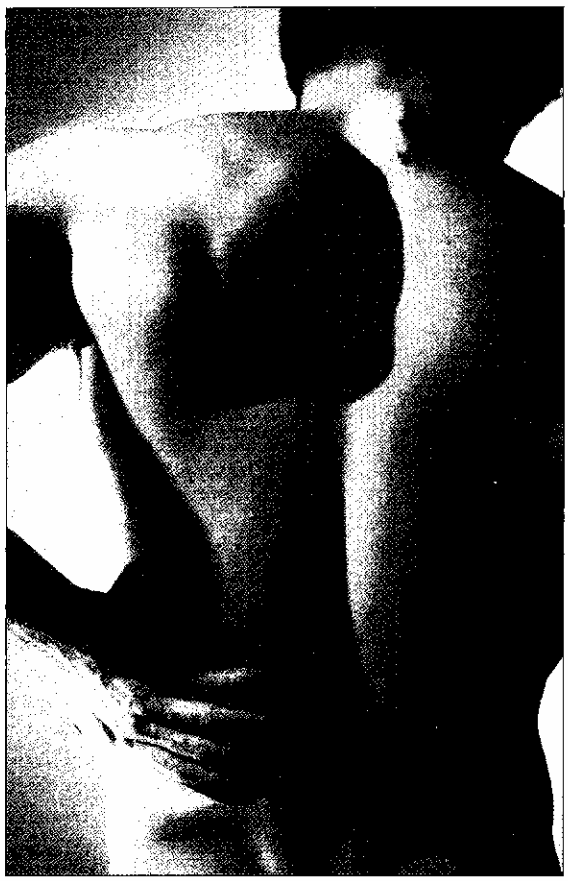
INTRODUCTION TO A REFERRED SYMPATHETIC PAIN MAP



The Fibromatome Map bridges the gap between recent pharmaceutical discoveries of widespread pain due to hyperactive nerves and interventional spine medicine by effectively identifying and treating specific nerve roots that cause widespread pain.

By Mathew C. Wallack, MD

The following article offers several new avenues of thought in identifying specific pain patterns in fibromyalgia patients as well as a possible new strategy in treatment. Although Dr. Wallack's theories need to be studied in a double-blind investigation, his viewpoints and patient treatment outcomes seem impressive and definitely warrant further investigation. Pushing scientists to look outside the box is always a little on the adventurous side but this kind of thinking has historically lead to new diagnostic protocols and resulted in better treatment options for patients.

— Rae Marie Gleason

Fibromyalgia Department Editor

This paper presents a description of a unique and previously undescribed map of referred sympathetically-mediated pain. The mapping is based upon pain relief with selective nerve root procedures, primarily within the thoracic spine. The mechanism for their efficacy is hypothesized to be via the sympathetic afferents, which travel through the dorsal root ganglion (DRG).

In a manner similar to a dermatomal map, each spinal cord segmental level from T1 to L2 is described as having a specific region of the body that it innervates, with each level identified using the newly-coined term "fibromatome." The map is meant to supplement the radicular and peripheral nerve maps and to be applied in cases in which these maps do not apply or when the response to treatments for radicular or peripheral nerve pain are ineffective. Notably, the fibromatome map is unique in that at certain levels patients can develop almost hemibody symptoms, and can account for pain complaints that are currently described as non-physiological. An understanding of fibromatomes may allow spine physicians to synergistically treat these conditions both pharmaceutically and interventionally.

Discovery

This concept was initially discovered after a number of patients who had undergone thoracic spine epidurals reported unexpected relief of symptoms such as extremity pain or headaches. A classic example of this phenomenon is illustrated in Figure 1. The patient is a 37-year-old disabled gentleman with widespread pain diagnosed as vasculitic arthritis, who subsequently had significant relief of all of his widespread pain with thoracic nerve root procedures. The pain drawings, before and after the first two thoracic epidural steroid injections (TESIs), clearly indicate widespread relief of all left sided pain (notably, the right-sided pain was initially worse).

