patients with axial neck pain, especially unilateral or involving the shoulder or deltoid, should have a complete shoulder examination. Shoulder pain often results in severe, secondary axial neck pain or is confused for a C5 radiculopathy [51].

Thus rotator-cuff, acromial-clavicular and glenohumeral pathology should be considered. Tenderness to palpation, decreased range of motion, and specific impingement tests are warranted, along with imaging studies in appropriate patients. In our practice, we refer these patients to a physiatrist or orthopedic shoulder specialist to rule in or rule out a problem in this area, better clarify the clinical picture.

■ Vascular pathology

A rare but dangerous source of neck pain is arterial dissection. Sudden, severe pain may be related to carotid, vertebral and aortic dissection [52–54]. Often this is accompanied by changes in vital signs or neurologic examination and warrants emergent hospital-based work-up.

■ Rheumatologic process

Rheumatologic disorders are beyond the scope of this article; however, seronegative and seropositive spondyloarthropathies may result in axial neck pain. Appropriate work-up, especially in patients with multiple joint complaints, should be considered; however, these patients are often very challenging to treat surgically [55]. Poor bone quality and treatment with anti-inflammatory medications make healing difficult. Thus, unless there is overt spinal instability, neurologic compromise or gross deformity, we typically recommend nonoperative treatment.

■ Work-up & treatment

As noted above, the most ominous pathologies can be suspected based on history alone. However, the patient's description of pain onset and distribution, and exacerbating and relieving factors provides great insight into the primary pain generator. In many cases, however, the description will be nonspecific.

Currently, there is no 'gold standard' or validated sequence of studies to diagnose neck pain. Instead, most studies seek to simply confirm or rule out a specific pathology. Most studies have a high false-positive rate, with a large number of normal controls demonstrating abnormal findings [37,41]. Thus, the clinician must take care not to use tests simply to justify a treatment strategy. Due to this challenge, one editorial recently suggested that clinicians approach these tests as predictors of response to therapy, rather than tools for diagnosis. Thus, patients should be relieved of the expectation for 'diagnosis; treatment; cure,' but instead regard testing as a way to predict which therapeutic modality they will have the best response from [56].

Appropriate imaging studies seek to rule-out instability and neural element compromise. Provided the patient is able to move their head without issue, plain x-rays provide an excellent basic screen [57]. On lateral, anteroposterior and open-mouth views, general assessment can be made of spine alignment, degenerative changes and gross pathologic processes. Flexion-extension views can assess macroinstability and are the simplest dynamic study to perform [58]. MRI (or myelogram if required) is useful to assess neural element compromise, fluid in the facet joints and unusual signal in disc, ligament or bone complexes. Finally, reconstructed CT images may be necessary to examine bony structures in detail.

However, the presence and severity of persistent neck pain is not correlated with the degree of degenerative changes seen on x-ray [12,13,45]. Degenerative changes of aging are the rule, not the exception [12,45]. In one study of 200 asymptomatic patients, 95% of men and 70% of women had at least one degenerative change on plain radiographs [59] and another reported 70% of patients over 70 years of age had degenerative changes on plain radiographs [60–62]. Another study of 63 asymptomatic volunteers demonstrated that 19% had MRI abnormalities, and other studies have shown that MRI abnormalities are insufficient to demonstrate a characteristic discogenic pain marker [63,64]. Thus, many patients will have degenerative changes on their imaging studies, and it is erroneous to immediately attribute axial pain to these imaging aberrations.

In most cases, provided gross instability and neurologic compromise are ruled out, patients should attempt conservative treatment. We strongly advocate rest, with lifting restrictions, gentle stretching, anti-inflammatories and pain medications in the acute phase of axial neck pain. Treatment should focus on the gradual resumption of normal activities. If neck pain persists, patients should begin a program of physical therapy emphasizing neck strengthening [65]. In a meta-analysis of randomized controlled trials involving nonspecific neck pain, manipulation, multimodal interventions, exercise and manual therapy had a significant effect on pain, while acupuncture and manual therapy significantly decreased disability [66,67]. Physicians should be very cognizant of medication requirements, and begin transitioning to appropriate chronic pain medication regimens if appropriate. Pain consultation and the judicious use of pain injections may be considered.

