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# Research Paper Review

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## Dorsal Scapular Nerve Neuropathy: Clinical Overview

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## ABSTRACT

***INTRODUCTION:*** *The purpose of this paper is to elucidate this little known cause of upper back pain through a narrative review of the literature and to discuss the possible role of the dorsal scapular nerve (DSN) in the etiopathology of other similar diagnoses in this area including cervicogenic dorsalgia (CD), notalgia paresthetica (NP), SICK scapula and a posterolateral arm pain pattern. Dorsal scapular nerve (DSN) neuropathy has been a rarely thought of differential diagnosis for mid scapular, upper to mid back and costovertebral pain. These are common conditions presenting to chiropractic, physiotherapy, massage therapy and medical offices.*

***METHODS****: The methods used to gather articles for this paper included: searching electronic databases; and hand searching relevant references from journal articles and textbook chapters.*

***RESULTS****: One hundred-fourteen articles were retrieved. After removing duplicates, there were 57 articles of which 29 were retrieved. There were 26 articles and textbook chapters retrieved by hand searching equaling 55 articles retrieved of which 47 relevant articles were used in this report.*

***DISCUSSION****: The anatomy, pathway and function of the dorsal scapular nerve can be varied and exceptionally rarely may include a sensory component. The signs and symptoms, therefore, may include pain, atrophy, scapular winging, and dysesthesia. The mechanism of injury to the DSN is also quite varied ranging from postural to overuse in overhead work and sport. Other conditions in this area, including CD, NP, SICK scapula and a posterolateral arm pain pattern bear a striking resemblance to DSN neuropathy.*

***CONCLUSION****: DSN neuropathy should be included in the list of common differential diagnoses of upper and mid-thoracic pain, stiffness, dysesthesia and dysfunction. The study also brings forward interesting connections between DSN neuropathy, CD, NP, SICK scapula and a posterolateral arm pain pattern.*

# ANALYSIS

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## Background Information

In the past, dorsal scapular nerve (DSN) neuropathy has rarely been considered as a differential diagnosis for mid scapular or upper to mid back pain (1). However, a number of studies have shown evidence that individuals with these types of pain patterns who do not respond to normal care may be suffering from DSN neuropathy, making this a differential diagnosis that should be included in these types of cases.

DSN neuropathy shares many signs and symptoms with other diagnoses, including cervicogenic dorsalgia (CD), notalgia paresthetica (NP), SICK scapula, and a general posterolateral arm pain pattern. From an anatomical standpoint, the DSN provides a direct link from the mid to lower cervical spine to the mid-scapular area (7).

This paper provides a narrative review of the anatomy and function of the DSN, an exploration of the epidemiology, sign and symptoms, and possible mechanisms of DSN injury, and a look at the possible role of DSN neuropathy in other diagnoses in the area.

# SUMMARY

## Dorsal Scapular Nerve (DSN) Overview:

*Anatomy:*

Typically, the DSN is reported to arise from the anterior ramus of the C5 nerve root, or as the first branch of the superior trunk of the brachial plexus (7). However, a study by Ballesteros and Ramirez (7) only found this presentation in 17.9% of cadavers. In 30.4% of cadavers, it arose from the usual position, but also shared a common branching trunk with the long thoracic nerve, in 28.4% it arose from the C4 nerve root and in 23.1% it arose from C4 and C5 nerve roots. Tubbs et al. (8) looked at 10 cadavers (20 sides) and found that the DSN arose from the C5 and C6 spinal nerves in 19 cases, while Lee et al. (17) found a DSN origin from the fifth cervical anterior ramus in 75.8% of cases. In 9% of cases, it arose from the superior trunk of the plexus, in 7.6% of cases it was from the fourth and fifth cervical anterior rami, and in another 7.6% of cases, from the sixth cervical anterior rami. Finally, Nguyen et al. (18) found a C5 origin in 70% of 23 cadavers, 22% from C4, and 8% from C6. As you can see, human anatomy, in this case for the DSN, is variable!

*Pathway:*

Chen et al. (15) described the DSN as passing immediately obliquely and inferiorly through the middle scalene without innervating the muscle. This means the middle scalene a possible entrapment site for the DSN, thus, its function may be affected by abnormal tension arising from this area of the cervical spine. Next, the DSN runs inferiorly and slightly laterally between the superior fibres of the upper trapezius (medially) and the levator scapulae (laterally) before passing deep to the upper trapezius fibres as they curve laterally toward the acromion, lying anterior to the rhomboid major and minor, but posterior to the serratus posterior superior muscles (SPS). The main trunk of the DSN lies medial to the medial border of the scapula and travels inferiorly to the inferior medial border of the scapula, typically around the level of the T7 spinous process (20).