Because these epidurals typically produced a warm/hot sensation (similar to a sympathetic block) and were located within the thoracic spine, I reasoned that they were affecting sympathetically-mediated pain. Over time, I recognized that these procedures positively affected complaints mediated by the autonomic

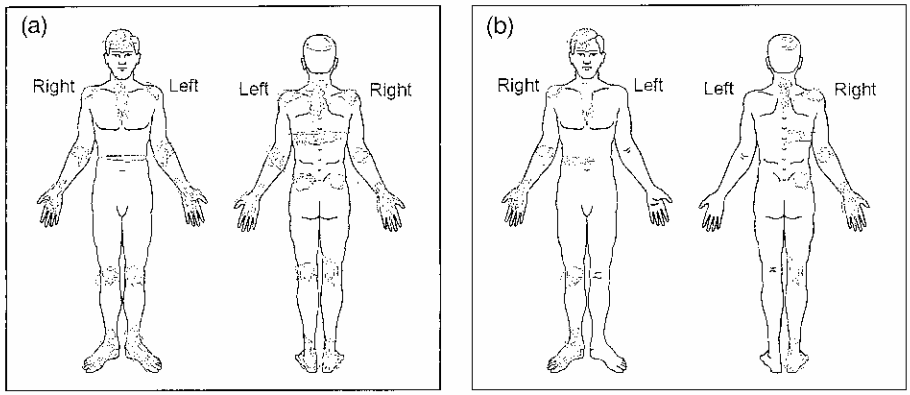


FIGURE 1. *Pre- (a) and Post- (b) Treatment Pain Diagrams. Post-treatment diagram is three weeks after second TFSI. Pain Diagrams such as these were the impetus to my belief that thoracic spine dysfunction could cause widespread pain.*

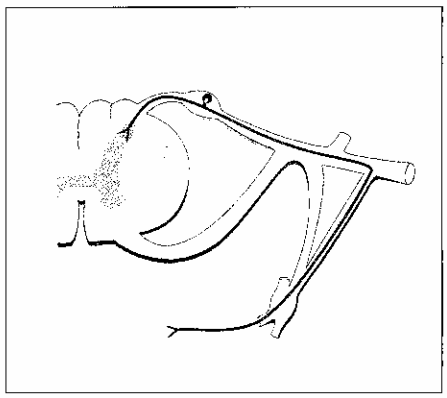


FIGURE 2. *Illustration of sympathetic afferents that enter via a specific dorsal root ganglion.*[1]

nervous system—such as sinus congestion, reactive airway disease, IBS and bladder dysfunction, thermoregulatory dysfunction, Raynauds, and peripheral edema. This strengthened my belief that I was treating sympathetically-mediated pain. While these epidurals were the impetus to my current work using nerve root procedures, it is important to note that, as a treatment, they are problematic and may cause increasing pain if done without proper training.

Fibromatomes

I have defined fibromatomes as specific regions of referred sympathetic pain depending upon the level of the spine affected. The term fibromatome is analogous to dermatome. While a dermatomal pain pattern refers to the region innervated by the sensory afferents via a specific dorsal root ganglion, a fibromatomal pattern refers to the region of referred pain innervated by the sympathetic afferents that enter via a specific dorsal root ganglion (see Figure 2). Notably, although the initial work was done in fibromyalgia patients (hence the term fibromatomes), many patients without fibromyalgia will have similar pain generators (see case reports).

In much the same way as a patient presenting with low back pain radiating down the lateral leg to the dorsal foot that is completely relieved with a L5 nerve block has pain in an L5 dermatome; a patient with unexplained calf pain, (often associated with anterior thigh pain) which is completely relieved with a T9 nerve root procedure would be considered to have pain in a T9 fibromatome. Notably, this description of the T9 fibromatome is based upon a series of patients being successfully treated (i.e. 95+% relief for at least one month) for similar symptoms with T9 nerve root procedures. As the examples below indicate, these procedures have been done in patients with a variety of complaints and, even when successful, only treat specific regions of pain.

Example 1. A 50-year-old woman with generalized pain (i.e. severe fibromyalgia) presents with a chief complaint of left anterior thigh and posterior calf pain. Patient has radiological rotational/scoliotic abnormalites and tenderness to palpation at T9. Left T9 selective nerve root block (SNRB) provides the patient with 10 months of relief in the T9 fibromatome distribution (i.e. anterior thigh and posterior calf). All other pain remained stable following the SNRB.

