The Various Faces of Referred Pain

A Literature Review

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Abstract

This paper will review the literature past and present concerning three main categories of referred pain. If one wants to treat the whole patient, then he/she must have a working knowledge of referred pain. When someone mentions referred pain, the first thought is most likely to be, myofascial trigger points. This is one type of referred pain, but there are a few others to think about. These include pseudoradicular syndromes, as well as spinal pain patterns. A patient does not present with just one of these three main categories of referred pain. Various combinations of these referrals need to thus be inspected to get to the heart of the patients problem. The chiropractor that can integrate these concepts will be a very valuable asset in their community.

Chapter One: The Problem

A) Introduction:

Referred pain, according to Stedman's Concise Medical Dictionary, "is pain at a site other than the actual location of trauma or disease". [1] Most chiropractors deal with this day in day out in some capacity. A patient may present with whiplash and have referred pain into the head (cephalgia). They may also present with a sprained ankle with pain into the foot. In extreme cases a patient may even present with a myocardial infarction with referred pain into the neck and/or left arm.

A chiropractor when treating a patient for a condition will take a complete history and perform a physical examination. This is when he/she will come up with a list of potential differential diagnoses. A lot of times this will include myofascial pain and various segmental spine conditions (ex. Cervical Sprain/Strain). With the patient workup complete, a treatment plan is created. This treatment may include ultrasound, electrical muscle simulation, soft tissue manipulation, as well as an adjustment of the affected area(s). Most patients will have marked improvement from this approach.

B) Statement of the Problem:

The chiropractic profession is here to help treat their patient's needs. Primarily the needs related to the central nervous system and the bones that support and protect it are the focus. This focus is carried out by an ever-increasing assortment of techniques. Some of the various techniques are concentrated on whole body wellness care. There is a depth of understanding required for this type of care, which one only briefly covers in Chiropractic school curriculums.

If one wants to treat the whole patient, then he/she must increase their knowledge to include a more diverse understanding of referred pain. When someone mentions referred pain, the most

thought of is likely trigger points. This is a type of referred pain, but there are several others to think about. These include pseudoradicular syndromes and spinal pain patterns.

A patient does not present with just one of these three main categories of referred pain. Various combinations of these referrals need to thus be inspected to get to the heart of the patients problem. The chiropractor that can integrate these concepts will be a very valuable asset in their community.

This paper will review the literature past and present concerning the three main categories of referred pain. Breaking each of these down into their referral patterns and showing that these three distinct referred pain categories are not to be viewed exclusively. With this information, a chiropractor will be better able to diagnose their patient, as well as treat them.

C) Purpose of the Study:

The purpose of this study is to review the literature of the past and present concerning the three main categories of referred pain: Myofascial trigger points, pseudoradicular syndromes and spinal pain patterns. With this topic, there is a lot of past work that is still correct and vital even with the major advances of today's research. This combined knowledge of past and present, will help the chiropractor to better treat his/her patients overall needs. This means less wondering why an adjustment will not hold or why a certain pain will not go away.

Chapter 2: Methodology

A) Introduction:

Chapter two will discuss the methodological approach, research design and literature selection criteria for this research proposal.

B) Description of Methodological Approach:

An automated search was conducted at Logan College of Chiropractic over several days from April 1, 2004 to February 15, 2005. Searches for literature were done on Bridges a MOBIUS Library Catalog (Logan Database), ChiroWeb.com, JVSR Journal, Index of Chiropractic Literature, Pub Med and general Internet searches. Key words "pain referral" and "referred pain" revealed nearly 8,000 results on the Internet, so the focus became the more professional literature sources. To narrow the search to the general idea of the referred pain and not on the various examples of referred pain, keywords like "pain" and "myofascial pain" were used. This revealed about 500 books that Logan had on their shelves. A few titles mentioned "referral" in them. This led to a search of the shelves for these books and others like them. A review of fourteen books has been narrowed to seven that were informative on the "Referred Pain" topic. Further research was performed by searching MOBIUS for the subjects: myofascial trigger points, fibromyalgia, viscerosomatic pain, somatovisceral pain, disc lesions and facet syndrome.

C) Research Design:

The majority of books utilized for this literature review were from 1998-2004, while only one was printed as far back as 1977. These books do make reference to various books and studies from earlier times.

D) Literature Section:

The selection process for this literature review revolved around chiropractic assessment, diagnosis and treatment of referred pain of their patients. Some of the assessment and treatment techniques were borrowed from Acupuncture and Massage Therapy (Myofascial and Neuromuscular).

Chapter 3: Review of Literature

A) Introduction:

This review will include a detailed description of the three main types of referred pain, list some of the most common referral patterns and discuss the benefits to integration into one's practice.

B) Literature Review:

Pain is a multifaceted paradigm associated with self-reported, subjective pain and any behaviors associated with that painful occurrence. [2] The ambiguity of the various definitions of pain makes classification most difficult. Most pain syndromes are classified based on signs, symptoms and behavior, instead of on causal factors. [2] A factor that interferes with making a distinct classification as to the type of pain is the presence of comorbidity. [2] It is up to the chiropractor to pay attention, not only to the signs, symptoms and patient behavior, but also most especially to any possible cause of the manifestation of pain. This helps to better distinguish between one or more causes of pain.

To better diagnose a patient's pain, a good chiropractor needs to have a firm grasp of the various types of pain referral patterns. There are three major categories of pain that include: 1) Myofascial Trigger Points, 2) Pseudoradicular Syndromes and 3) Spinal Pain Patterns. [3] Each major category consisting of various sub categories.

1) Myofascial Trigger Points

Myofascial trigger points are areas of increased irritability in muscle, fascia, ligaments and periostium associated with a condition called chronic myofascial pain. In some literature, you will still see the older term, myofascial pain syndrome. A syndrome consists of a specific set of signs and symptoms that occur collectively. On the other hand, a disease has a known and

defined cause, with mechanism(s) for producing symptoms. Myofascial pain due to trigger points is now considered a true disease, rather than a syndrome. [3] Chronic myofascial pain is considered nonprogressive, nondegenerative and noninflamitory. These trigger points, when present, feel like knots, nodules, or taut ropy bands that can be palpated and refer pain to other areas of the body in specific, predictable local and referred patterns. (See Appendix: Figure 1) These referral patterns do not follow the traditional dermatomal or myotomal patterns. The pain is often described as dull, achy and deep with varying frequency and intensity. [5] Stimulation of some trigger points may cause such seemingly unrelated signs and symptoms, as migraines, jaw pain, other headaches, neck pain, low back pain, earaches, pseudo-heart pain, heartburn, earaches and many more. [6]

Histological dysfunction and metabolic distress are thought to be possible causes of trigger points. [7] With direct palpation, there may be an observable twitch response along the skin by associated muscular activity. [7] According to, Wall & Melzack (1989), trigger point referral patterns are a major cause of sustained pain and dysfunction. They believe that trigger points are involved in all chronic pain conditions. In fact, they feel that trigger points play a major role in chronic myofascial pain.

