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Visceral Referred Pain to the Shoulder

An important component of the initial orthopedic evaluation is the differentiation of the causes of the patient's pain complaints between a musculoskeletal origin and a visceral pathologic condition or disease. Screening for visceral disease is important for several reasons, including the following: (1) many diseases mimic orthopedic pain and symptoms, and a subsequent delay in diagnosis and treatment may lead to severe morbidity or death; (2) a notable increase is reported in the number of people who are more than 60 years old who seek orthopedic medical care, and this patient population is at the greatest risk for visceral disease; (3) as of June 2010, 46 states in the United States had unlimited or provisional direct access to physical therapy services; (4) the physical therapy profession is committed to entry-level Doctor of Physical Therapy degree programs and complete autonomous practice by the year 2020[1]; (5) an aggressive managed care environment in some states encourages primary care physicians to limit the number of referrals to specialists, as well as to limit referrals for diagnostic testing; and, finally, (6) comorbid medical problems are important to identify because they have an impact on treatment planning with respect to safety issues, selection of the appropriate interventions (manual therapy, exercise, modalities, home management strategies, ergonomic advice, diet and nutritional advice), and prognosis. The physical therapist in an outpatient orthopedic setting is evaluating and treating patients who may have greater morbidity and may be more acutely ill than the patients who were referred for outpatient physical therapy 20 years ago. Boissonnault and Koopmeiners[2] found, in their study, that approximately 50% of all the patients referred for outpatient orthopedic physical therapy have at least one of the following diagnoses: high blood pressure, depression, asthma, chemical dependency, anemia, thyroid problems, cancer, diabetes, rheumatoid arthritis, kidney problems, hepatitis, or heart attack.

Pain may be defined as an unpleasant sensory and emotional experience associated with actual or potential tissue damage.[3] True visceral pain can be experienced within the involved viscus.[4,5] It is often described as deep, dull, achy, colicky, and poorly localized.[4-6] Visceral injury or disease can elicit a strong autonomic reflex phenomenon, including sudomotor changes (increased sweating), vasomotor responses (blood vessel), changes in arterial pressure and heart rate, and an intense psychic or emotional reaction.[3,5,7] Viscera are innervated by nociceptors (see Fig 2).[4,8] These free nerve endings are found in the loose connective tissue walls of the viscus, including the epithelial and serous linings, and in the walls of the local blood vessels in the viscus.[4] After activation of these nociceptors by sufficient chemical or mechanical stimulation, neural information is transmitted along small unmyelinated type C nerve fibers within sympathetic and parasympathetic nerves.[4,8-10] This information is subsequently relayed to the mixed spinal nerve, the dorsal root, and into the dorsal horn of the spinal cord. Second-order neurons in the dorsal horn project into the anterior-lateral system.[8] In the anterior-lateral system, nociceptive impulses ascend through the spinothalamic, spinoreticular, and spinomesencephalic tracts.[8] The targets in the brain for these tracts are the thalamus, reticular formation, and midbrain, respectively.[8]

Chemical stimulation of nociceptors may result from a buildup of metabolic end products, such as bradykinins or proteolytic enzymes, secondary to ischemia of the viscus.[4] Prolonged spasm or distention of the smooth muscle wall of viscera can cause ischemia secondary to a collapse of the microvascular network within the viscus.[4] Chemicals, such as acidic gastric fluid, can leak through a gastric or duodenal ulcer into the peritoneal cavity, with resulting local abdominal pain.[4,11] Mechanical stimulation of visceral nociceptors can occur secondary to torsion and traction of the mesentery, distention of a hollow viscus, or impaction.[3-7] Distention may result from a local obstruction, such as a kidney stone, or from local edema caused by infection or inflammation.[4] Spasm of visceral smooth muscle may also be a sufficient mechanical stimulus to activate the nociceptors of the involved viscus.[4,6,11]

Visceral pain is not uncommon in patients suffering from neoplastic disease. Pain complaints in patients with cancer have several origins. *Somatic pain* results from activation of nociceptors in cutaneous and deep tissues (e.g., tumor metastasis to bone) and is usually constant and localized.[3] Visceral pain

results from stretching and distending, or from the production of an inflammatory response and the release of algesic chemicals in the vicinity of nociceptors.[3-5] This inflammation can provoke a central sensitization phenomenon that results in a lowering of the threshold of activation of neurons in the dorsal horn, which can subsequently produce referred hyperalgesia (exaggerated response to a painful stimulus).[12] Metastatic tumor infiltration of bone and gastrointestinal and genitourinary tumors that invade abdominal and pelvic viscera are very common causes of pain in patients with cancer.[3] *Deafferentation pain* results from injury to the peripheral or central nervous system as a result of tumor compression or infiltration of peripheral nerves or the spinal cord. This type of pain also results from injury to peripheral nerves as a result of surgery, chemotherapy, or radiation therapy for cancer.[3] Examples are metastatic or radiation-induced brachial or
lumbosacral plexopathies, epidural spinal cord or cauda equina compression, and postherpetic neuralgia.[3]

Investigators have observed that visceral disease produces not only orthopedic-like pain, but also true orthopedic dysfunction.[13,14] For example, pain referred to the T4 spinal segment from cardiac tissue (angina) may cause reflex muscle guarding of the tonic muscles surrounding T4 and may therefore interfere with normal mobility. This process may then produce movement around a nonphysiologic axis at that segment that predisposes the segment to injury. Even in the absence of acute injury, hypomobility at T4, induced by muscle guarding, can inhibit full flexion and abduction at the shoulder. Subsequently, this situation could initiate a cascade of events leading to shoulder impingement and rotator cuff tendinopathy (see Fig. 6). This patient, for example, with signs and symptoms consistent with supraspinatus tendinosis, may experience a prolonged rehabilitation effort if the T4 dysfunction and cardiac symptoms are not addressed.

