Clinical Presentation, Quantitative Sensory Testing, and Therapy of 2 Patients With Fourth Thoracic Syndrome

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Abstract

Objective: The aim of the study was to describe 2 representative cases of patients presenting to an osteopathic pain practice with signs and symptoms consistent with the fourth thoracic (T4) syndrome. In addition, this article reports the application of quantitative thermosensory testing and dynamometer strength testing to confirm associated sensory and motor strength changes. Nonmanipulative therapeutic interventions are reported for the first time.

Clinical Features: Two patients experienced paresthesias in all digits of the hands, glove-like numbness of the hands and forearm, weakness (unable to open jars), hand clumsiness, upper extremity coldness, fullness or tightness, deep aching pain, and other signs and symptoms consistent with T4 syndrome. The patients were evaluated using quantitative thermosensory testing and handgrip dynamometry before and after treatment.

Intervention and Outcome: Relief of bilateral arm pain, numbness, and paresthesias occurred after intramuscular injections of 1 to 2 mL of 0.5% bupivacaine at the fourth thoracic paraspinal level. Additional therapy for associated signs and symptoms was provided using an anticonvulsant (gabapentin).

Conclusion: The clinical presentation of the patients reported in this article provides a description and additional information regarding T4 syndrome. (J Manipulative Physiol Ther 2006;29:403-408)

Key Indexing Terms: *Paresthesia; Thoracic Vertebrae; Manipulation, Spinal; Pain Measurement; Gabapentin*

The fourth thoracic (T4) syndrome was first described in chiropractic literature in the late 1950s, but it has only rarely been discussed in the allopathic literature.[1] In this report, we further define the T4 syndrome, describe potential diagnostic tools, and introduce nonmanipulative therapeutic options for this rare condition.

Patients presenting with T4 syndrome experience paresthesias in all digits of the hands, glove-like numbness of the hands and forearm, weakness (unable to open jars), hand clumsiness, upper extremity coldness, a sense of fullness, tightness, and deep aching pain. Other reported symptoms include back pain and stiffness and frequent headaches. Although other chronic pain conditions report sensory dysfunction and pain facilitation, this compilation of observed signs and symptoms seems best identified as a specific syndrome, the T4 syndrome.[2-6]

The 2 patients described in this article are representative of more than 30 patients who presented to a large private pain practice for evaluation of signs and symptoms consistent with T4 syndrome.[7-10]

Methods

Selection of representative patients for this article was accomplished after a review of medical records from a private pain practice. The 2 patients selected for this report demonstrated a compilation of signs and symptoms consistent with T4 syndrome and were representative of the observed response to the used diagnostic and therapeutic interventions.

Thermosensory perception in these patients was completed using the TSA-2001 (MEDOC, Ltd, Minneapolis, Minn), a computerized device used in clinical and research settings for the assessment of small-diameter nerve fiber function.[11-16] Electromyography and nerve conduction testing sample large myelinated fiber function, whereas quantitative thermosensory testing (QST) examines smaller nociceptive, pain and temperature (C and A delta) fiber function. The TSA-2001 is capable of maintaining a linear

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temperature change through a feedback mechanism. This apparatus uses a Peltier-type thermode that consists of a semiconductor junction containing a temperature sensor controlled by the patient permitting the measurement of thresholds of warming, cooling perception, and thermal (hot and cold) hyperalgesia. The Peltier thermode was placed in contact with the skin at selected thoracic paraspinal dermatomes and distal upper extremities. The method of limits was performed with increasing stimuli, directed from adaptation range toward the sensation range and thermal pain thresholds. Subjects depressed a switch (held in the free hand) at the instant they perceived a specific sensation or upon reaching cold or hot thermal tolerance level. The skin adaptation temperature was a steady 32°C, and stimulator temperature range was 0°C to 50°C. Three readings were obtained at each location and averaged to determine a single threshold score for each side.