Example 2. A 60-year-old gentleman with failed lumbar spine syndrome and intractable low back pain secondarily complains of a 50-year history of left (more so than right) calf pain (he had fallen off a roof when he was 10 years old). Patient has radiological rotational/scoliotic abnormalites (see Figure 3) and tenderness to palpation at T9. Left T9 SNRB provides the patient with 8 months of calf pain relief. A Left T9 pulsed radiofrequency of the dorsal root ganglion (PRFDRG) performed 4 months ago has provided the patient with no recurrence of calf pain. Low back pain remains severe.

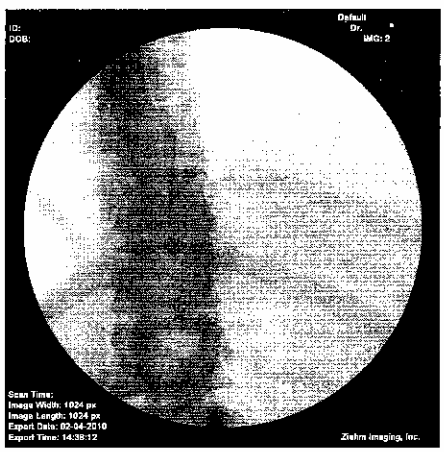


FIGURE 3. *Radiological rotational/scoliotic abnormalities in 60-year-old man.*

Understandably, this concept seems completely unique. However, I would like to point that all of us accept that cardiac ischemia often refers pain to the arm, neck, jaw, etc., and therefore already accept a phenomenon very similar to the concepts described in this paper. Basic science research that is consistent with a similar mechanism includes studies showing cardiac ischemia causes increased amplitude on EMG over T4-5 in dogs,[2] and that myocardial ischemia is mediated by sympathetic afferents in cats.[3]

X-Ray Abnormalities

As described in the above examples, there are often notable scoliotic and/or rotational changes at affected levels (usually within the thoracic spine). Notably, these skeletal abnormalities are oftentimes much more impressive than underlying cervical and lumbar spine dysfunction which are not easily seen using plain x-rays. These abnormalities can be very impressive such as in Figure 4a, a patient who was told by repeated doctors that she should not have widespread pain because there was nothing wrong with her. Figure 4b illustrates her initial pain diagram (pre-) and a recent post-treatment diagram after undergoing a number of thoracic spine procedures.

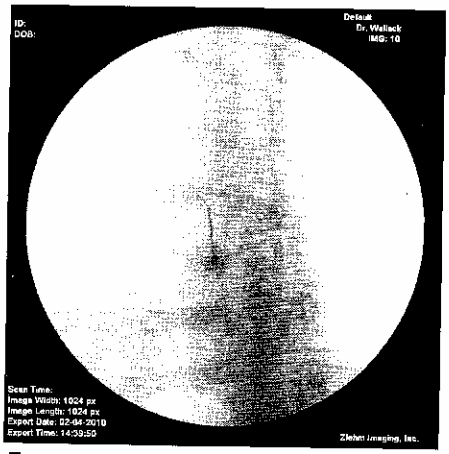


FIGURE 4A. *Female patient with impressive skeletal abnormalities.*

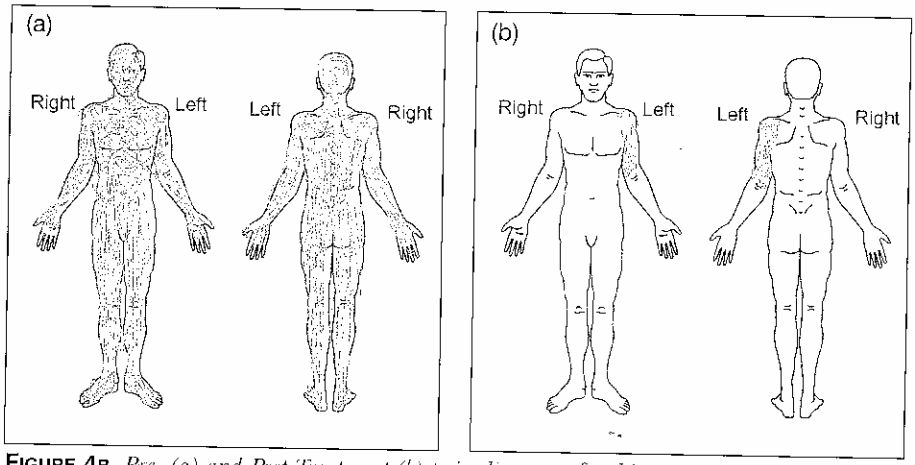


FIGURE 4B. *Pre- (a) and Post-Treatment (b) pain diagrams for this patient after thoracic spine procedures.*