A thorough physical examination of the cervical and thoracic spine, ribcage, and shoulder is important to identify impairments and to determine whether a musculoskeletal reason for the patient's shoulder pain exists. Two important aspects of the orthopedic evaluation that help the clinician to screen for visceral pathologic condition or disease are a careful history and palpation (Box 1).

A self-administered patient questionnaire (Fig. 1) is also useful as a quick screen for a possible visceral pathologic condition or disease. For example, if a patient has a few checks under the "yes" column for pulmonary, then the physical therapist should refer to the "Lung" section later in this lesson. This approach allows the physical therapist to analyze the patient's signs and symptoms to see whether they correlate with a possible medical disorder in the lung. The idea is not to diagnose visceral disease, which should be left to the physician, but rather to assess whether the patient's symptoms

BOX 1 Questions During a Patient Visit and Warning Signs That Can Be Garnered from Those Questions

Questions that Should Be Part of Your Standard Interview

- Describe the first and last time you experienced these same complaints.
- Are your symptoms the result of a trauma, or are they of a gradual or insidious onset?
- Was it a macrotrauma (motor vehicle accident, fall, or work or sports injury) or repeated microtrauma (overuse injury or cumulative trauma disorder)?
- What was the mechanism of injury?
- Do you have any other complaints of pain throughout the rest of your body: head, neck, temporomandibular joint (TMJ), chest, back, abdomen, arms, or legs?
- Do you have any other symptoms throughout the rest of your body: headaches, tinnitus, vision changes, nausea, vomiting, dizziness, shortness of breath, weakness, fatigue, fever, bowel or bladder changes, numbness, tingling, or pins or needles?
- Is your pain worse while sleeping?
- Do certain positions or activities change your pain, by either aggravating or relieving your symptoms?
- Does eating or digesting a meal affect your pain?
- Does bowel or bladder activity affect your pain?
- Does coughing, laughing, or deep breathing affect your pain?
- Does your shoulder pain get worse with exertional activities, such as climbing stairs, that do not directly involve your shoulder?

Warning Signs that May Indicate a Possible Visceral Pathologic Condition or Disease

- Pain is constant.
- The onset of pain is not related to trauma or chronic overuse.
- Pain is described as throbbing, pulsating, deep aching, knifelike, or colicky.
- Rest does not relieve pain or symptoms.
- Constitutional symptoms are present: fever, night sweats, nausea, vomiting, pale skin, dizziness, fatigue, or unexplained weight loss.
- Pain is worse during sleep.
- Pain does not change with changes in arm position or upper extremity activity.
- Pain changes in relation to organ function (eating, bowel or bladder activity, or coughing or deep breathing).
- Indigestion, diarrhea, constipation, or rectal bleeding is present.
- Shoulder pain increases with exertion that does not stress the shoulder, such as walking or climbing stairs.

Data from Boissonnault WG, Bass C: Pathological origins of trunk and neck pain: pelvic and abdominal visceral disorders, *J Orthop Sports Phys Ther* 12:192, 1990; and Goodman CC, Snyder TEK: Introduction to differential screening in physical therapy. In *Differential diagnosis in physical therapy,* ed 2, Philadelphia, 1995, Saunders.

are orthopedic in origin, to acknowledge comorbid disease, and to refer the patient for medical follow-up for an undiagnosed disorder that is not musculoskeletal.

The second important aspect of the evaluation is palpation. Palpation should include the lymph nodes (for infection or neoplasm)—which are normally 1 to 2 cm—in the cervical (medial border of sternocleidomastoid, anterior to upper trapezius muscle), supraclavicular, axillary, and femoral triangle regions.[4,15,16] Abnormal findings are swollen, tender, or immovable lymph nodes.[16] The physical therapist palpates the abdomen for muscle rigidity and significant local tenderness (possible visceral disease) or for a large, pulsatile mass (indicative of an aortic aneurysm).[4,16,17] The right upper abdominal quadrant is palpated to assess the liver, gallbladder, and portions of the small and large intestines, whereas the left upper abdominal quadrant is palpated to assess the stomach,