Patients most often diagnosed with chronic myofascial pain are between the ages of 30 –60 years old, with a declining prevalence with increasing age. [5] Patients rarely present to the office, by pointing to a specific muscle as the source of their pain. However, they typically point to a general area/region as their site of pain. There is some confusion for the patient, when their chiropractor diagnoses the problem as being related to some other area, other than the general area they pointed out. This is when the chiropractor needs to explain the concept of trigger point referral patterns to the patient. Some common referral pattern misdiagnoses when trigger points were actually the cause of the symptoms are:

Initial Diagnosis [8]	Likely Trigger Point Sources [8]
Angina Pectoris (atypical)	Pectoralis Major
Appendicitis	Lower Rectus Abdominus
Atypical Migraine	SCM, Temporalis, Posterior Cervical
Low Back Pain	Low Rectus Abd, T/Lumbar paraspinals
Occipital Headache	Posterior Cervicals

Gutstein (1956) believes that manipulation of trigger points would decrease the symptoms experienced by the individual. The symptoms affected would include, pain, modification of pain, itching, hypersensitivity to physiologic stimuli, spasm, twitching, weakness and trembling of striated muscles; hypertonus or hypotonus of smooth muscle blood vessels, and of internal organs; hypersecretion or hyposecretion of visceral, sebaceous and sudatory glands. [3] These trigger points are considered to be "Active trigger points" since they are responsible for current symptomatology. There are many trigger points that are termed "Latent trigger points", since they are non-tender to pressure. [3]

Mechanical stresses can cause many of the active trigger points to remain active, even with direct treatment of the trigger point. Activation of the latent trigger points can also result from mechanical stresses. This makes it vital that one check for pelvic tilt, leg length inequalities, scoliosis, kyphosis, hypolordosis, and etc. when treating a patient. [9]

Medical stresses contribute to widespread, chronic myofascial pain syndromes. They are also considered chronic muscle pain. This condition is another variety of myofascial trigger points termed fibromyalgia. [9] There is one distinct difference between myofascial trigger points and fibromyalgia, in that palpation of the tender points of fibromyalgia does not cause a local twitch response. [5] Women more often than men are found to have fibromyalgia. In order for one to be diagnosed with fibromyalgia, they have to have widespread pain, usually associated with sleep disturbances, morning stiffness, and severe chronic fatigue for more than three months. [9 10]

A patient must also have pain and trigger points in no fewer than 11 of 18 sites with 4kg of finger pressure applied. [11] (See Appendix: Figure 2)

According to Gustein, the changes necessary for the onset of fibromyalgia include, localized sympathetic dominance, associated with changes in the hydrogen ion concentration, calcium and sodium balance in the tissues fluids. These changes are linked to vasoconstriction and hypoxia/ischemia. It is believed that this change affecting the pain sensors and proprioceptors results in pain. [3] The result of the increased pain is more muscle spasms and hard nodules. These spasms and nodules increase the amount of local vasocomotor and musculomotor stimulation, leading to a perpetual cycle of "Pain-Spasm-Pain". [3]

For the treatment of both chronic muscle pain and fibromyalgia, a multi-disciplinary approach needs to be utilized. Treatments that include the patient's participation are more likely to be successful. [4] It is crucial to identify, eliminate and/or correct perpetuating factors. [4] When treating chronic muscle pain, it is also important to remember that trigger points usually refer pain to other areas. Therefore, the actual area of dysfunction needing treatment may not be located in the area that is actually hurting.[12] This concept emphasizes how vital it is that the chiropractor who is treating patients with chronic muscle pain must have a good working knowledge of trigger point referral patterns.[12]

Nonpharmacologic, physical intervention approaches to treatment, according to Travell and Simons, will affect, but not necessarily deactivate a trigger point. [8] Other nonphysical intervention, such as biofeedback, positive thinking, progressive relaxation, meditation and others will not help.[12] Acupressure, cranialsacral therapy, shiatsu, myofascial release, deep tissue bodywork, Swedish massage and other forms of therapeutic treatment may not be specific enough to successfully treat trigger points. Applications of electrical stimulation, as well as heat and cold are likely to provide only temporary relief. If too broad of approach to physical

methods are applied, they may also fail.[12] For example, conventional stretching exercises or yoga are not likely to be specific enough to improve trigger points, and if overdone, they may even make the condition worse. [12]

Exercise programs, though minimally effective by themselves, are a vital part of any course of treatment in Fibromyalgia. The natural tendency when fatigued is to try and rest as much as possible. The result is deconditioning of the muscle tissue and a worsening the symptoms of Fibromyalgia. It is better to slowly incorporate a moderate workout routine of aerobic exercise, strength training, and stretching into every day. Regular exercise is beneficial in treating sleep disorders, which play a major role in Fibromyalgia Syndrome. However, it is important to start slowly, with perhaps five minutes of light aerobic exercise per day, but never to doing anything that increase muscle pain. [13]

Many people today are looking for a more holistic/natural approach for most aliments, preferring treatment with herbs and nutrition to standard medications. Proper nutrition is a key in decreasing the muscular tension and trigger points that are caused by certain foods and beverages. Removal of excitotoxins, such as: caffeine, alcohol, aspartame and Monosodium glutamate (MSG), along with refined sugars, sucrose, chocolate and nicotine are vital in helping manage the symptoms. [13 14] Helpful nutritional supplements include calcium/magnesium tablets, malic acid, and B-complex. [15] Commonly used herbs include St. John's Wort for depression, Valerian for sleep disorders, and Evening Primrose Oil, whose fatty acids benefit the body in many ways without causing adverse side effects. [4]

Because modern chiropractic treatment has evolved to incorporate mind, body, and spirit, it is an ideal approach to treating the multifaceted symptoms of Fibromyalgia Syndrome. Any adjustment given must be gentle and to the tolerance of the patient. The adjustment should be targeted at keeping the spinal biomechanics in alignment allowing minimal stress on the

muscular system. Fibromyalgia can be rather slow to respond, so patience is needed. As a general rule of thumb, it is best to try regular chiropractic treatment for at least three to four weeks before deciding its effectiveness.

Any direct treatment of trigger points needs to be applied directly to the trigger points to successfully neutralize them.[9] The two methods to treat trigger points that Travell and Simons discuss most, are "trigger point injections" and "spray and stretch." Doctors or physical therapists usually carry out both of these treatments.

Trigger point injections are usually given using a local anesthetic. However, the use of a acupuncture, may be useful in some patients.[4 9] These injections are less likely to be beneficial in patients who have both chronic muscle pain and fibromyalgia.[4] There are many doctors who perform trigger point injections, but there are few who can do them properly. Administering the injections requires a great deal of skill; and a lack of expertise can cause more harm than good.[9] Even when properly done, trigger point injections can be very painful. Medication prior to the actual trigger point injection may be helpful.[4] Inducing considerable pain in this population can cause long-lasting neuroplastic changes in the spinal cord that tend to enhance pain.[4] Spray and stretch is safer and easier to use than trigger point injections, and is the method generally favored by Travell and Simons.[9]

Spray and stretch differs from conventional stretching in that the trigger point is directly treated before the affected muscle is stretched. The skin is sprayed with a vapocoolant spray, and then the affected muscle is stretched. A thorough knowledge of trigger point locations and referral patterns is vital to proper application, especially since the trigger point involved may not be within the area that is actually hurting. Several other steps, including correct chilling of the skin, rewarming and possible gentle movement through the complete range of motion, are essential.