The Jamar Hand Dynamometer (JA Preston Corp, Jackson, Mich), a hydraulic device used to evaluate grip strength, was used to document hand weakness as well as therapeutic responses. The Jamar Hand Dynamometer displays isometric grip force from 0 to 200 lb using a dual-scale readout. The peak-hold needle automatically retains the highest reading until reset. All measurements were performed for both dominant and nondominant hands. Subjects performed 3 maximum attempts for each measurement and the average value of these trials was recorded. One-minute rests were given between each attempt, and hands were alternated to minimize fatigue affects. No verbal encouragements were performed.

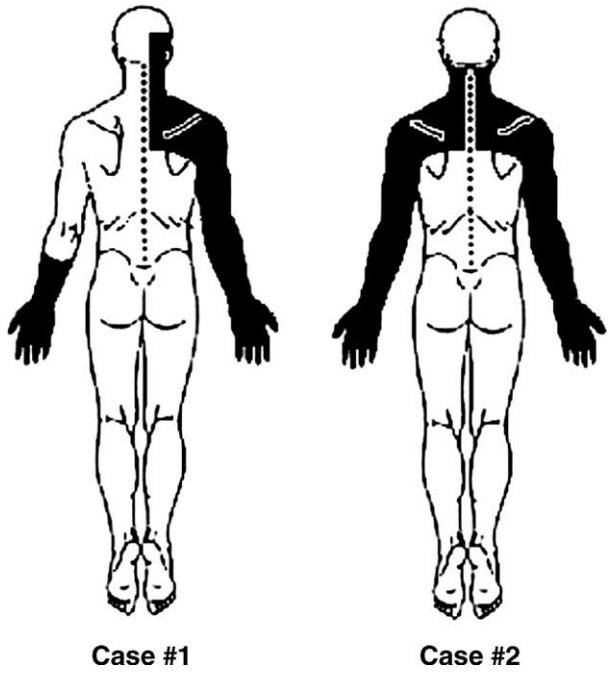

Fig 1. *Distribution of symptoms of 2 flexion-hyperextension injuries. Case 1 represents an injury from the left side and case 2 represents a posterior impact injury.*

Case 1

A 54-year-old female hotel desk clerk was initially seen 1 month after a motor vehicle crash in which her car was hit from the side by a much larger vehicle. She was thrown to the passenger's side striking her head without loss of consciousness. Pain in the head, neck, and shoulders began almost immediately. A cervical spine radiograph series performed in the local emergency department documented the absence of fractures.

When seen for the first time, she complained that her hands felt numb and clumsy. Grasping objects was difficult and she would frequently drop objects from either hand. She described tingling in her arms and all of the digits of both hands. The paresthesias were frequent when driving, at rest, or when lying in bed. She stated that when in bed, her arms and hands felt cold and that the prickling sensation would wake her up at least twice at night. After awakening she would shake her hands out to "wake them up." She described her arm muscles as feeling full, sore, and tight. The bilateral arm pain was worse on the right. Upper back and neck pain was also described and was associated with new-onset occipital headaches and right eye pain that caused difficulty in initiating and maintaining sleep. Previous treatments with naproxen, carisoprodol, and ibuprofen provided minimal relief. A magnetic resonance imaging of the cervical spine showed no abnormalities. Electromyography and nerve conduction study of the upper extremities showed no evidence of neuropathy, radiculopathy, or myelopathy.

The initial neurologic examination showed increased cutaneous sensibility thresholds for pinprick, temperature, and vibration with sensory dysfunction described as 50% worse on the right. Light touch and pinprick of the posterior scalp, right side of the neck, and right shoulder were described as "barely noticeable." Tuning fork vibration perception was greatly reduced over the right hand, arm, and upper back, and awareness of proprioceptive finger movements of the right hand was slightly reduced. Left-sided pinprick and temperature hypoesthesia were noted to extend as far as the mid forearm. She had previously been unaware of the decreased sensory perception in the shoulder, neck, and posterior scalp (Fig 1). Strength testing revealed slight (5−/5) bilateral grasp weakness. The remainder of the neurologic examination was normal including deep tendon reflexes and Babinski's testing. Adson's test for thoracic outlet syndrome and Phalen's and Tinel's tests for carpal tunnel syndrome were negative.