Patient Questionnaire

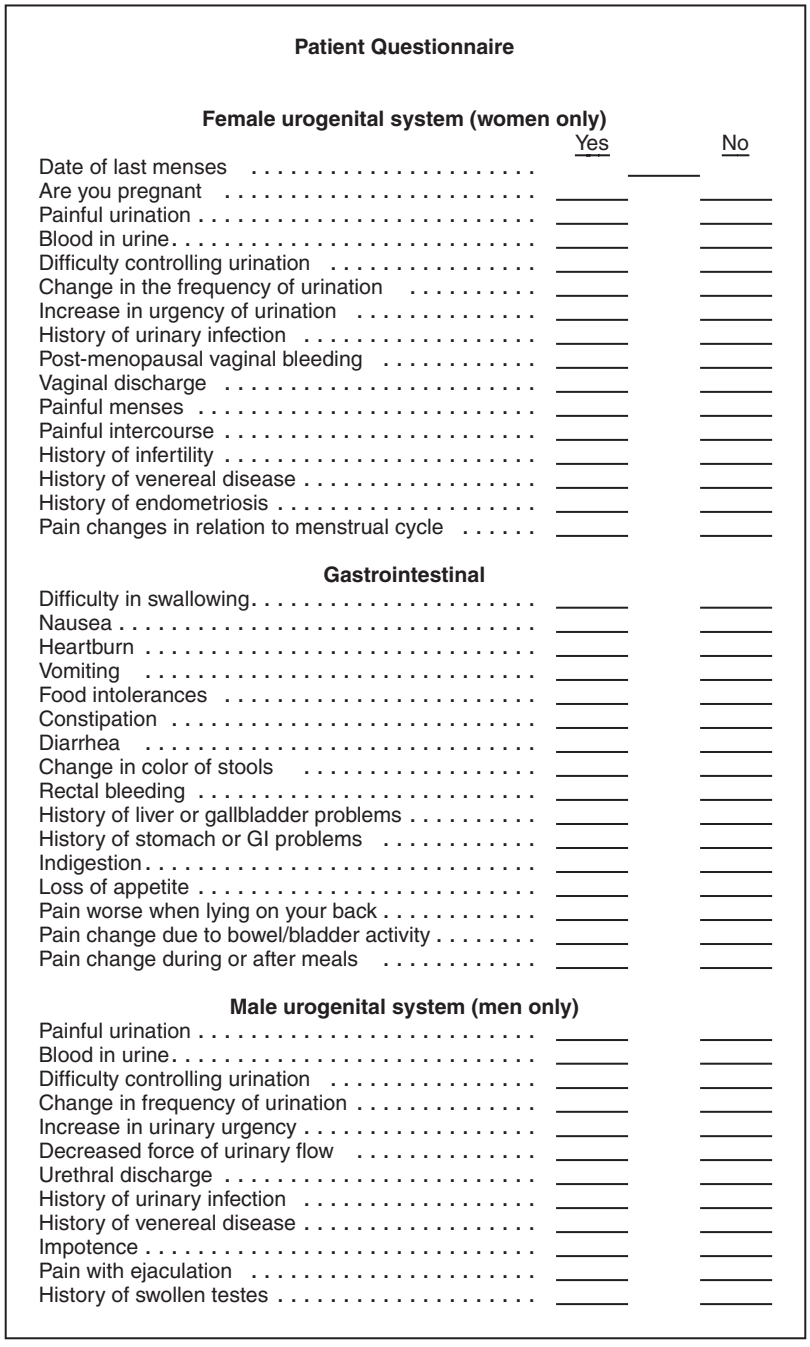
Name _____ Date _____

	Yes	No
Age	_____	
Height	_____	
Weight	_____	
Fever and/or chills	_____	_____
Unexplained weight change	_____	_____
Night pain/disturbed sleep	_____	_____
Episode of fainting	_____	_____
Dry mouth (difficulty swallowing)	_____	_____
Dry eyes (red, itchy, sandy)	_____	_____
History of illness prior to onset of pain	_____	_____
History of cancer	_____	_____
Family history of cancer	_____	_____
Recent surgery (dental also)	_____	_____
Do you self inject medicines/drugs	_____	_____
Diabetic	_____	_____
Pain of gradual onset (no trauma)	_____	_____
Constant pain	_____	_____
Pain worse at night	_____	_____
Pain relieved by rest	_____	_____
Pulmonary		
History of smoking	_____	_____
Shortness of breath	_____	_____
Fatigue	_____	_____
Wheezing or prolonged cough	_____	_____
History of asthma, emphysema or COPD	_____	_____
History of pneumonia or tuberculosis	_____	_____
Cardiovascular		
Heart murmur/heart valve problem	_____	_____
History of heart problems	_____	_____
Sweating with pain	_____	_____
Rapid throbbing or fluttering of heart	_____	_____
High blood pressure	_____	_____
Dizziness (sit to stand)	_____	_____
Swelling in extremities	_____	_____
History of rheumatic fever	_____	_____
Elevated cholesterol level	_____	_____
Family history of heart disease	_____	_____
Pain/symptoms increase with walking or stair climbing and relieved with rest	_____	_____
Pregnant women only		
Constant backache	_____	_____
Increased uterine contractions	_____	_____
Menstrual cramps	_____	_____
Constant pelvic pressure	_____	_____
Increased amount of vaginal discharge	_____	_____
Increased consistency of vaginal discharge	_____	_____
Color change of vaginal discharge	_____	_____
Increased frequency of urination	_____	_____

A

Figure 1 **A** and **B**, Self-administered patient questionnaire.