Fibromatome Map

These maps were developed by evaluating pain diagrams before and after selective nerve root blocks (at least 1 to 2 weeks) and, more recently, pulsed radiofrequency of the dorsal root ganglion. Notably, the latter method—being more effective, less painful, much safer and technically easier—is the only method I currently use. Also, of note at the level in which the DRG/SNRB is performed, I have been doing medial branch block procedures but have come to believe it is the former procedure that is providing the greater amount of relief. In regards to the validity of this map from an interventional spine perspective, the author would like to reiterate or point out the following observations:

1) Involved regions of the spine are typically tender to palpation and have abnormalities under x-ray, usually with rotational or scoliotic changes.
2) The case reports presented all report 95 to 100% relief of symptoms in involved regions (unless otherwise noted).
3) The case reports presented all have had at least 1 month of relief (unless otherwise noted).
4) The case reports presented all have had chronic intractable pain (unless otherwise noted).
5) These patients typically have undergone other procedures including, in some cases, surgery without relief of pain in involved regions and usually have other painful regions that are not affected by the specific procedure described.
6) The thoracic nerve root procedures were performed without conscious sedation in a manner that involved eliciting dysesthesia in a dermatomal pattern of the treated nerve root (along with proper spread of contrast). These are the most painful therapeutic procedures that I have performed and it seems unlikely to be a placebo response in patients who return for additional procedures.

The following case reports represent examples of the most commonly seen pain patterns and distributions (i.e., mapping). However, there is a great deal of overlap among levels and, at all levels, partial, alternative or more widespread patterns are seen. Ultimately, fibromatomal patterns are much more complicated then dermatomal patterns and the effective treatment of referred sympathetic pain with selective nerve procedures is a much more complicated process. On the other hand, effectively treating these referred sympathetic pain syndromes can be more rewarding due to the improvement in the co-existing autonomic dysfunction. Treatment for these referred sympathetic pain syndromes should only be initiated after spinal interventions for somatic pain syndromes are exhausted or are highly unlikely to provide improvement. I believe they should be considered prior to spinal surgery unless the case is straightforward (i.e., herniated disc with nerve root impingement).

Surprisingly, a number of the levels treat arthralgias—more so than neuropathic-type pain. This seems counter-intuitive. However, the joint pain in fibromyalgia, long considered a rheumatological condition, is actually due to neurological dysfunction according to many recent studies. The fibromatome map is the link, via the autonomic nervous system, that answers this previously unexplained phenomenon. Notably, these patients are often diagnosed with arthritis but clinically it seems they can be distinguished from true arthritis by the fact that they often relieve pressure in their joints by writhing or popping the involved joints. In addition to the discovery of various arthralgias being due to thoracic spine conditions, the author would like to point out that some of the case reports include the discovery of other thoracic spine-mediated conditions including headache, pseudo-radiculopathy, and pseudo-polyneurpathy.

In addition to the descriptions of the fibromatomal levels, I have included summaries and case reports for some of the levels that I most commonly treat.

T1: Lateral posterior neck to upper trapezius without radiation into arm increased with arm abduction towards 180 degrees; may be associated with distal arm and hand symptoms.

T2: Key feature is tightness of lateral arm from shoulder to elbow with arm abduction to 180 degrees; in addition to improving pain in this region, T2 RF DRG's have provided some patients with relief of lower extremity symptoms.

T3: Pain and tightness in scapular region with or without arm referral with arm abduction to 180 degrees; no clear mapping pattern has been elucidated.

The mapping pattern for the T4 level and below are better understood.