The musculoskeletal examination was positive for limited and painful neck movement. Myofascial pain to palpation was most prominent in the upper left side of the back. The right occipital area and the right carotid

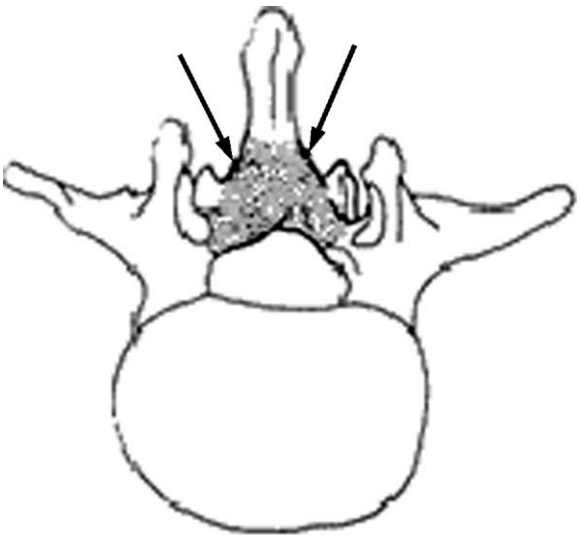

Fig 2. *Paraspinal anesthetic block at the vertebral lamina.*

artery area demonstrated allodynia with marked sensitivity to light rubbing and palpation. Digital pressure to the fifth, sixth, and seventh cervical and first, third, and fourth thoracic spinous processes and surrounding muscles demonstrated mechanical hyperalgesia, and a pain response was elicited. Reduced mobility of the upper thoracic spine was also noted.

Treatment consisted of a series of 3 bilateral paraspinal injections at the fourth thoracic spinal level completed in an outpatient surgical setting. With the patient lying prone and using fluoroscopic guidance, a 25-gauge needle (1 1/2 in) was inserted lateral to the T4 spinous process (Fig 2). Radiopaque contrast confirmed the location of the needle on the proximal vertebral lamina. This was followed by insertion of a mixture of 2 mL 0.5% bupivacaine HCl and 1/4 mL of methylprednisolone acetate (20 mg/mL).

With the first injection, the patient described a paresthesia sensation that traveled into the neck and down into the arms as far as the elbow. Immediately after the injection the patient reported relief of hand and arm paresthesias. Post-paraspinal injection neurologic testing showed return of pinprick (nociception) perception in the hands. Light touch perception and tuning fork vibration testing at the fingertips showed markedly improved sensory discrimination in both hands. Postinjection QST showed enhanced thermal sensory perception in both hands and dorsal spine, that is, lower thermal detection (negative sensory response) and lower pain thresholds (positive sensory response) (Table 1). After the injection, improved grasp strength was documented using a handheld Jamar dynamometer (Table 2).

The initial injection was followed by 2 more injections completed 2 weeks apart. Each subsequent fourth thoracic paraspinal block provided symptom relief of increasing duration. With each block, the patient reported paresthesias

Table 1. *Quantitative sensory testing (°C) values before and after treatment for patient 1*

Location	Cold before	Cold after	Hot before	Hot after
Left thumb	0.6	22.1	47.3	43.3
Right thumb	12.8	20.1	49	44.7
Left superficial radial nerve	3.8	18	48.6	45.2
Right superficial radial nerve	15.3	17.1	47.1	44.8
Left first thoracic spinal level	9.6	22.4	48.1	41
Right first thoracic spinal level	17.1	22.8	44.5	40.5

Table 2. *Grip strength values before and after treatment for patient 1*

	Hand dynamometer testing	
	Left hand (kg)	Right hand (kg)
Before T4 injection	12	14
Immediately after T4 injection	24	30
20 min after T4 injection	34	40

that traveled into her arms. This was followed by marked reduction in paresthesias, arm pain, and sensory dysfunction. On a subsequent visit, the patient reported that she periodically experienced hypoesthesia and paresthesias in her right arm and hand lasting 10 to 15 minutes and occurred 3 or 4 times a day. After initiation of Neurontin (Park-Davis [Pfizer], Morris Plains, NJ) (gabapentin) 600 mg 3 times per day, the patient reported a decrease in arm discomfort and frequency of her paresthesias. The arm pain was described as 2 to 4 of 10 in severity and, overall, the patient reported "75%" improvement. Upper back pain had also resolved and she was sleeping better. Headaches were reduced in frequency and occurred approximately every 1 to 2 weeks. Episodic numbness in the right hand also persisted. Examination showed decreased vibratory sensation, light touch, and pinprick perception in the right hand compared with the left. The right side of the occiput demonstrated moderate mechanical hyperalgesia.