The most important diagnostic tools for determining the etiology of axial neck pain often provide relief from symptoms. Using the patient's

history and imaging studies for guidance, the clinician may be able to narrow down the primary pain generators. This may allow them to attempt selective pain procedures, which not only provide confirmation of pain source, but pain relief as well. For instance, selective facet injections or nerve root blocks are often useful adjuncts to basic conservative treatment [37,43].

The one exception to this is suspected discogenic pain. In these cases, provocative testing, such as cervical discography can be useful in diagnosis, but is an uncomfortable test and should be reserved for the very rare patient that may be a surgical candidate. Discs with moderate to severe concordant pain levels should be considered positive, and adjacent control levels must be used [12]. Only discs that are positive should be considered potential surgical targets. As with facet joint injections, this test has been associated with a high false-positive rate that can reach greater than 40% [37]. It should be noted that there is a great deal of debate over the effectiveness of cervical discography. [37,61,62,68–75].

Surgical considerations

In patients who have failed conservative treatment, a surgical consultation may be requested. However, patients suffering from axial neck pain should be warned that very few will have surgically treatable pathologies, and fewer still will benefit from aggressive, invasive procedures. In patients who are deemed appropriate surgical candidates, the best results in our experience are achieved in those whose pain management regimen is well coordinated. Most will require short-acting narcotics briefly during the healing process, and preoperative opioid tolerances make postoperative pain control challenging. In addition, as most procedures will entail a bony fusion, nonsteroidal anti-inflammatory medication, steroid use, nicotine dependence and other impediments to bone healing should be strongly discouraged. Finally, it is important to note any psychosocial confounding factors.

As stated above, patients with instability or neurologic compromise warrant surgical consultation. Axial neck pain associated with radiculopathy, myelopathy or pathologic instability/impingement, may be surgical candidates. However, patients with cervical spondylosis and axial neck pain in the absence of other concurrent symptoms are generally not considered for surgery [12].

In patients with severe, unrelenting axial neck pain and degenerative spondylolisthesis that have

exhausted all conservative treatment options and who have examination, imaging and discogram results supporting a one- or two-level discogenic pain generator, surgery may be an option. In these cases, as the disc itself is suspected to be the pain generator, logic suggests removing the disc will be of benefit. There is some supportive evidence that this approach is effective. Studies of anterior cervical discectomy and fusion anterior discectomy with fusion for radiculopathy have resulted in relief of axial neck pain in a small subset of patients suffering from both [8,9,40]; however, it is unclear if this was a secondary pain generator. There is a group of frequently cited studies retrospectively reviewing a small series of patients who underwent cervical fusion for neck pain without radiculopathy. The majority focus on anterior discectomy with fusion [7,8,76,77], although one explored only posterior fixation without disc ablation [7]. All studies demonstrated a benefit, with 70–93% of patients having good-to-excellent pain relief. However, this encouraging data is somewhat misleading, as none of these studies have been deemed scientifically admissible under evidence-based guidelines. Only one study, a randomized clinical trial with adequate numbers and controls, has focused on a primary complaint of axial neck pain. This study has failed to demonstrate clinical effectiveness of surgical treatment [78]. Thus, current published guidelines from the Task Force on Neck Pain and Its Associated Disorders recommends avoiding surgery in patients with axial neck pain

alone, and no signs of neurologic compromise or major pathology [79].

Conclusion

Neck pain is common. Appropriate work-up to determine the primary pain generator will allow the clinician to provide appropriate treatment. Without evidence of neurologic compromise, major deformity, or spinal instability, surgical management is usually ill-advised.

Future perspective

It is likely that the aging population will be burdened with ever-increasing complaints of neck pain. Unfortunately, no ‘silver bullet’ is appearing on the surgical horizon to solve this problem. In addition, without robust evidence of benefit (which to this point has been lacking), many insurance carriers may refuse to cover surgical procedures done chiefly for neck pain without overt instability. Thus, we may see patients move even farther from surgery, which may be for the better.

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Executive summary

- Neck pain is common and the work-up should focus on locating a primary pain generator.
- The physician must rule out red flags (such as malignancy, tumor, infection, myelopathy, instability and vascular lesions).
- Common pain generators include cervical degenerative discs, muscle strain, cervical facets, rheumatologic disease, shoulder/rotator-cuff pathology, and C4 radiculopathy or peripheral nerve pathology.
- Treatment should focus on the primary pain generator.
- In most cases surgery can and should be avoided.

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