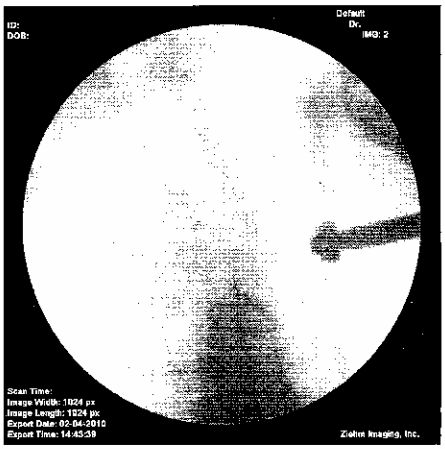


FIGURE 5. *Thoracic region scoliosis including T4-T5 level of patient with acute wrist pain.*

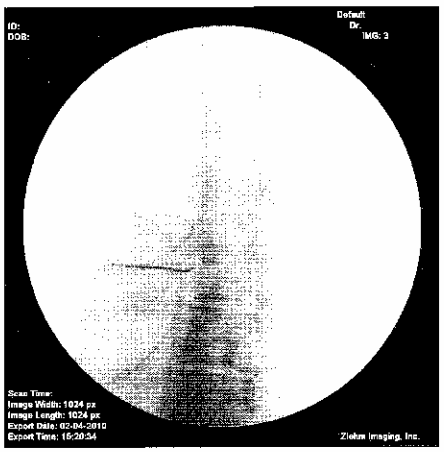


FIGURE 6. *Example of female patient with T5-6 scoliosis and rotational changes. Patient presented with intractable headaches, polyneuropathy type symptoms and fibromyalgia which was relieved with T5 nerve root procedure.*

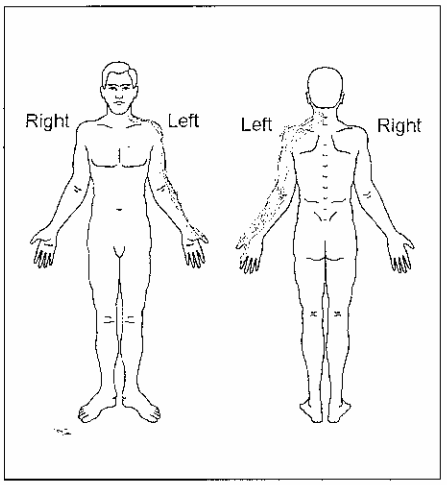


FIGURE 7. *Pain diagram for 60-year-old woman with failed neck and back surgery syndrome.*

T4: Key feature is tightness of dorsal arm from shoulder to elbow with arm abduction to 180 degrees; often associated with joint pain (most notably wrist, knee, and ankle).

Case Report T4-a. A 60-year-old gentleman who is status post (s/p) 10 different pain-related surgeries with marginal-to-poor results presented acutely with right wrist pain, swelling, and decreased range of motion. Associated complaints included mid scapular region pain and tightness of dorsal proximal arm with abduction to 180 degrees. In September of 2009, a Right T4 SNRB was performed with near immediate complete relief of symptoms for six weeks. A Right T4 PRFDRG performed in October 2009 has continued the relief without recurrence to date (January 20, 2010). Notably, nearly every region (except right low back) has been successfully treated using similar procedures (see Figure 5).

Case Report T4-b. A 40-year-old gentleman with multiple pain complaints who reported episodes of all-over body pain occurring on a daily basis. These episodes always begin with right wrist pain and within one hour spreads to the right greater than left side of his body. The patient was usually incapacitated for a few hours. The patient is s/p a Right T4 SNRB in March of 2009 with complete relief of right-sided arthralgias and low back pain (does have some ongoing right-sided neck pain) to date. The patient underwent a Left T4 DRG on January 29, 2010 for left-sided symptoms.

Case Report T4-c. A 35-year-old female presents with fibromyalgia with right shoulder pain. She underwent a Right T4 PRFDRG on December 14, 2009. She returned 2 weeks later stating the procedure was not successful for the shoulder pain but, incidentally, her right wrist and ankle felt much better (these were not mentioned as regions of significant pain prior to the procedure). Subsequently, a Right T2 PRFDRG on December 28, 2009 provided excellent relief of shoulder and axial spine pain as well as generalized fibromyalgia symptoms including fatigue, myalgias, etc., to date.