Improper technique can do more harm than good. Travell and Simons believe that the safest and most effective therapy, however, is a "deep stroking massage" directly to the trigger point.[9] This treatment is more specific and has a greater effect on the trigger point than spray and stretch. There is also less risk to muscle attachments. Deep stroking massage can be nearly as effective as, and in some cases superior to, trigger point injections. Deep stroking massage can sometimes be adapted for self-treatment, which has the obvious benefit of providing pain relief, but can also return some degree of control back to the patient. [9]

Along a more pharmacologic approach, Nonsteroidal anti-inflammatory drugs (NSAIDs) do not appear to be very beneficial in treating the symptoms of chronic muscle pain. The use of low-dose antidepressants or narcotics may offer relief. Tricyclic antidepressants are an example of low-dose antidepressants, which may be prescribed for patients to take at bedtime, to help relieve symptoms.[16]

Opioid narcotics are not usually considered as a first-line treatment for chronic muscle pain, but for some patients they may be a viable option for pain relief, since NSAIDs are not likely to be beneficial.[4] As always, healthcare providers and patients must be clear about the differences between addiction, tolerance, physical dependence and pseudo-addiction; there is ample data to support that the development of true narcotic addiction is extremely rare in patients who use narcotics for pain relief.[17] More education, however, is needed on the appropriate use of narcotics in patients with chronic muscular pain. Patients who take narcotics for chronic pain do not get "high" or "euphoric;" instead, they are usually relieved to regain a semblance of what they had once considered a normal lifestyle.

Narcotics seldom eliminate pain entirely, but they may reduce it to a level that allows the addition of other modalities and adjustments to a patients treatment plan, to further reduce pain and facilitate a healthier lifestyle.[4] When a combination of medications and other therapies is

found that helps the patient's pain, it is appropriate to continue using them; otherwise, symptoms will reoccur.[4]

2) Pseudoradicular Syndromes

Viscerosomatic pain (Visceral pain) and Somatovisceral (Somatic pain) pain are the two main categories of pseudoradicular syndromes. The viscera are thought to be relatively insensitive, yet excessive stretching or contraction of smooth muscle, as well as certain pathological conditions may bring about an awareness, discomfort and/or pain sensation. [18] Visceral pain is recognized most notably by the characteristics of being poorly localized with referral to somatic structures. There are five main characteristics of viscerosomatic pain which include: 1) Visceral pain is not evoked from all viscera, 2) Visceral pain is not linked to visceral injury, 3) Visceral pain is referred to other locations, 4) Visceral pain is diffuse and poorly localized, and 5) Visceral pain is accompanied by motor and autonomic reflexes. [19] True visceral pains, such as heartburn, nausea, hunger, bladder or rectal fullness and sexual sensations, can be provoked acutely with poor localization, along with feelings of dullness and achyness. [18] There is also a general feeling of being ill, with strong autonomic responses like sweating and nausea. . [19] With prolonged stimulation of visceral nociception, the pain becomes more localized and is felt in more superficial structures, sometimes at places far removed from the originating organ of true visceral pain. This phenomenon is termed referred pain. Along with referred pain, there typically is an associated hyperreflexia, muscle and skin tenderness, as well as muscle spasms. [19]

Visceral pain is usually associated with inflammation or chemical irritants, such as stomach acid. This suggests that visceral afferent nerves are more sensitized as a result of inflammation are more likely to produce pain when stimulated. [20] The activation of chemically sensitive visceral afferents is the result of complex mechanisms that lead to the buildup of metabolic

products. Some of these metabolic products (metabolic wastes) can directly stimulate or sensitize the nerve endings, while other indirect metabolites play a role. [19] With ischemia of certain visceral organs, there is a resultant hypoxia. Hypoxia creates local anaerobic conditions, which results in a buildup of lactic acid. These processes are thought to be two important stimuli of the visceral afferent nerve endings. Hypercapnia is also present in ischemic conditions and causes a raise in tissue pH similar to lactic acid, however it is not considered to be a major contributor in the pain pathway.[19] The source of the pH change is the more important factor. The presence of molecular oxygen during both ischemia and reperfusion, leads to the formation of several oxygen species. Two of theses species include, H2O2 and –OH are catalyzed through the Haber-Weis reaction in the presence of free iron. These products are produced to such extent that they overwhelm the bodies' local protective mechanisms resulting in stimulation of the nerve endings. [19] The increase in the utilization of the cyclooxygenase pathway leads to increased production of PGE2. PGE2 has the effect of sensitizing the nerve endings to such substances as bradykinin, a byproduct of ischemia. Bradykinin has a direct effect on the nerve endings, as well as being a stimulant of the cyclooxygenase pathway producing PGE2. [19] The product, 8R, 15 SdiHETE, from the 15-lipoxygenase pathway, acts like PGE2 in increasing afferent nerve endings. The 5-lipooxygenase pathway has the opposite effect from PGE2 and 8R, 15 SdiHETE, in that LTB4 is produced and has an effect of inhibiting the afferent nerve endings during ischemic conditions. [19]

The combination of the above metabolic pathway products results in an overall increase in afferent nerve stimulation in the abdominal region during ischemic conditions. Bouts of extreme ischemia have even been associated with strong cardiovascular reflex pains. [19] More studies are needed to better understand the role of other metabolic products, like substance P and others, that may play a role in the stimulation of the visceral afferent pathways.

With the stimulation of the visceral afferent pathway, there is now a link from the ischemic/metabolic changes of the visceral system to the nervous system. This begins the true viscerosomatic reflex (See Appendix: Figure 3), which is the result of an afferent stimulus coming from a visceral pathology/stressor that has stimulated visceral receptors. The stimulus travels from the visceral receptors to the dorsal horn of the spinal cord, synapsing with interconnecting neurons. From the neurons, the stimulus is relayed to the sympathetic and peripheral motor efferents resulting in sensory and motor changes in somatic tissues. [21]

The viscerosomatic reflex is polysynaptic, with visceral afferents synapsing in the dorsal horn. Some postsynaptic fibers ascend toward the brain, while others relay to the motor efferents. [21] Stimulation from the visceral system, somatic system, as well as higher centers of the brain come together in the dorsal horn of the spinal cord. This connection is thought to allow for a spillover from one system to another resulting in facilitation, suppression or recruitment. [21] The general referral sites for the visceral system includes: 1) Thoracic viscera refer to the T1-T5 spinal levels, 2) Abdominal viscera refer to the T5-T10 spinal levels, and 3) Pelvic viscera refer to the T10-T12 spinal levels. [21] (See Appendix: Figure 4)

A myocardial infarction is an example of a viscerosomatic referred pain. Each heartbeat requires energy. That energy comes from the flow of blood through the coronary arteries. A blood clot interfering with the flow of oxygenated blood to any one or more of these arteries is termed a myocardial infarction. This cuts off a section of the heart off from its blood supply. This lack of blood sets off a discharge of messages via the nerve fibers that supply the heart to the spinal cord. The patient immediately experiences a deep diffuse stomach discomfort and a feeling that something is very wrong. The nerve fibers in the heart do not allow for precise localization, but they allow a general feeling of anguish, breathlessness, nausea and sweating. [22] This is only the beginning of the pains experienced by a heart attack patient. With the continued

blocking of the coronary arteries there is a spillover of excitation into nearby pathways, leading to the traditional pain we hear about in the chest, arms and neck.

There are other viscerosomatic pain patterns that occur, such as the appendix having a referral of pain more central in the abdomen at first, and then progressing to the more traditionally known right lower quadrant pain. The pancreas has a referral pattern to the middle of the back that is relieved with leaning forward. Heartburn of acid reflux is a referral of pain to the throat that results from stomach acid leaking out through the esophageal sphincter, which most often relieved by sitting up. This is just a few of the more well-known viscerosomatic referral patterns.