Tubbs et al. (8) showed the DSN intertwined with the dorsal scapular artery along the anterior border of the rhomboid major and minor muscles in all 20 sides (in ten cadavers). Lee et al. (17) showed that the DSN pierced both the middle and posterior scalenes in 6.4% of cases, while Martin and Fish (21) showed the DSN piercing the levator scapulae in 9 of 35 dissected specimens. This suggests the levator scapulae as another possible site of compression or irritation. Finally, Nguyen et al. (18) showed the DSN piercing the middle scalene in 74% of cases, while it passes anterior and posterior to the middle scalene, each in 13% of cases.

*Function:*

The main function of the DSN is the innervation of the rhomboid major and minor, which retract, elevate, and stabilize the scapula and rotate the lateral border of the scapula downward (21). It also innervates the levator scapulae (LS) muscle, along with C3 and C4 via the cervical plexus (22). The LS elevates the scapula, rotates the glenoid cavity inferiorly by rotating the scapula, and retracts the scapula (20). It also functions as an accessory breathing muscle in dysfunctional breathing (23).

Nguyen et al. (18) found that while the DSN followed that pattern of innervation in 52% of cases, in 48% of cases it innervated the LS only. However, no mention was made of what innervated the rhomboids in these cases. Malessy et al. (19) reported that the cranial aspect of LS was innervated by a branch of C3, while the caudal aspect was innervated by C4, which then combined with a C5 branch to innervate the rhomboids.

A cadaveric case report by Kida and Tani (24) found a branch of the DSN innervating the serratus posterior superior (SPS) - the SPS is normally innervated by the intercostal nerves from T1 to T4 or T5 (25). While the SPS is generally described as having a respiratory function, Vilensky et al. (25) suggest that it may not be active during respiration and may actually serve a proprioceptive function for the thoracic spine, possibly during respiration.

*Epidemiology:*

Generally speaking, less is known about thoracic spine pain compared to neck or low back pain. The annual prevalence of thoracic spine pain ranges from 15-34.8% in Swedish adults (2) and the lifetime prevalence ranges from 15.6-19.5% in adolescents (3). In adolescents, associated factors include female gender, postural changes associated with backpack use, backpack weight, participation in specific sports, chair height at school, and difficulty with homework (3). In adults, associated factors include concurrent musculoskeletal symptoms, difficulty performing activities of daily living, and, in individuals injured in motor vehicle accidents, neck pain (4).

Sultan et al. (1) studied 55 patients with unilateral interscapular pain and diagnoses varying from no diagnosis to thoracic degenerative discogenic pain, costovertebral joint dysfunction, levator scapulae syndrome, thoracic facet syndrome, dorsal back strain, myofascial pain of the rhomboids, and finally, DSN entrapment. Of these, 29 patients (52.7%) showed evidence of DSN neuropathy, with another 5 at the upper cut-off limit.

*Signs & Symptoms of DSN Neuropathy:*

DSN neuropathy presents on a spectrum from complete function with minimal clinical consequences to complete atrophy of the muscles it innervates. This includes varying levels of pain intensity and character along a portion of, or the entire pathway of the nerve, and tightness and weakness in the muscles it innervates (1). Symptoms can also include dysesthesia and pruritis (itchy skin) in the midscapular region (1), radiating pain along the posterolateral aspect of the shoulder, arm, and forearm (15), loss of pinprick sensation medial to the scapular border (1), and varying levels of loss of range of motion of the cervical spine, most commonly in ipsilateral rotation and contralateral lateral flexion (16). It has also been reported to be involved in neck, axilla, and lateral thoracic wall pain (15).

DSN pain has been reported to be aggravated by cervical flexion, ipsilateral lateral flexion (1), and extension (14), and palpation of the thoracic spinous (15), thoracic facet and costotransverse joints (1). Relative hypertrophy and spasm has been reported in the neck musculature (26) and due to possible muscle weakness, varying levels of scapular winging may be seen.

*Etiology:*

The main etiology for DSN entrapment is commonly reported as hypertrophy of the middle scalene, compressing the nerve as it passes through (15), however, a variety of different mechanisms have been reported in the literature. These include:

- Repetitive lifting
- Thoracic disc surgery

- Compression from a corrective brace for scoliosis
- Repetitive overhead activity
- Poor posture
- Traction injury to the nerve secondary to a whiplash event

In summary, the DSN may be injured by repetitive overhead activity, during work and sport/recreation that may involve heavy loads, chronic postural strain, iatrogenic causes (post-surgical or post-bracing), or following a crash involving a motor vehicle.