(Continued)



Patient Questionnaire

Female urogenital system (women only)

	Yes	No
Date of last menses		
Are you pregnant		
Painful urination		
Blood in urine		
Difficulty controlling urination		
Change in the frequency of urination		
Increase in urgency of urination		
History of urinary infection		
Post-menopausal vaginal bleeding		
Vaginal discharge		
Painful menses		
Painful intercourse		
History of infertility		
History of venereal disease		
History of endometriosis		
Pain changes in relation to menstrual cycle		

Gastrointestinal

Difficulty in swallowing		
Nausea		
Heartburn		
Vomiting		
Food intolerances		
Constipation		
Diarrhea		
Change in color of stools		
Rectal bleeding		
History of liver or gallbladder problems		
History of stomach or GI problems		
Indigestion		
Loss of appetite		
Pain worse when lying on your back		
Pain change due to bowel/bladder activity		
Pain change during or after meals		

Male urogenital system (men only)

Painful urination		
Blood in urine		
Difficulty controlling urination		
Change in frequency of urination		
Increase in urinary urgency		
Decreased force of urinary flow		
Urethral discharge		
History of urinary infection		
History of venereal disease		
Impotence		
Pain with ejaculation		
History of swollen testes		

B

Figure 1—cont'd

spleen, tail of the pancreas, and portions of the small and large intestines.[17] The kidneys lie deep posteriorly in the left and right upper abdominal quadrants. The appendix and large intestine are found in the right lower quadrant, whereas other portions of the large intestine may be found in the left lower quadrant.[17] A tender mass in the femoral triangle or groin area may indicate a hernia.[17] When evaluating abdominal tenderness, the physical therapist must differentiate the source as the superficial myofascial wall or the deep viscera. If palpable tenderness is elicited at rest and again with the abdominal wall contracted, then the symptoms are probably originating from the myofascial abdominal wall.[17] If, however, the palpable tenderness disappears when the abdominal muscles are contracted, then deep visceral disease should be suspected.[17] Again, the objective is not to diagnose medical disease, but to know when to refer the patient for medical follow-up. Even though the patient's shoulder pain may not be visceral in origin, the physical therapist may be the first to discover a comorbid medical problem.

The ability to palpate and interpret peripheral pulses is another important diagnostic tool for the physical therapist. Palpating the arterial pulses can help to identify cardiovascular

and peripheral vascular disease. The arterial pulses may be palpated in the upper extremity (axillary artery in the axilla, brachial artery in the cubital fossa, and ulnar and radial arteries at the wrist) and lower extremity (femoral artery at the femoral triangle, popliteal artery at the popliteal fossa, posterior tibialis artery posterior to the medial malleolus, and dorsal pedis artery at the base of the first and second metatarsal bones).[4,16,18,19] When palpating a pulse, the therapist needs to compare the amplitude and force of pulsations in one artery with those in the corresponding vessel on the opposite side.[18] Palpation of the artery should be performed with a light pressure and a sensitive touch. If the pressure is firm, then the physical therapist risks not being able to perceive a weak pulse or misinterpreting his or her own pulse as that of the patient's.[18] Pulsations may be recorded as normal (4), slightly (3), moderately (2), or markedly reduced (1), or absent (0).[18]

The physical therapist must be alert and aware of older elderly patients who have osteoarthritis, degenerative joint disease (DJD), degenerative disk disease (DDD), or spondylosis. One should not assume that the DJD seen on the patient's imaging studies is the source of the pain. Many asymptomatic older persons have abnormal radiographs indicating the presence of these diseases. The older members of society are at a greater risk for visceral abnormalities and disease. In addition, previously healed orthopedic injuries may appear to be symptomatic, but the pain could be a "misinterpretation" by the brain as a result of facilitation from a segmentally related visceral organ in a diseased state.[20,21]

THEORIES ON VISCERAL REFERRED PAIN

1. Referred pain is pain experienced in tissues that are not the site of tissue damage and whose afferent or efferent neurons are not physically involved in any way.[22]
2. Pain happens within the central nervous system, not in the damaged tissue itself. Pain does not really happen in the hands, feet, or head. It happens in the images of the hands, feet, or head that are held in the brain.[22]
3. Referred pain from deep somatic structures is often indistinguishable from visceral referred pain.[23]
4. Visceral pain fibers constitute less than 10% of the total afferent input to the lower thoracic segments of the spinal cord and are activated rarely.[8] In this way, a visceral stimulus may be mistaken for the more familiar somatic pain.[8]
5. Visceral referred pain may be caused by misinterpretation by the sensory cortex.[24] Over the years, specific cortical cells are repeatedly stimulated by nociceptive activity from a specific area of the skin. When nociceptors of a viscus are eventually stimulated chemically or mechanically, these same sensory cortex cells may become stimulated, and the cortex may interpret the origin of this sensory input based on past experience. The pain therefore is perceived to arise from the area of skin that has repeatedly stimulated these cortical cells in the past. The referred pain may lie within the dermatome of those spinal segments that receive sensory information from the viscera.[24]

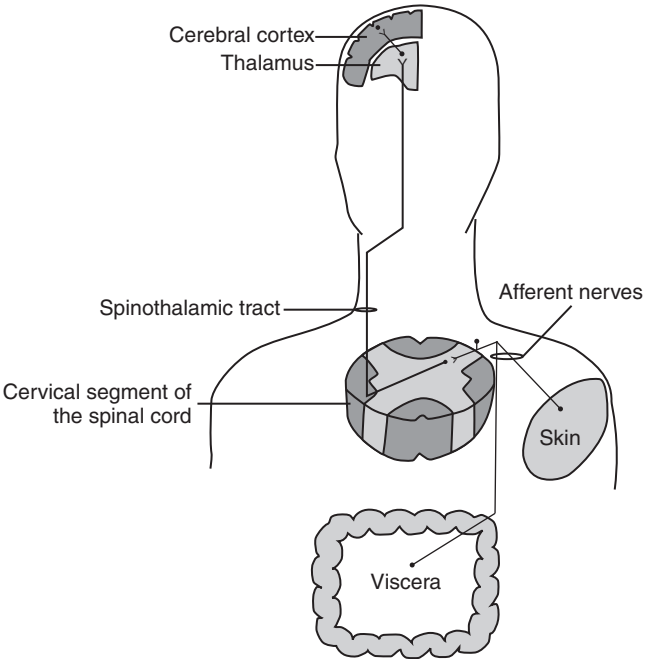


Figure 2 Schematic drawing of a single afferent nerve fiber receiving input from both skin and viscera.