T5: Key feature #1 is parasthesias, numbness, and pain of the entire arm and oftentimes fingers with arm abduction to 180 degrees. Key feature #2 is posterior leg pain. Also frequently, hands and feet pain and parasthesias (distal more so then proximal; e.g., tips of fingers and toes).

Case Report T5-a. A 52-year-old woman with a long history of fibromyalgia involving extremities diffusely with parasthesias and pain radiating to upper and lower extremity digits (the leg symptoms are primarily in the posterior distribution). Patient is s/p Left T5 SNRB in October 2008 for left arm pain without re-occurrence of symptoms. She is s/p Right T5 SNRB in March 2009 for right greater than left posterior leg pain, and right arm pain without re-occurrence of symptoms for seven months. Patient is s/p Right T5 PRFDRG on December 2, 2009 for distal (elbow to hand and knee to foot) extremity and neck pain (right side only in upper extremity and right greater then left in neck and legs) without re-occurrence of right-sided symptoms to date (two months). Patient reports relief of all fibromyalgia symptoms (i.e. fatigue, IBS, etc) as long as extremity pain is kept at bay.

Case Report T5-b. A 38-year-old woman with fibromyalgia and severe headaches/migraines. In regards to the patient's headaches, she has numerous failed therapies including hysterectomy since her headaches were exacerbated by her menses. Patient's fibromyalgia primarily involves neck and right greater than left parasthesias of the extremities. Patient is s/p Right T5 SNRB in May 2009 with near complete relief of headaches and fibromyalgia for five months. Symptoms re-occurred in November 2009 but subsequently involved the left side. Patient is s/p Left T5 PRFDRG on November 17, 2009 with relief of symptoms to date (see Figure 6).

Case Report T5-c. 60 year old woman with failed neck and back surgery syndrome who presented with left arm pain and numbness in a radicular distribution radiating to the thumb (see Figure 7). The patient is status post Left T5 PRFDRG on 10/21/09 with 100% relief for 4 months.

T6: Key feature is pattern of joint pain involving hands, elbows, knees, and feet. Also can cause regions of pain including scapular/trapezius and greater trochantor.

Case Report T6-a. A 58-year-old female with fibromyalgia is s/p a number of procedures with relief of various painful regions presented with glove and stocking pattern of neuropathic and arthritic symptoms. Patient is s/p Right T6 PRFDRG

on 11/17/09 without any re-occurrence of these symptoms to date.

Case Report T6-b. 32-year-old female with lumbago and bilateral knee pain (right greater than left) who is s/p Right T6 SNRB x 2, each of which gave her approximately six weeks of relief of her knee and, to a lesser degree, back pain. Patiently subsequently underwent a Right T6 PRFDRG on November 15, 2010 with complete relief of her knee pain to date. Notably, patient's knee pain had specific clinical features that help to identify knee pain due to a referred sympathetic phenomenon versus an intrinsic joint pain syndrome. These included severe tightness posteriorly radiating six inches above and below the joint and severe pain overnight and first thing in the morning that improved with ambulation.

T7: Key feature is widespread pain oftentimes involving entire arm and sometimes hand as well as lateral leg.

Case Report T7-a. 50-year-old gentleman with intractable low back and lateral leg pain without foot pain is s/p numerous interventional spinal procedures and failed lumbar spine surgery who is s/p Left T7 PRFDRG on December 12, 2009 and Right T7 PRFDRG on January 4, 2010 without any re-occurrence of symptoms.

T8: Key feature is low back pain; can be associated with leg pain, oftentimes involving anterior shin or knee.

Case Report T8-a. 44-year-old male with fibromyalgia-type symptoms (i.e. diffuse pain associated with fatigue, etc.) with failed lumbar spine. Numerous spinal interventions including rhizotomy failed to provide patient with significant relief of his low back pain, and he required two canes to ambulate safely due to his legs giving out. Subsequently, patient underwent four consecutive Left T8 SNRB's that provided approximately two months of low back pain relief (concurrently SNRB's would also relieve migraines). On January 3, 2010, the patient underwent a failed Left T8 PRFDRG (soon after determined that the probe was malfunctioning) which markedly increased lumbago, headache, and episodes of sudden leg weakness. Procedure successfully repeated on January 20, 2010 with complete relief of all symptoms and patient stating he felt wonderful.