To differentiate visceral pain from superficial somatic pain, there is a distinction that visceral pain is typically dull and diffuse, while somatic pain is more well localized. Pathological stimulation of the superficial somatic structures would provoke a specific, well-localized protective response, such as flexion-withdrawal reflex. Any visceral pathology stimulation would be more generalized. [19] There is a vast overlap in the physical descriptors that patients use to describe both visceral pain and somatic pain. This generalization does not allow for easy differentiation between visceral or somatic pain by descriptors alone. Regardless of the confusion of describing pain symptoms, there is a distinct difference between visceral pain and superficial somatic pain.

Any symptoms of referred visceral pain are used diagnostically to determine internal organ dysfunctions. The clinical importance of proper understanding of the symptoms of visceral referred pain has been investigated as a major focus since the middle of the 19th century. With the invention of more technology to view/access the internal structures, there has been less focus on the subject and more on proper testing strategies to investigate the symptoms experienced by the patient. [19]

Somatovisceral pain is a misnomer, in that there is no real pain experienced in the visceral organs upon stimulation of the somatic nervous system. To better understand this, an explanation of the reflex patterns involved in the somatovisceral reflex is in order. The motor afferent neurons of agonist muscles receive afferent input from the agonist and antagonist muscles. The motor reflex beginning in the muscle afferents is termed a proprioceptive reflex. The motor reflex beginning in the antagonist muscle afferent is termed an exteroceptive reflex. Stimulation of the exteroceptive reflex may also occur with excitation of the cutaneous afferents. Reflex regulation of the autonomic nervous system is very similar to the somatic nervous system, except that the visceral organ receives both parasympathetic and sympathetic innervations. The parasympathetic and parasympathetic systems are independent; yet act reciprocally like their somatic counter parts. The activity of the autonomic preganglionic neurons from the brain stem or the spinal cord can be regulated by excitation of the proprioceptive and/or exteroceptive afferents. The proprioceptive afferents are the visceral afferents from the visceral organ itself, while the exteroceptive afferents are other visceral and somatic afferents. [21] This reflex is better known for its effects on the autonomic nervous system and associated organ(s).

With lab tests performed on anesthetized animals, all emotional input is removed. Upon anesthetizing the animals, somatic afferent nerve stimulation was shown to have a reflexive regulatory effect on the different visceral functions. The conclusion after these tests, was that the effects of somatic afferent stimulation are dependent on which organ and on the specific spinal afferent segments stimulated. Thus only certain visceral organs react to certain levels and/or areas of stimulation. [21] For example, cerebral blood flow is dramatically increased with stimulation of the skin of the hindlimb or forelimb, while gastrointestinal motility is strongly inhibited upon stimulation of the abdominal skin. Somatic afferent stimulation will always have

an effect on heart rate, gastric motility, as well as the functions of the bladder, adrenal medulla, sweat glands, adrenal cortex and cerebral blood flow. [21]

There is still, to this day, some confusion as to understanding which way the communication between viscera and somatic tissues occurs, how the sensory changes in the referred zones are produced, how autonomic changes in referred zones are generated, how trophic changes are brought about, as well as how the beneficial effects on viscera and deep somatic tissue occur from exertion on the body surface. It is commonly accepted that most of the above effects are linked in the neurologically controlled via the spinal cord with the sympathetic system having a major influence. [21]

Testing for both viscerosomatic and somatovisceral pain is centered on the one common link. The central nervous system is that link. The spinal column houses the central nervous system and is the key to the referred pain that patients experience. Improper motion between the vertebral segments, as well as the differences in muscular tension from spinal segment to spinal segment are the main criteria used to locate the related region of the spinal column. [21] Compiling this information with a proper history, consultation and examination is like putting the pieces of a puzzle together. If you put them together right, then you get a pretty picture, but missing of these pieces leaves one with a rather jumbled one.

The motion tests used to stress the available motion are of a passive nature, comparing the segments ability to move, along with its range of motion in flexion, extension, bilateral lateral flexion, as well as bilateral rotation. The data received at each level is compared to the corresponding motion segments above and below. Active respiration is a sixth motion that is also analyzed in inspiration and expiration from segment to segment. [21] Any restrictions in motion clues the chiropractor to look at the surrounding musculature innervated by that restricted motion segment. Frequently there is tenderness with touching or motioning the affected region

of the spine. They will find hypertonic, hypotonic or normal muscular tone. The hypertonic and hypotonic muscles with their corresponding restricted motion segment are also linked together with their associated visceral organ(s). [21]

Many individual case studies and group studies have shown that chiropractic adjustments can and do have an effect on the visceral and somatic systems. In one study there were 15 individuals evaluated for changes in pupillary diameter following a sham adjustment or true chiropractic adjustment. [23] Upon completion of the study, it was concluded that an adjustment could elicit an autonomic somatovisceral reflex of pupillary diameter. Investigators reported seeing parasympathetic and sympathetic responses in the different subjects with adjustments in the same segmental region. The true adjustments given to those who were subluxated showed the most consistent change in pupillary diameter. This study has shown that an adjustment does have wide spread effects in the nervous and visceral systems related to the treated segmental level. [23]

In another study, a 39-year-old woman with mechanically induced pelvic pain and organic dysfunction without back pain. She relates her pelvic pain to a fall down a flight of stairs when she was 18 years of age. The diagnosis of her symptoms was related to lower sacral nerve root compression. [24] This and other reported cases showed that even severe and long-standing pelvic organic dysfunction in patients with signs of lower sacral nerve root compression responded very effectively to chiropractic distractive decompressive manipulation. This is more impressive, when compared to the results of more conventional procedures. [24]

As the above studies show, treatment of the involved spinal segments has the ability to affect the visceral organs innervated by that same segment. Chiropractic adjustments delivered to the vertebral segment, with aberrant motion, are aimed at restoring the joint to its proper alignment and motion. Restoring proper motion helps to decrease the somatic afferent stimulation that has

been adding to the facilitation of spinal pathways, thus breaking the self-perpetuating cycle between the viscera, spinal cord and musculature. Breaking this cycle includes a decrease in somatic motor efferent stimulation, allowing muscular activity to return to normal. This is the more obvious result that can be seen and/or palpated after an adjustment, but there is also a change in the autonomic (sympathetic and parasympathetic) nervous system. These changes involve normalizing any over or under stimulation of either the sympathetic or parasympathetic pathways allowing a return to a more normal visceral tone.

As an adjunct to chiropractic adjustments, other modalities are often utilized to facilitate breaking the cycle between the viscera, spinal cord and musculature, these include: various forms of massage therapy, electrical muscle stimulation, ultrasound, acupuncture, strengthening exercises, stretching exercises, pain medication, muscle relaxers and anti-inflammatories. The use medications are more to help bring inflammation and pain down to a tolerable level, so that normal activities of daily living can be achieved. Alternatives to the typical medical doctor type treatments are more effective at helping remove the actual problem and not just mask the symptoms. Massage therapies are used to help restore proper posture and joint movement, remove waste products that build up from spasms and trigger points, all of which allows for normalization of muscle tone. Electrical muscle stimulation is ideal for reduction of pain and muscle spasms, also the removal of waste products that build up from spasms and trigger points. The use of acupuncture is suited for pain management, reduction of muscle spasms and trigger points, and also in balancing the energies of the bodies various systems. Ultrasound therapy is used to help remove waste products, breakup scar tissue and increase blood flow to the area for nutrition. Once the pain levels are starting to improve, then a combination of muscle strengthening and stretching are added to the treatment protocol to help prevent a reoccurrence.