6. Sensory fibers dichotomize as they "leave" the spinal cord, with one branch passing to a viscus as the other branch travels to a site of reference in muscle or skin (Fig. 2).[25,26]
7. Visceral nociceptor activity converges with input from somatic nociceptors into common pools of spinothalamic tract cells in the dorsal horn of the spinal cord. Visceral pain is then referred to remote cutaneous sites because the brain misinterprets the input as coming from a peripheral cutaneous source, which frequently bombards the central nervous system with sensory stimuli (Fig. 3).[3,5-8,17,23,27-29]

VISCERA CAPABLE OF REFERRING PAIN TO THE SHOULDER

Diaphragm

Although the diaphragm is a musculotendinous structure and not a viscus, it is interesting in terms of the distance it refers its pain to the shoulder. In addition, many viscera (lung, esophagus, stomach, liver, and pancreas) can refer pain to the shoulder through contact with the diaphragm (Fig. 4).[4] The central portion of the diaphragm, which is segmentally innervated by cervical nerves C3 to C5 through the phrenic nerve, can refer pain to the shoulder.[4,25,29-36] The peripheral portion of the diaphragm is innervated by the lower six or seven intercostal nerves and does not refer pain to the shoulder.[37] In the rat, cervical (C3, C4) dorsal root ganglion cells were seen that had collateral nerve fibers, which emanated

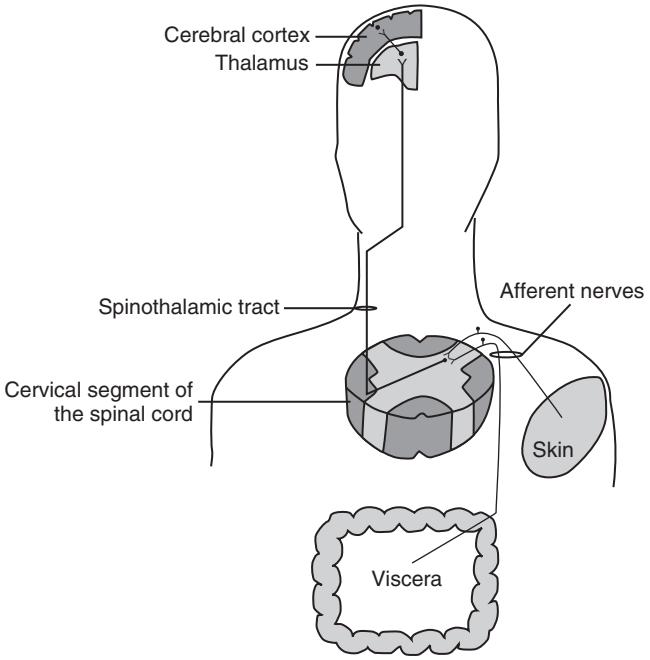


Figure 3 Schematic drawing of a visceral afferent nerve and a somatic afferent nerve converging onto the same spinothalamic tract cell in the dorsal horn of the spinal cord.

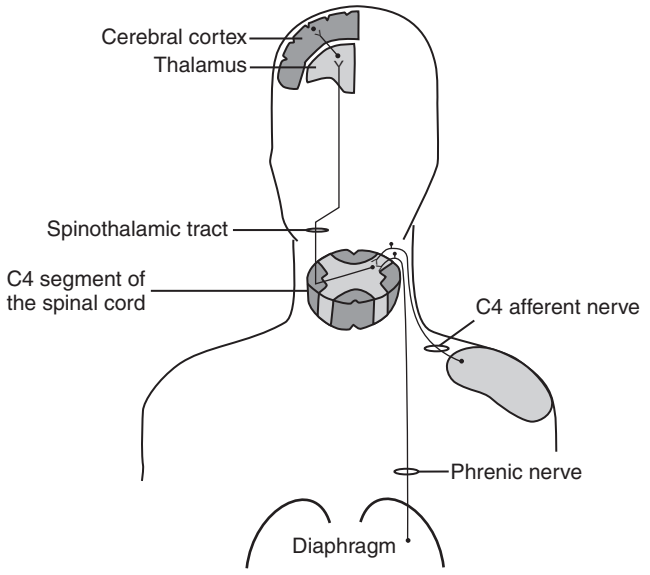


Figure 4 Schematic drawing of an afferent nerve from the diaphragm converging onto the same spinothalamic tract cell as a somatic afferent nerve from the skin of the shoulder.

from both the diaphragm and the skin of the shoulder (see Fig. 2).[25] Patients usually have a history of direct or indirect (e.g., severe twisting motions) trauma to the rib cage and diaphragm. Diaphragmatic strain may occur secondary to strong, sudden bursts of trunk rotation in a poorly conditioned athlete playing golf, tennis, or racquetball, for instance.