Case Report T8-b. A 54-year-old female is s/p seven back surgeries without significant relief who presented with severe lumbago (left low back worse). Pain radiated into left greater trochanteric region and anterior shin. Right leg pain in an L5 distribution. Patient is s/p Left T8 SNRB in October 2008 with complete relief of left low back and leg pain to date. Notably, Right L5 PRFDRG/SNRB aborted due to anatomy.

T9: Key feature is calf pain, oftentimes associated with anterior thigh pain; can cause more widespread pain including involvement of upper body.

Case Report T9-a. A 44-year-old female with fibromyalgia including prominent fatigue, most notable region of pain involved the right anterior thigh and (posterior) calf. Patient is s/p Right T9 SNRB in January 2009 with complete relief of lower extremity pain as well as all fibromyalgia complaints through December 2009. Notably patient had other thoracic nerve root procedures performed but this level seemed most beneficial for her generalized fibromyalgia complaints.

T10: Key feature is low back pain radiating to, and associated with, knee pain.

Case Report T10-a. A 39-year-old female with a 6-year history of right knee pain following a fall. Patient is s/p two knee surgeries without significant change in symptoms. Patient also with right greater than left low back pain that radiates down anterior thigh to right knee. Patient s/p Right T10 SNRB in November 2008 without any re-occurrence of symptoms.

T11: Key feature is lumbago radiating posteriorly to ankle without foot involvement.

Case Report T11-a. A 54-year-old male with intractable low back pain (left more so than right) radiating into posterior leg down to ankle without involvement of feet underwent Left T11 PRFDRG on January 12, 2010. Patient reports 100% relief of left-sided symptoms on February 4, 2010.

T12: Key feature is lumbago radiating posteriorly down leg with foot involvement.

L1: Key feature is lumbago radiating posteriorly to knee.

L2: Key feature is lumbago radiating to buttock, possibly to knee.

These cases reiterate that fibromatome patterns in a particular individual patient may include additional regions or have more limited distributions. Fibromatome patterns are more complicated then dermatome patterns. However, as described in some of the fibromyagia patients that when the proper fibromatome is treated, the benefits can extend far beyond pain relief and the treatment can make a remarkable improvement in a patient's quality of life.

Discussion

The description of a referred pain map due to sympathetic dysfunction at specific levels of the spine is a wholly unique concept in the field of interventional spine medicine. Therefore, I will briefly discuss a few topics that I believe to be supportive of this concept.

Anatomical. Unlike the somatic portion of the nervous system, sympathetic fibers often travel vertically within the sympathetic chain and there is a great deal of variation in pre- and post-ganglionic nerve travel distal to the spinal cord. Finally, the sympathetic neurons that innervate the entire body are all located within the thoracic and upper lumbar regions of the spine and thus inherently innervate regions of the body in a pattern that is non-dermatomal. Given these anatomical features, it is within reason that a mapping pattern—totally unique from the somatic nervous system—is possible.

Neurological. Every component of the nervous system that is anatomically well understood is highly organized. This seems completely logical when one considers the possibility of a disorganized nervous system. Given the complicated functions of the autonomic nervous system throughout the body, it has to be highly organized. This has to involve all components of the ANS, including the sympathetic afferents at the dorsal root ganglion. Even if the map that I am presenting is not ultimately correct, there indeed has to be a high degree of ANS organization that has yet to be understood.

Embryological. A detailed discussion regarding this topic is beyond the scope of this paper. However, my review of the literature is notable for statements indicating that spinal neurons involved with the autonomic nervous system do project superiorly and inferiorly. For example, Cornbrook et al. describe "T4

projections to the cervical level arise from cells clustered in the rostral end…while T4 projections to lumbar chain ganglia arise from cells clustered in the caudal end of the T4 caudal pool."[4]

Radiological. As mentioned above, rotational/scoliotic abnormalities are typically noted at involved regions under X-ray. In some cases, the abnormalities are quite impressive. For example, the patient in Figure 4, had for years been told that there was nothing wrong with her that could be causing her widespread pain, yet patients with much more subtle cervical and lumbar abnormalities—seen only with MRI—are readily diagnosed with a physiological pain generator. Again, even if the fibromatomal map that I am describing is not correct, the specialty of interventional spine needs to address the issue of widespread pain in patients with significant scoliotic/rotational abnormalities and tenderness to palpation of the thoracic spine.