Adding these therapies in various combinations with chiropractic adjustments has a summation effect, making each more effective than if used individually.

3) Spinal Pain Patterns

Most people will experience either pain in their neck, mid back, or low back at sometime in their life. About 60% will experience low back pain that forces them to take more than a week off work. In most of cases, the pain will subside in about one to three weeks, while others may take months or they may never fully recover. There are three main possible causes of spinal pain patterns that appear directly related to the spine, which include: intervertebral discs, facet joints and vertebral fractures. [22]

The intervertebral disc is the main joint of articulation between vertebrae composed of an anulus fibrosis and nucleus pulposis. The nucleus is 90% water in a young person and is like an incompressible gel. As one ages, the disc ages itself by becoming more dehydrated and less flexible. Over the day a process called creep takes place, where the disc is compressed due to the forces of gravity. This condition is reversed while we sleep. [25] Pressures in the disc also vary depending on posture. The most pressure is achieved during sitting while leaning forward (275%) [26] (See Appendix: Figure 5)

Disc degeneration takes place in three clinical stages: 1) Dysfunction, 2) Instability and 3) Stabilization. With intervertebral disc dysfunction, there is little actual pathology and findings are subtle or nonexistent. Common diagnosis in this stage is Lumbago and rotary strain. Instability involves abnormal movement with more severe complaints from the patient. At this level there are now objective findings present. Treatment is conservative with surgery as a final option. Stabilization occurs with severe degenerative changes. The disc and facets have a

reduction in the range of motion possible at the once unstable joint. Improvement in symptoms may occur, but there is a high likelihood that stenosis will occur. [26]

There are seven classifications of low back pain, these include: 1) Acute back sprain (Type I), 2) Idiopathic fluid ingestion (Type II), 3) Posterolateral anulus disruption (Type III), 4) Bulging disc (Type IV), 5) Sequestered fragment (Type V), 6) Displaced sequestered fragment (Type VI) and 7) Degenerative disc (Type VII). Type I acute back sprain is associated with lifting an excessive load. The result is immediate, severe pain that may last for several weeks. A cause for the pain is thought to be the result of muscle belly rupture or mild end-plate fracture. [26]

Type II idiopathic fluid ingestion is associated with low back pain and local muscular spasms. The cause of the pain and spasm is related to the escaping of fluid from the nucleus pulposis irritating the nociceptors in the outer anulus fibrosis. The outer anulus fibrosis contains afferent and efferent nerve fibers. The afferent nerve endings are associated with proprioception and nociception. Chemical nociception comes from the intervertebral disc. There is some belief the free nerve endings are associated with vascular changes. A lack of motion in the joint will not allow proper nutrition to get into the intervertebral disc and the resulting waste products buildup will set off the nociceptive nerve endings in the outer anulus. This means pain would be experienced as a result. [26] The type of pain experienced is usually not explainable through x-ray or MRI because, no disc bulge or herniation is visible to explain the symptoms. A discogram is needed to see the leakage of fluid from the nucleus pulposis in the disc, which is actually the cause of the pain. [26]

Type III posterolateral anulus disruption is damage to the anulus in the posterolateral aspect of the disc causing low back pain with referral to the sacroiliac region, the buttock or the back of the thigh. This type of referral of pain is differentiated from true sciatica; by the lack of positive straight leg raise test and no neuromuscular deficit. The healing process for this type of disc

damage is through reabsorption, neutralization of the irritant or by phagocytosis. This healing process takes about 2-3 months. [26]

The Type IV bulging disc is responsible for generating low back pain with sciatica. The bulge is believed to be held in place by the posterior longitudinal ligament. With this condition there is the possibility of "true sciatica" which can be caused by chemical irritation or mechanical pressure on the nerve root. The straight leg raise is positive with type IV bulging disc. Also, there is pain found in the low back, buttock, thigh, lower leg, and foot that can possibly be increased with sneezing and/or coughing. [26]

Type V sequestered fragment is a section of the nucleus pulposis that is able to move about the disc depending where disruption is in the anulus. This movement is able to cause irritation of the anular fibers by physical or chemical means. There is often a bulge associated with the sequestered fragment causing true sciatica. The movement of the sequestered fragment may move away from the anulus and be asymptomatic or cause symptoms of pain in the spine, referred pain and true sciatica. [26]

Type VI displaced sequestered fragment is displacement of the nucleus pulposis or the anulus fibrosis causing low back pain and sciatica. Nerve root irritation occurs from one or a combination of chemical irritation, mechanical pressure or autoimmune response. There may be a narrowing of the intervertebral foramen caused by the displaced fragment. Displaced sequestered fragments may respond to axial traction or adjustment, but most often they need to be removed by surgery. [26]

The Type VII degenerative disc is unable to function in its capacity of shock absorber due to so much disruption of the anular fibers. There are arthritic degenerative processes of the vertebral bodies or the intervertebral joint. The pain can come or go, as well as be chronic. [26]

In studies of chiropractic adjustments of patients with disc lesions, the technique used was Cox flexion distraction techniques. With this technique, the patients were grouped into those with low back pain only and those with low back pain with sciatica. Treatment of those with sciatica below the knee were treated with flexion only until their symptoms reduced by 50%, then all ranges were added to treatment at that time. Those with pain only in the low back or only to the knee were treated with all ranges of motion the whole time. The adjustments have been shown to be beneficial through increasing spinal range of motion, decreasing nociceptors irritation, as well as shifting the biomechanics of the weightbearing spine more to the intervertebral disc. This shift, along with increased spinal range of motion is attributed as the reason that patients experience great relief. [26]

Along with chiropractic adjustments, physical exercises need to be added to stabilize the core musculature. The goal is to reduce any hyperlordosis or increase the overall lordosis. To decrease the lordosis, there is use of abdominal strengthening, hamstrings and lumbar stabilizer muscles, as well as also stretching the lumbar erectors and quadriceps muscles. To increasing the lordosis involves strengthening the quadriceps muscles and low back erectors, along with stretches to the hip flexors and hamstring muscles. In cervical disc conditions, there is more of a focus on restoring the lordotic curve and reduce the muscular pull on the neck. This is accomplished by strengthening the deep neck flexors, while stretching the scalenes and posterior cervical musculature. [15]

The facet joint is responsible for stabilizing the spine in rotation and slippage. In a healthy person, the facets carry approximately 20-25% of axial forces. With disc degeneration or thinning, this number may rise to near 70%. [25] This increased load placed on the facet will not go without negative results, since it is a synovial joint, development of osteoarthritis may occur. [25]

The degeneration in the facet will cause increased scleratogenous pain due to a rich supply of nociceptors in the facet capsule. [25 27] This condition is called facet syndrome.