## Possible Role of DSN Neuropathy in Other Conditions

*Cervicogenic Dorsalgia (CD):*

Maigne has suggested that 70% of common dorsal (thoracic) pain originates from the lower cervical spine (6). Engel and Gatterman (6) suggest that the cervical spine irritation that creates the thoracic spine pain may be caused by a variety of structures, including the disc and the facet, thus the diagnosis should include these as the primary diagnosis, with the thoracic pain mentioned as an associated symptom. CD pain has been described as well localized or diffuse, a cramping sensation, the sensation of a weight, a burning or painful tension, a feeling of fatigue, and/or a deep-seated intrathoracic pain. It has also been suggested that cervical ROM can range from normal to markedly decreased in certain directions and that the interscapular pain can be recreated by ipsilateral cervical spine rotation and further increased by cervical extension from the rotated position. Pain usually decreases with rest, but can be aggravated during sleeping, especially if the patient's preferred position is prone with rotation to the affected side (5). A consistent point of pain is commonly found just lateral to the spinous processes between T5 and T6.

Radiographs are commonly negative in both CD and DSN neuropathy and both are often misdiagnosed as a subluxated rib or a trigger point (6), thoracic posterior facet syndrome, thoracic subluxation, T4 syndrome, discogenic disease, costovertebral lesion, intercostal muscle spasm, or interscapular or scapular muscle spasm (1).

Treatment of CD focuses on the cervical spine (5), commonly using manipulation, exercise, and soft tissue therapy to the thoracic and cervical regions. This often leads to temporary relief only, which should suggest to the practitioner that the intrathoracic pain has a different primary cause (27). Due to the similarities in the presentation of DSN neuropathy and CD, further investigation should be carried out to see if they are actually the same condition.

*Notalgia Paresthetica (NP):*

NP is characterized by unilateral pruritis in an area medial to the scapula and lateral to the thoracic spine (9), often accompanied by pain, numbness or tingling, paresthesia or hyperesthesia, and local hyperpigmentation thought to be a result of chronic scratching

(11). The condition is believed to be neurogenic in origin as drugs used to help treat nerve pain are effective in the short term (11). Most often, NP is attributed to entrapment of the T2-T6 posterior rami supplying cutaneous innervation to the area, but the true etiology remains unknown (12). Other suggested causes include spasms of the paraspinal muscles, particularly the multifidus, rhomboids, and trapezius, or impingement as a result of degenerative changes in the thoracic spine and/or herniated thoracic discs (28). Other treatments aimed at these proposed causes, such as exercise, acupuncture, osteopathic treatments, ultrasound, and radiation physiotherapy, have had some success.

Both NP and DSN neuropathy show similar pain patterns and are predominantly chronic conditions found in middle to older aged women. However, one area of comparison between the two requires further study. The T6 dermatome falls below the level of the inferior border of the scapula (29) and the rhomboid attachment onto the scapula. This suggests that a DSN neuropathy alone would not affect this area, although a combination of a DSN neuropathy and thoracic cutaneous nerve neuropathy could be the cause of this pattern.

*SICK Scapula:*

SICK scapula (Scapular malposition, Inferior medial border prominence, Coracoid pain and malposition, and dysKinesis of scapular movement) is a complex of scapular issues that commonly affect overhead athletes. Some components of SICK scapula are strikingly similar to findings of DSN neuropathy. Signs and symptoms may include anterior shoulder pain, posterosuperior scapular pain, superior shoulder pain, proximal lateral arm pain, or any combination of the above. In addition, posterosuperior scapular pain can radiate into the ipsilateral paraspinous cervical region, the patients may complain of radicular/thoracic outlet type symptoms and winging of the medial border of the affected scapula may be seen at rest, becoming more prominent with the cocking and elevation phase of pitching. It is suggested that this is associated with upper and lower trapezius and rhomboid muscle weakness (13).

In SICK scapula patients with scapular winging, interscapular pain and radiation along the posterolateral arm and forearm, DSN neuropathy should be considered due to its association with overuse injuries in overhead athletes (1).