Symptoms

Pain in the shoulder is most often felt at the top or posterior portions of the shoulder, that is, at the superior angle of the scapula, in the suprascapular region, or along the upper trapezius muscle.[30,31] The upper arm and anterior portions of the shoulder are not common areas of referred pain for the diaphragm. Normally, the patient has no complaints of pain in the region of the diaphragm, unless the patient suffered trauma or a musculoskeletal strain to the surrounding tissues.

Signs

Shoulder pain is reproduced or exacerbated by deep breathing, coughing, or sneezing.[32,35,36] The patient may note local tenderness during palpation of the diaphragm, but generally no shoulder pain is elicited because it is difficult to reach the central portion of the diaphragm, and the peripheral portion does not refer pain to the shoulder. Full active and passive shoulder elevation in standing may cause pain because this motion changes the shape of the rib cage and subsequently puts tension on the diaphragm.[32] If the diaphragm is the primary source of the patient's referred shoulder pain, then active range of motion (AROM), passive ROM (PROM), and special tests of the shoulder with the patient seated and the thoracic spine in a slumped or flexed posture (to minimize stress on the diaphragm) should not increase the patient's pain.

Pneumoperitoneum

Pneumoperitoneum, or air in the peritoneal cavity, can refer pain to the shoulder because of pressure on the central portion of the diaphragm by trapped air (see Fig. 4).[30-32,38-43]

Patients have a history of acute visceral pain (before perforation), recent abdominal or vaginal surgery, current pregnancy, or recent parturition. Air may be released into the peritoneal cavity in several different ways. Perforation of an abdominal viscus can release air into the peritoneum.[30,40,44] Examples include peptic ulcer, acute pancreatitis, perforated appendix, and splenic infarct or rupture.[32,40,44] Abdominal or vaginal surgical procedures that allow free air to enter and become trapped within the peritoneal cavity, or operations that necessitate insufflation of the peritoneum, are another source of referred pain to the shoulder.[45] Although rare, certain activities during pregnancy, within 6 weeks post partum, or following abdominal or vaginal surgery can lead to pneumoperitoneum. These include menstruation, effervescent vaginal douching, knee to chest stretching exercises, vigorous sexual intercourse, and orogenital insufflation.[38,39,41,42] The last two activities in rare cases can be fatal because of air embolism.[38,39,41-43] To create pneumoperitoneum under these circumstances, air must first enter the vagina before it passes through a patent os cervix to enter the body cavity of the cervix and must subsequently travel through the uterine tube before escaping into the peritoneal cavity (Fig. 5). To create air embolism, the air under positive pressure is introduced through the endometrium into dilated vessels of the uterine wall. The greatest risk is to

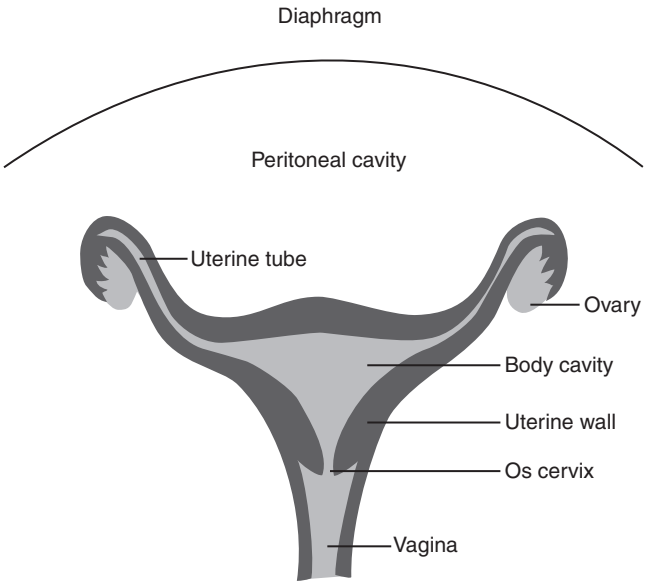


Figure 5 Schematic drawing of the pathway that air must travel to create pneumoperitoneum.

women who have had trauma to their uterine wall (e.g., recent surgery, biopsy or an intrauterine device) that would allow blood vessels to come in contact with air forced into the uterus. Once the air has entered the venous drainage of the uterus, it travels up the inferior vena cava. If large amounts of air reach the heart rapidly, the air bubbles will prevent the blood from flowing into the pulmonary artery; cardiac arrest is then possible.

Symptoms

The patient may complain of acute or spasmodic shoulder or abdominal pain, especially in the case of perforated abdominal viscus. In the case of splenic infarct or rupture, the pain is in the left shoulder.[44] Symptoms vary depending on which viscus is perforated.

Pain in the shoulder is most often felt at the top or posterior portions of the shoulder, that is, at the superior angle of the scapula, in the suprascapular region, or along the upper trapezius muscle.[30,31] The upper arm and anterior portions of the shoulder are not common areas of referred pain for the diaphragm. Normally, the patient has no complaints of pain directly attributable to the diaphragm.