The patient cervical facet syndrome may present with a history of dull, achy pain, sharp with acute episodes, headaches and limited range of motion. Occasionally the scleratogenous type pain will radiate into the shoulder or mid back region, but it will rarely radiate beyond the upper thoracic spine or past the elbow. (See appendix: Figure 6) There most often will be a history of whiplash.[15]

Upon examination, the patient may present with: 1) More pain on extension, 2) If antalgia is present, it will be away from the involved side, 3) Orthopedic test will present as: pain with lateral bending extension, local pain with cervical compression, decreased pain with distraction, negative for nerve root tension signs, 4) Possible muscle guarding and decreased range of motion, and 5) Noneurological deficits in deep tendon reflex or muscular strength. [15]

A patient with lumbar facet syndrome will present with a history of low back pain at rest that is relieved with limited activity. They will describe the pain as sharp, well-defined, superficial pain that may be unilateral. More pain is produced with extension of the spine, excessive sitting and repetitive movements. Weather changes may also be an aggravating to the patient. [14]

There is more diffuse pain and stiffness in the morning, along with sacroiliac joint pain. The pain may radiate into the upper thighs, groin, hip, buttocks and often in the leg. (See appendix: Figure 7) Relief is most common sitting for short periods or lying down with the knees pulled up. This position opens the facet joint taking pressure off the nociceptors in the joint capsule. [14]

Upon examination, there will be tenderness to palpation of the lumbar spinous processes and transverse processes. Neurological testing will be essentially negative. Orthopedic tests that will show up as positive are: 1) Straight leg raise, 2) Goldthwait's may be positive, 3) Kemp's test

positive for low back pain and not radicular symptoms, 4) Dejardine's triad may be positive and 5) Spinous percussion tenderness. [14]

There are several treatments that are used for facet syndromes, these include: 1) Facet injections, 2) Facet denervation, 3) Chiropractic adjustments and 4) Physical exercises. With facet injections, there is a corticosteroid that is injected into the involved facet joint. Results varied from study to study using different corticosteroids. The studies of chronic facet pain that used a combination of lidocaine (2%) injected into the facet joint, followed by 2mg of cortivazol injected near the joint had the most relief at 22 of 40 reporting near 90% relief of pain. Other studies were showing 1 in 5 showing improvement for 1-6 months. These results vary from 20% to 55% showing improvement. Facet joint injections are done routinely in the United States despite these low numbers. [26]

Radiofrequency facet denervation is a procedure that destroys the nerve supply to the facet joint. Clinical studies have shown that 42 of 82 patients treated had at least 50% relief of symptoms. From the original 42 patients that showed at least 50% relief, 45% of those had at least 50% relief 2 years after the procedure. Further testing on the patients that had little to no relief showed that their source of pain was more related to the intervertebral disc. These results indicate that facet joint and capsule are not the main source of pain in chronic low back patients. [26]

In studies of chiropractic adjustments of patients with facet syndrome, the technique used was Cox flexion distraction techniques. With this technique, the patients were grouped into those with low back pain only and those with low back pain with sciatica. Treatment of those with sciatica below the knee were treated with flexion only until their symptoms reduced by 50%, then all ranges were added to treatment at that time. Those with pain only in the low back or only to the knee were treated with all ranges of motion the whole time. The adjustments have

been shown to be beneficial through increasing spinal range of motion, decreasing nociceptors irritation, as well as shifting the biomechanics of the weightbearing spine more to the intervertebral disc. This shift, along with increased spinal range of motion is attributed as the reason that patients experience great relief. [26]

Along with chiropractic adjustments, physical exercises need to be added to stabilize the core musculature. This is accomplished for lumbar facet syndrome through strengthening the abdominals, hamstrings and lumbar stabilizer muscles, as well as also stretching the lumbar erectors and quadriceps muscles. The goal is to reduce the hyperlordosis that is commonly present in facet syndrome. In cervical facet syndrome, there is more of a focus on restoring the lordotic curve and reduce the muscular pull on the neck. This is accomplished by strengthening the deep neck flexors, while stretching the scalenes and posterior cervical musculature. [15]

Vertebral fractures are a source of pain along with the facet joints and intervertebral discs. The fractures of the vertebral endplate can, either induce pain through direct mechanical stimulation of the nociceptors in the outer rings of the anulus or by chemical irritation from bleeding into the intervertebral joint space. This type of pain would be quite like the pain associated with Type II idiopathic fluid ingestion. [26]

Along with a vertebral body fracture, there are also fractures that involve the pars interarticularis, facet, transverse process and spinous process. A pars interarticularis fracture is know as a spondylolysis and occurs in children by 5 to 6 years of age. There may or may not be low back pain involved with this type of fracture. [15] Patients are often asymptomatic. If the fracture allows for anterior vertebral slippage, then there may be low back pain present from increased stresses on the facets and intervertebral discs. The most frequent cause of a pars fracture is repetitive flexion and extension activities, like gymnastics and rowing. Any pain will be in a nondermatomal pain pattern into the leg, but this is a rare occurrence. [15]

The basic treatment for a vertebral body fracture is rest and time. In more and more cases of vertebral body fracture, people are having a rubbery/concrete substance injected into the vertebra to return strength and stability to the area, along with minimizing the postural changes. Depending on the grade of slippage present after acquiring a pars defect, the treatment may vary. Grades I and II spondylolisthesis may be treated by adjusting the vertebra above the associated level for biomechanical effects. Individuals with grades III and IV spondylolisthesis may require bracing or surgery for stability. Some physical therapies, like ultrasound, muscle stimulation and massage therapy may also be utilized to offer some relief of symptoms. [15]

C) Conclusion:

Referred pain is a challenging concept to grasp. Truly knowing the referral patterns of: 1) Myofascial trigger points, 2) Pseudoradicular syndromes and 3) Spinal pain patterns is vital as a chiropractor in making proper diagnoses. The key to proper treatment of patient's symptoms comes from paying careful attention to what they say during the history and consultation process. A well-taken history will point a chiropractor in the right direction in deciding what physical exams to perform, which will prove or disprove their differential diagnosis. Once the proper diagnosis is obtained, the proper treatment can begin. Without it, any treatment given is just a shot in the dark at finding a solution to the patient's symptoms. One would not want to give a person with a grade III or IV spondylolisthesis an adjustment on an already hypermobile vertebral segment. A patient with fibromyalgia may not be able to handle an adjustment or deep massage treatment. If one runs into a patient that is not responding as expected to a given treatment, then step back and reassess, because the proper diagnosis of the referral patterns is everything.