Six months after the T4 paraspinal injections, a series of 3 cervical epidural injections were performed to provide further relief of sensory dysfunction in the right hand and to provide headache relief. One week after the third epidural block, the patient reported that these blocks had helped "tremendously" and the numbness in the right hand had completely resolved. At a final visit, the patient reported that the therapeutic interventions and ongoing gabapentin therapy continued to be effective and her T4 symptoms had not returned.

Table 3. *Quantitative sensory testing (°C) values before and after treatment for patient 2*

Patient 2	Cold before	Cold after	Hot before	Hot after
Left index finger	0	10.7	48.2	45.6
Right index Finger	0	10.4	49	42.9
Left fifth digit	0	9.6	48.3	46.2
Right fifth digit	0	10	48	43.4
Left fourth thoracic spinal level	0	8.4	48.4	45.2
Right fourth thoracic spinal level	0	8.3	46.4	42.8

Table 4. *Grip strength values before and after treatment for patient 2*

	Hand dynamometer testing	
	Left hand (kg)	Right hand (kg)
Before T4 injection	7.3	7.7
Immediately after T4 injection	10.0	10.0
20 min after T4 injection	15.4	17.2

Case 2

A 34-year-old woman had muscle contraction headaches, pain over the right temporomandibular joint, cramping, hypoesthesia, pain, paresthesias, and sharp shooting dysesthesias in the upper extremities and weakness and clumsiness after a whiplash injury of the cervical and thoracic spine. She described her hands as "feeling cold and falling asleep." Consequently, she rubbed her wrists and fingers continuously causing calluses to develop in those areas. Sleeping on her side increased the numbness in her arms and shoulders.

Her physical examination showed slight (5−/5) weakness in bilateral grasp, and diminished touch, temperature, and vibration perception. Proprioception was mildly decreased in the fingers. The sensory loss extended to the upper back and neck (Fig 1). The remainder of her neurologic examination was unremarkable. The musculoskeletal examination revealed decreased range of motion in the cervical spine. The patient showed decreased neck flexion with an average movement of 16°. Cervical spine extension, lateral flexion, and rotation movements were painful and greatly diminished. Bilateral shoulder trigger point tenderness and thoracic spinal and myofascial mechanical hyperalgesia were present. Pressure applied to the fourth thoracic spinous process reproduced her paresthesias in the arms, hands, and fingers. The skull base was tender, and pressure applied to the occiput caused worsening of her headache and retroorbital pain. Adson's test for thoracic outlet syndrome was negative. Electromyogram and nerve conduction studies of the upper extremities were normal. Magnetic resonance imaging of the head and neck revealed a mild central bulging of the C5-6 disk.

This patient received a series of 3 bilateral paraspinal injections with 2.0 mL of 0.5% bupivacaine HCl and 1/2 mL of methylprednisolone acetate (40 mg/mL) at the T4 spinous process. Quantitative thermosensory testing was completed before and immediately after fourth paraspinal thoracic injections (Table 3) to demonstrate the presence of sensory disturbance in this patient. Immediately after the T4 injection, the patient reported rapid and complete relief of the paresthesias along with markedly diminished aching and tightness in her forearms. Hyperalgesia to deep palpation was also greatly reduced. The neurologic examination postinjection showed enhanced perception of pinprick, temperature, vibration, and proprioception in her fingers. On her left side, the hypoesthesia was localized to the mid left palm and the right upper extremity symptoms were completely relieved. The handheld Jamar dynamometer demonstrated a rapid increase in grasp strength that improved over the next 20 minutes (Table 4).