Signs

Shoulder pain may be reproduced or exacerbated by deep breathing, coughing, or sneezing.[32,35,36] The patient often notes no local tenderness during palpation of the diaphragm because the peripheral portion has not been traumatized. Full active and passive shoulder elevation in standing may cause pain because this motion changes the shape of the rib cage and subsequently puts tension on the diaphragm.[32] If the diaphragm is the primary source of the patient's referred shoulder pain, then AROM, PROM, and special tests of the shoulder with the patient seated and the thoracic spine in a slumped or flexed posture (to minimize stress on the diaphragm) should not increase the patient's pain. In the case of perforated viscus, pain or rigidity are noted with abdominal palpation. An upright plain anterior-posterior radiograph demonstrates free intraperitoneal air under one or both hemidiaphragms.[38]

Lung

The lung, which is innervated by thoracic nerves T5-6, is capable of referring pain from two distinct diseases to the shoulder.[4,30,32,33,36,46-59] The first is pulmonary infarction, which is often secondary to pulmonary embolism. The second is Pancoast's tumor.[32,49]

Pulmonary Infarction

The most common cause of pulmonary embolism is deep venous thrombosis (DVT) originating in the proximal deep venous system of the lower legs.[49] Risk factors for DVT include recent surgery, blood stasis caused by bed rest, endothelial (blood vessel) injury from surgery or trauma, and a state of hypercoagulation.[49] Other risk factors include congestive heart failure, trauma, surgery (especially of the hip, knee, and prostate), age greater than 50 years, infection, diabetes, obesity, pregnancy, and oral contraceptive use.[49] Pain is normally referred to the shoulder because of contact with the central portion of the diaphragm (see Fig. 4).[30-32] This potentially fatal condition necessitates rapid referral for emergency medical attention.

Symptoms

When the inferior lobe of the lung is involved and is in contact with the diaphragm, the referred pain is most often felt at the top or posterior portions of the shoulder, that is, at the superior angle of the scapula, in the suprascapular region, or along the upper trapezius muscle.[30,31] The upper arm and anterior portions of the shoulder are not common areas of referred pain for the diaphragm. The region surrounding the diaphragm may be free of pain. When the diaphragm is not involved, pain may be referred to the scapula or interscapular region. Patients usually report the relief of pain when they are lying on the involved shoulder. Symptoms related directly to pulmonary embolism may include swollen and painful legs with walking, acute dyspnea or tachypnea, chest pain, tachycardia, low-grade fever, rales, diffuse wheezing, decreased breath sounds, persistent cough, restlessness, and acute anxiety.[49-51]

Signs

Shoulder pain may be reproduced or exacerbated in cases with diaphragmatic irritation by deep breathing, coughing, or sneezing.[32,35] The patient often notes no local tenderness during palpation of the diaphragm because the peripheral portion has not been traumatized. Full active and passive shoulder elevation in standing may cause pain because this motion changes the shape of the rib cage and subsequently

puts tension on the diaphragm.[32] If the diaphragm is the primary source of the patient's referred shoulder pain, then AROM, PROM, and special tests of the shoulder with the patient seated and the thoracic spine in a slumped or flexed posture (to minimize stress on the diaphragm) should not increase the patient's pain. Chest radiographs, arterial blood gas studies, pulmonary angiography, and ventilation-perfusion scintigraphy are the most common diagnostic tools.[52] Plain radiographs can miss the pulmonary infarct if it is in the inferior lobe of the lung and is hidden by the dome of the diaphragm.[32]

Pancoast's Tumor

Pancoast's tumor occurs in the apical portion of the lung.[30,32,36,46,48,49,53,54] Lung cancer is the most common fatal cancer in both men and women.[53] It commonly refers pain to the supraclavicular fossa, usually on the right side.[32] Pain from Pancoast's tumor may be referred to the shoulder because of the involvement of the upper ribs.[54] Shoulder and arm pain may also occur secondary to contact between the cancerous lobes of the lung and the eighth cervical (C8) and first thoracic (T1) nerves. This contact results in shoulder and upper extremity symptoms similar to those of myocardial infarction, brachial plexus lesion, thoracic outlet syndrome, ulnar neuropathy, and C8 or T1 nerve root injury.[36,46,48,49,53,54] The chest wall and subpleural lymphatics are often invaded by the tumor.[54] Other structures that may be involved include the subclavian artery and vein, internal jugular vein, phrenic nerve, vagus nerve, common carotid artery, recurrent laryngeal nerve, sympathetic chain, and stellate ganglion.[46,48,54] Cancer can metastasize to the lungs from carcinomas in the kidney, breast, pancreas, colon, or uterus.[49] Smoking is a risk factor.[36,49] The peak incidence occurs in smokers who are approximately 60 years of age.[36] Suspicions should be raised in patients who are more 50 years of age, have a long history of smoking, and present with vague or equivocal musculoskeletal signs.

The lung itself is a common source of metastatic cancer to the bone, liver, adrenal glands, and brain.[49,53] Symptoms associated with cancer of the spine include a deep, dull ache that may be unrelieved by rest.[53] Pain often precedes a pathologic fracture.[53] If a fracture is present, then the pain may be sharp, localized, and associated with swelling.[53] Pain is often reproduced by mechanical stress, which simulates pure musculoskeletal dysfunction. Neurologic signs and symptoms, present in some patients, are caused by compression of the spinal cord, C8, or T1 nerves. Percussion of a spinous process with a reflex hammer exacerbates pain from the involved vertebrae.[53] A tuning fork may also be used to elicit symptoms from the involved vertebrae.