Appendix

Figure 1: Myofascial Trigger Points

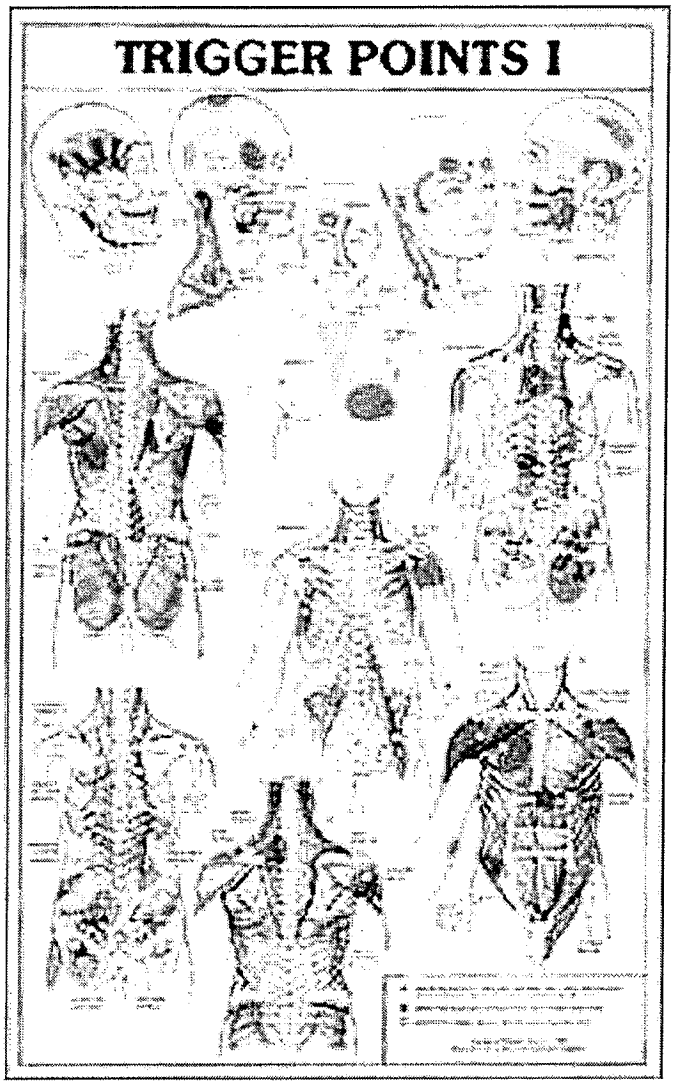


Figure 2: 18 points to diagnose fibromyalgia

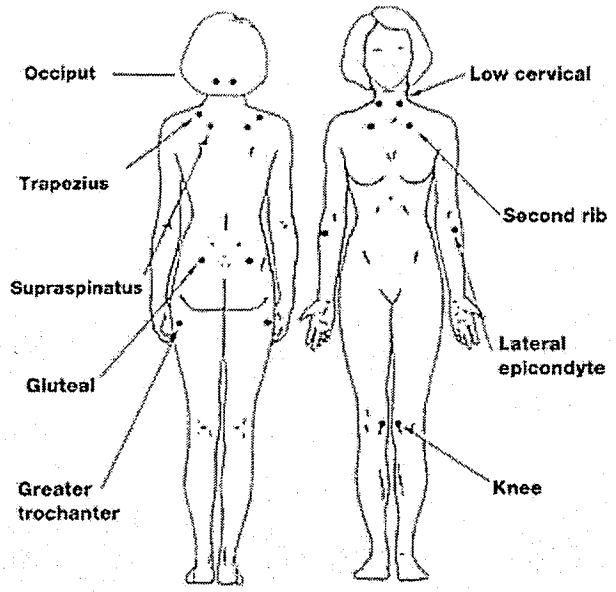


Figure 3: Viscerosomatic reflex

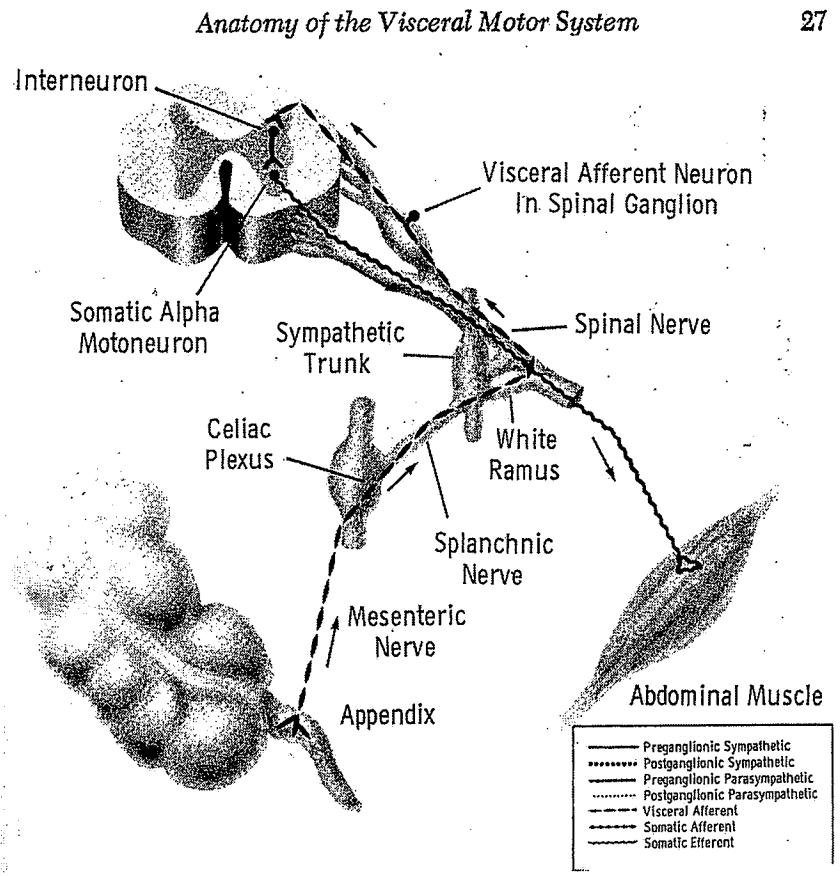


Figure 4: Viscerosomatic referral patterns

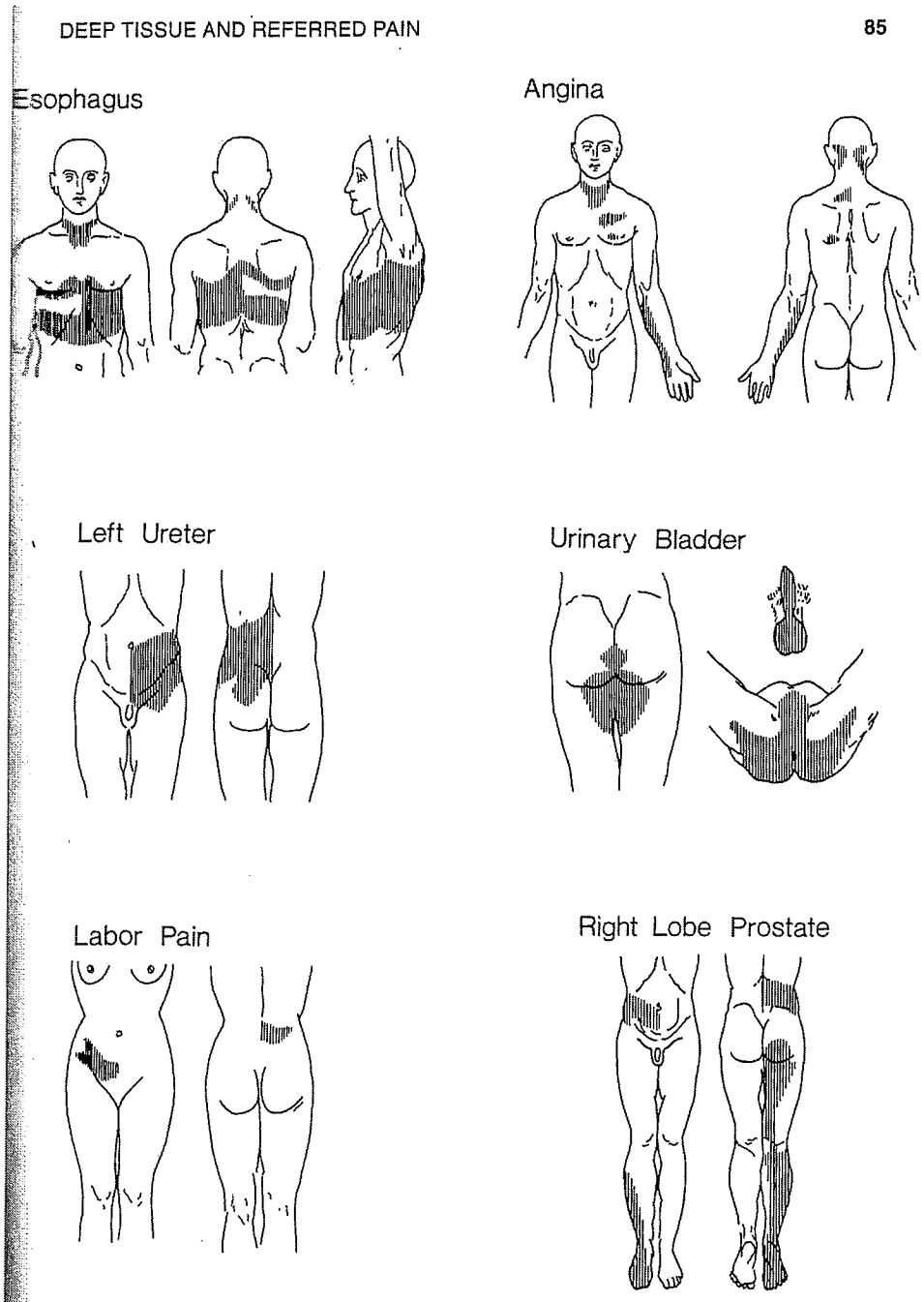


Figure 4.2 *Stippled regions* illustrate zones of cutaneous hyperalgesia produced by disease of different viscera. (Adapted from Head, H.: On disturbances of sensation with especial reference to the pain of visceral disease. *Brain* **16**:1–132, 1893.)

Figure 5: Disc pressures

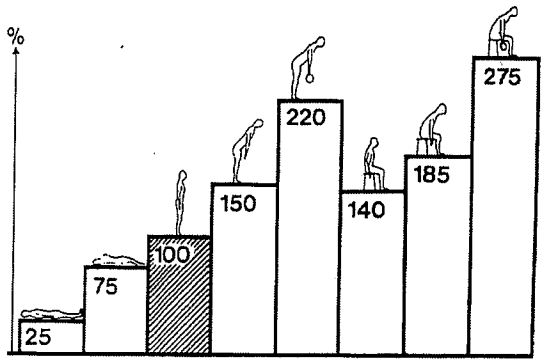


Figure 2.76. Relative change in pressure (or load) in the third lumbar disc in various positions in living subjects. (Reprinted with permission from Nachemson AL. The lumbar spine, an orthopaedic challenge. Spine 1976;1(1):61.)