After a series of 3 T4 paraspinal injections, osteopathic thoracic spinal mobilization techniques, and physical therapy treatments, the numbness in her hands was reported as "slight" and cramping in her fingers was greatly reduced. Neurontin (gabapentin) 400 mg, 2 to 3 times per day, was prescribed to be taken as needed. With the combined therapies of injections and gabapentin, the patient reported that her pain had decreased "70%" to approximately 2 to 3 of 10 in severity on a numerical descriptor pain scale. However, when the patient would forget to take gabapentin, transient shooting pains in the upper extremities would return. Eventually, after these combined therapeutic interventions consisting of paraspinal injections, gabapentin, and a course of physical therapy, the patient reported complete relief of her T4 syndrome related paresthesias, sensory disturbance, clumsiness, and upper extremity weakness. She also reported "90%" pain relief.

Discussion

Based on the experience of the first author, who has seen more than 30 patients with this constellation of signs and symptoms, T4 syndrome appears be a specific clinical entity. These patients, including those described in this article, report similar triggering mechanisms and physical complaints as those described in an earlier report that presented a large case series.[8] The significance of our report and others is that these complaints of a glove-like distribution of hand or forearm pain and numbness as well as motor weakness can often lead to a mistaken diagnosis, including somatization disorder.

The pathophysiologic mechanisms responsible for the constellation of signs and symptoms of T4 syndrome are unknown; it is thought that they are caused by noxious stimuli that mediate nociceptive information to spinal cord

neurons in the dorsal horn and spinal medulla. Involvement of the autonomic nervous system has been suggested.[10] The noxious stimuli that stimulate nociceptive impulses to spinal cord neurons in the dorsal horn and spinal medulla appear to induce enhanced sudomotor and vasomotor tone. These nociceptive impulses enter spinal cord lamina I neurons at the level of the 3 major cervical and upper sympathetic ganglia. Lamina I neurons project to the sympathetic nuclei in the thoracolumbar segments,[17] terminating in the preganglionic neurons in the intermediolateral column and others. This pain information is then relayed back to the neck and head via the sympathetic chain via both the preganglionic fibers to the head, neck, and shoulders, and postganglionic synaptic sympathetic connections to end organs resulting in the perception of pain. These sympathetic preganglionic cells control vasoconstrictor and sudomotor output to the skin and muscles of the extremities, thus, accounting for the prominent manifestations of vasomotor autonomic disturbances in T4 syndrome.

The QST findings that coincided with patient-reported pain reduction, paresthesia inhibition, and enhanced thermal sensitivity appear to be confirmatory of the reported sensory changes. Spinal or supraspinal sensory inhibition mechanisms appear to be reversed by nociceptive blockade when local anesthetic is introduced at the fourth thoracic spinal level.

In addition to sensory dysfunction, the patients presented in this report experienced motor neuron inhibition that manifested as bilateral grasp weakness. The greatly improved strength shown by these patients after paraspinal bupivacaine injections seems to imply the presence of reflex motor neuron inhibition that, like the tactile sensory dysfunction, is also responsive to spinal level injections of anesthetic. Leis and colleagues [18] have recently described nociception-induced motor neuron reflex inhibition at the dorsal horn.

Finally, in conjunction with anesthetic blockade an anticonvulsant, gabapentin (Neurontin), was used successfully for both patients in this report. The effectiveness of gabapentin in the treatment of nociceptive pain conditions including sympathetically mediated pain[19-21] and neuropathic pain[22,23] is well established in medical literature.

Conclusion

This article provides additional evidence from an osteopathic pain practice that a clinical syndrome first described in the chiropractic literature appears to be a distinct clinical syndrome. In addition, this article introduces for the first time additional diagnostic tools and alternative therapeutic options for those patients who occasionally no longer respond to more conservative chiropractic or osteopathic interventions. As future reports confirm our observations and the pathophysiology of this condition is further clarified, this little known clinical condition, potentially mistaken as a somatization disorder, may be more commonly recognized.

Practical Applications

- Information from this report will help practitioners better recognize and understand T4 syndrome.
- T4 syndrome should be considered when patients present with a unique constellation of signs and symptoms as described in this report.
- The method of treatment used in this report (injection) may help us better understand the underlying pathomechanics for T4 and other similar syndromes so that similar or other noninvasive therapies may be investigated.

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