*Posterolateral Arm Pain - C5 Peripheral Nerve Neuropathy:*

Posterior shoulder/posterolateral arm pain is often reported to be associated with DSN neuropathy, scapular dysfunction, and shoulder injuries (1). This can be accompanied by pain to the forearm and posterior hand (16) and the axilla and lateral thoracic wall (15). There is debate in the literature about the existence of active and latent trigger points and their ability to refer pain, versus the pain being of peripheral nerve origin (30). If looked at from a peripheral nerve standpoint, the above-mentioned pain pattern would be consistent with involvement of the DSN, long thoracic, suprascapular, and radial nerves, and possibly

the axillary and musculocutaneous nerves. All of these share a common connection to the C5 nerve root, suggesting a C5 peripheral nerve neuropathy. When considered from the perspective of trigger points, rhomboid trigger points (innervated by the DSN) refer locally and over the scapula; the LS (innervated by the DSN) refers to the rhomboid, scapula, and posterior shoulder area; the serratus anterior (innervated by the long thoracic nerve) refers to the rhomboid area, and the medial arm, forearm, and hand in the ulnar nerve distribution; the scalenes (innervated segmentally), supra- and infraspinatus (innervated by the suprascapular nerve), and the triceps brachii (innervated by the radial nerve) refer pain along the upper back, across the scapula, down the posterolateral arm to the hand; the posterior deltoid (innervated by the axillary nerve) refers locally and into the posterior upper arm; the coracobrachialis (innervated by the musculocutaneous nerve) refers to the posterolateral arm and forearm; and the bicep brachii and brachialis (innervated by the musculocutaneous nerve) refer locally and into the cubital fossa (31).

Neither theory completely explains the posterior pain pattern seen in DSN neuropathy. Thus, further study is needed to determine the cause.

## Etiopathology of Dorsal Scapular Nerve Neuropathy

Sultan et al. (1) suggest three possible mechanisms for the cause of pain in DSN neuropathy. These include:

1. entrapment or stretch of the nerve, inducing neuropathic trunk pain involving the nervi nervorum;
2. the presence of myofascial pain syndrome with DSN entrapment in the taut bands of the rhomboids which contain the trigger points; and
3. stretching of the cutaneous nerves from the posterior primary rami to the area due to scapular winging.

The first mechanism is plausible, as stretching of the nerve could cause activation of the nociceptive nervi nervorum that innervate that nerve (31). Mackinnon described a process where there is an interruption in the blood-nerve barrier, allowing a leakage of fluid from the microvessels supplying the nerve. This allows for an accumulation of inflammation-related mediators causing edema and eventually scar formation (32). This can cause a cycle of inflammation leading to a "mini-compartment" syndrome within the nerve. If there is repeated or continued trauma, this can lead to neural desensitization leading to more inflammation with even less trauma. Ellis (33) suggested that highly-innervated and inflammatory fibrous bands and persistent adhesions can form, adhering the nerve to adjacent structures and further limiting the movement of the nerve. These individual tension sites can add to the inflammation and make it important to evaluate the entire route of the nerve prior to treatment. The inflammation can also spread both within the nerve and outside of the nerve causing activation of the CNS (33) which can cause inflammation of adjacent/connected nerves, leading to mirror symptoms in the opposite limb.

While there is some debate about trigger points, most manual therapists accept that taut, palpable, painful bands can be found in muscles. It is possible that these could be initiated by DSN neuropathy and that these taut bands could cause entrapment of the thoracic medial cutaneous nerves from the thoracic posterior primary rami supplying this area as they pass through the rhomboid and trapezius (10).

DSN neuropathy can also cause scapular winging, leading to traction or compression of cutaneous branches. This could lead to continued inflammation and nervi nervorum irritation, causing both pain and sensory changes in the area.

Inflammation can spread into adjacent nerves, which can help to explain the pattern of posterolateral arm pain. The spread of inflammation can also make other nerves susceptible to fibrosis and persistent adhesions (32). Like other neuropathies, DSN neuropathy exists on a spectrum including various levels of pain intensity, dysesthesia, tingling, atrophy, and levels of spread to other adjacent nerves.

## CLINICAL APPLICATION & CONCLUSIONS

DSN neuropathy could be associated with, or actually be the condition known as cervicogenic dorsalgia. It may also have a role to play in notalgia paresthetica, SICK scapula, and a common pain pattern reported along the posterolateral arm and forearm associated with cases of neck, upper back, and shoulder pain. This particular role is deserving of further study. It is recommended that DSN neuropathy be considered as a potential cause of, or contributor to, upper to mid thoracic pain.

## STUDY METHODS

This was a narrative literature review. The author searched several electronic databases and then hand searched relevant references from journal articles and textbooks. The majority of the articles and textbook chapters were found through hand searching.

## STUDY STRENGTHS/WEAKNESSES

Strengths:

- The author of this study performed an extensive literature search and effectively communicated what is known about DSN neuropathy.

Weaknesses:

- As a rare condition, there is not a large body of evidence to review on this structure and its related clinical syndromes.

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