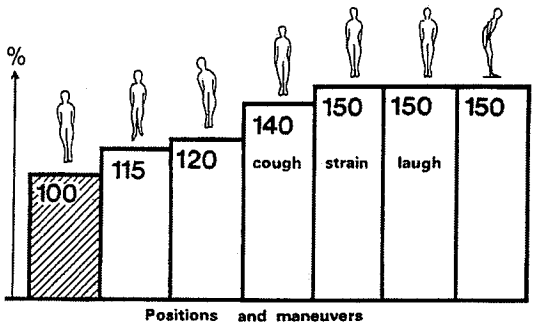


Figure 2.77. Relative change in pressure (or load) in the third lumbar disc in various maneuvers in living subjects. (Reprinted with permission from Nachemson AL. The lumbar spine, an orthopaedic challenge. Spine 1976;1(1):61.)

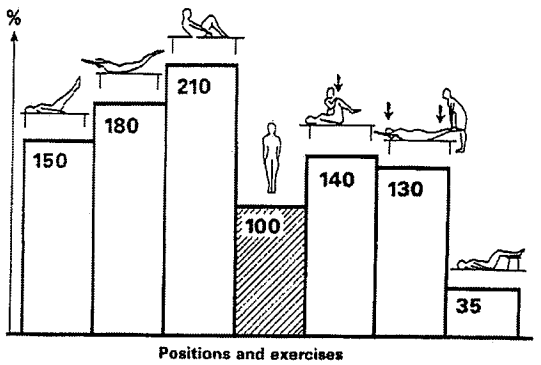


Figure 2.78. Relative change in pressure (or load) in the third lumbar disc in various muscle-strengthening exercise in living subjects. (Reprinted with permission from Nachemson AL. The lumbar spine, an orthopaedic challenge. Spine 1976;1(1):61.)

Figure 6: Cervical facet referral patterns

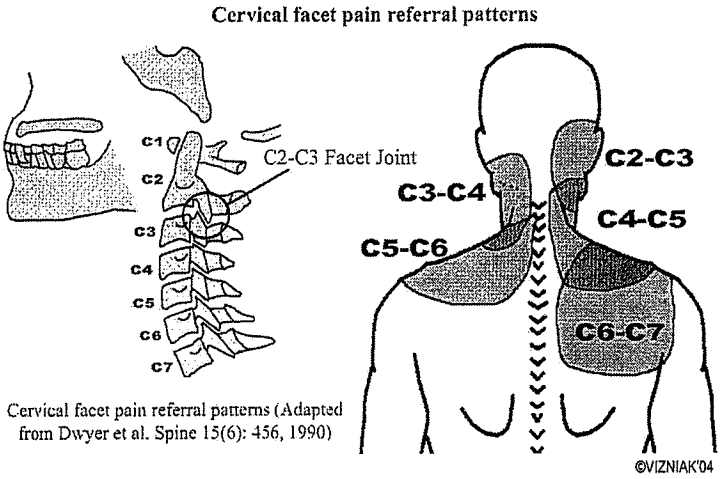
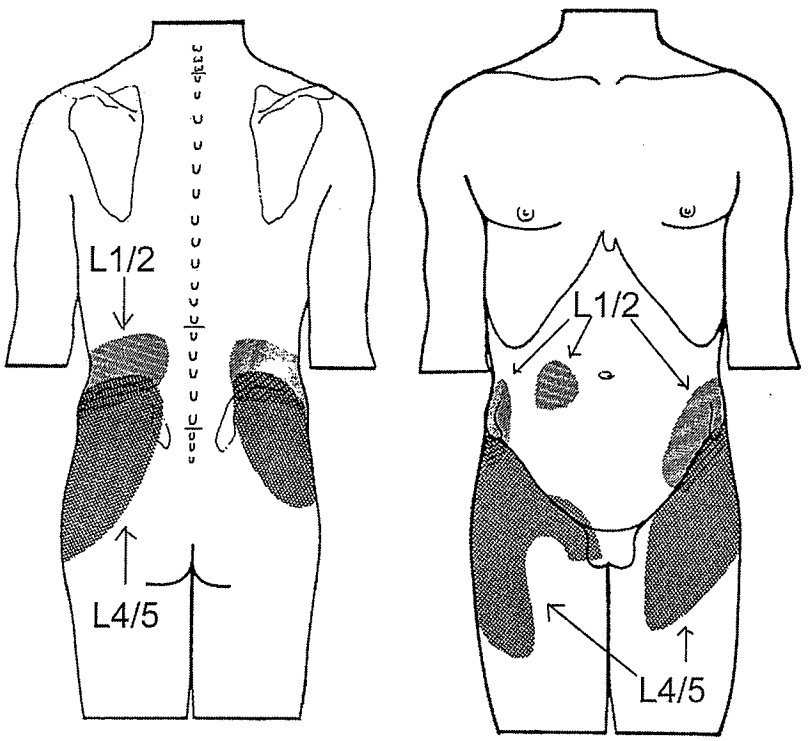


Figure 7: Lumbar facet referral patterns



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