Basic Science. A detailed discussion of the basic science work that has been done on fibromyalgia is beyond the scope of this paper. However, it is notable that the basic science information available is consistent with my work. I will review a few of these studies:

1) Functional analysis of the autonomic system in fibromyalgia patients has demonstrated disturbed activity characterized by hyperactivity of the sympathetic nervous system.[5]
2) Fibromyalgia patients have lower heart rate variability, indicating sustained sympathetic hyperactivity.[6]
3) The mean CSF concentration of Nerve Growth Factor, a substance known to participate in functional plasticity within the dorsal root ganglion and spinal cord is elevated.[7]
4) Multiple studies have shown elevated CSF levels of Substance P, which is a putative nociceptive neurotransmitter.[8]
5) Current pharmaceutical industry commercials present information indicating that fibromyalgia is due to nerve hypersensitivity (i.e. DRGs) causing widespread pain.

Medical. Many patients with pain do not respond maximally to therapies for somatic pain such as spinal/joint injections and surgeries, the most obvious example being fibromyalgia. Therefore, an alternative component of the nervous system must be involved. The sympathetic nervous system via a referred pain mechanism is one of very few mechanisms possible and is therefore worthy of consideration.

Conclusion

Clearly, what is described in this paper will be outside of the intellectual comfort zone of most readers. The obvious criticism being the fact that it is not a double-blinded study and that such studies will need to be performed to prove the existence of fibromatomes.

Logic and experience do tell us that with interventional spine procedures, especially with procedures as painful as selective thoracic nerve root procedures, it seems unlikely that patients will report false positive results. It seems even less likely that they will report pain relief in specific regions. For these reasons, I am hopeful that my colleagues will accept this paper for what it is: a descriptive report of this phenomenon.

I would like to also point out to my interventional spine colleagues that in many cases we really do not know the mechanism of the disease we are treating. We have all seen patients that are not responsive—or even worsened (failed spine syndrome)—by what we believe to be the best and most expensive treatments that modern medicine has to offer. Similarly, we have all walked into an exam room only to see a patient who appears to be in obvious misery, with a laundry list of symptoms, yet we have no idea what the cause of their suffering is and have little to offer. Clearly, we and other practitioners who treat pain issues are missing something in these cases.

For this reason, I believe that my work, which identifies an alternative pain generator, is worthy of consideration by pain practitioners. My recommendation for my colleagues is that when they are faced with a difficult case, especially in a patient with widespread pain, that they examine the thoracic spine under x-ray for rotational/scoliotic regions that are tender to palpation. Having said that, I very strongly recommend against initiating any injections in these areas since, without proper training, these procedures are likely to be detrimental (e.g., pain flare up or possibly spread the pain).

Although my interest in this phenomenon may be completely unique, I am hopeful that there are others who have a similar interest. I would very much appreciate and am eager to work with anyone of a similar mind set. I can be contacted through the Society of Scoliosis and Fibromyalgia Spinal Injectionists. I must mention that I have patented these treatment protocols, which I think is important to protect patients, but will provide full privileges to individuals who contact me and are interested in the treatments described.

Mathew C. Wallack, MD, graduated with a BA in philosophy from Franklin & Marshall College, and received his MD from Hahnemann/MCP (currently Drexel University). He completed residency in neurology with honors from Wake Forest/Bowman Gray. Dr. Wallack was part of a large neurology group including managing impatient service at a tertiary hospital for approximately 18 months were he became interested in interventional treatments for intractable headache sufferers. He subsequently did an interventional pain fellowship with anesthesiologists at University of Pittsburgh. Dr. Wallack has been in private practice (interventional pain) for 6 years initially with a focus in headaches. In 2006, Dr. Wallack identified an association between spinal dysfunction and fibromyalgia and that has been the focus of his work since that time.

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