Symptoms

Shoulder pain is the symptom present in more than 90% of patients with Pancoast's tumor.[46,49] Arm pain is also common, often involving the medial aspect of the forearm and hand, including the fourth and fifth digits.[46,48,54] Paresthesias may be felt in the arm and hand because of compression of the subclavian artery and vein or the lower portions of the brachial plexus.[54] Patients often report relief of pain when they lie on the involved shoulder. Associated symptoms include Horner's syndrome (contraction of the pupil, partial ptosis of the eyelid, loss of sweating over the affected side of the face, and recession of the eyeball back into the orbit), supraclavicular fullness, atrophy of the intrinsic muscles of the hand, and discoloration or edema of the arm.[32,46,48,49,54] In addition, some patients complain of a sore throat, fever, hoarseness, bloody sputum, unexplained weight loss, chronic cough, dyspnea, or wheezing.[36,48-50]

Signs

In cases of advanced disease, the clinical examination may show positive results for special tests and signs related to a brachial plexus lesion, thoracic outlet syndrome, ulnar neuropathy, or C8 and T1 nerve root injury. The patient should be referred for a chest radiograph. However, a bone lesion of the spine may be detected before a lung lesion on a plain radiograph because lung cancer metastasizes to the bone early.[49-53]

Esophagus

The esophagus, which is segmentally innervated by thoracic nerves T4 to T6, can refer pain to the shoulder through contact with the central portion of the diaphragm (see Fig. 4).[4,17,55] Esophageal pain is transmitted by afferents in the splanchnic and thoracic sympathetic nerves.[8] The primary afferent fibers, both A-delta and C-fiber neurons, pass through the paravertebral sympathetic chain and the rami communicantes to join the spinal nerve and enter the dorsal root ganglia before they enter the dorsal horn of the spinal cord.[8] Referred pain is thought to occur through convergence of visceral (cardiac and esophageal) and somatic afferents onto the same dorsal horn neurons (see Fig. 3).[8,56]

Symptoms

When the diseased esophagus is in contact with the diaphragm, the referred pain is most often felt at the top or posterior portions of the shoulder, that is, at the superior angle of the scapula, in the suprascapular region, or along the upper trapezius muscle.[30,31] The upper arm and anterior portions of the shoulder are not common areas of referred pain for the diaphragm. The region surrounding the diaphragm may be free of pain. When the diaphragm is not involved, pain may be referred to the scapula or interscapular region. Patients often report that the pain in the shoulder is exacerbated during or following meals.[4] They may also complain of substernal chest, neck, or back pain.[50] Other symptoms include difficulty swallowing, weight loss, and (in the late stages) drooling.[50] Symptoms associated with esophageal cancer are bloody cough, hoarseness, sore throat, nausea, vomiting, fever, hiccups, and bad breath.[50] Symptoms associated with reflux esophagitis are regurgitation, frequent vomiting, and a dry nocturnal cough.[50]

The patient complains of heartburn that is aggravated by strenuous exercise or by bending over or lying down and is relieved by sitting up or taking antacids.[50]

Signs

Diagnostic tests include a positive result of 24-hour intraesophageal pH and pressure recordings, acid perfusion, edrophonium stimulation, balloon distention, and ergonovine stimulation.[4,57,58] Shoulder pain, in cases with diaphragmatic irritation, may be reproduced or exacerbated by deep breathing, coughing, or sneezing.[32,35,36] The patient often notes no local tenderness during palpation of the diaphragm because the peripheral portion has not been traumatized. Full active and passive shoulder elevation in standing may cause pain because this motion changes the shape of the rib cage and subsequently puts tension on the diaphragm.[32] If the diaphragm is the primary source of the patient's referred shoulder pain, then AROM, PROM, and special tests of the shoulder with the patient seated and the thoracic spine in a slumped or flexed posture (to minimize stress on the diaphragm) should not increase the patient's pain.

Heart

The heart, which is innervated by thoracic nerves T1 to T5, can refer pain to the shoulder.[4,30-33,55,59] Cardiac afferent fibers have shown evidence of convergence with esophageal afferents and somatic afferents in the upper thoracic spinal cord.[23] In fact, esophageal chest pain is known to mimic angina pectoris.[57] In addition, convergence has been demonstrated among cardiac afferents, abdominal visceral afferents (e.g., gallbladder), and somatic afferents in the lower thoracic spinal cord.[23,56] Convergence has also been noted with proximal somatic afferents (shoulder), phrenic (diaphragm), and cardiopulmonary spinal afferents onto the cervical spinothalamic tract neurons (Fig. 6).[29] This explains how diaphragmatic disease and cardiac disease are both able to refer pain to the shoulder and to other cervical-related dermatomes. Heart disease is most common in men more than 40 years old and is associated with smoking, obesity, high blood pressure, diabetes, and physical inactivity.[36,60] Timely recognition of a cardiac problem cannot be overstated. Coronary artery disease may manifest as angina, myocardial infarction, heart failure, or sudden death.[36]

Symptoms

The patient may complain of pain in the left shoulder that is often associated with reports of numbness and tingling in the left hand.[19,31,50,60] Pain may also be felt in the chest, neck, arm (usually the left, and along a C8 and T1 distribution), jaw, posterior thorax, or epigastrium.[19,36,50,60] The patient may describe tightness, pressure sensations, throbbing, cramping, or aching in the foregoing areas.[19,36] Other symptoms include exertion and nocturnal dyspnea, ankle edema, palpitations, easy fatigability, syncope, weakness, anxiety, profuse sweating, nausea, vomiting, tachycardia, and bradycardia.[19,36,50]

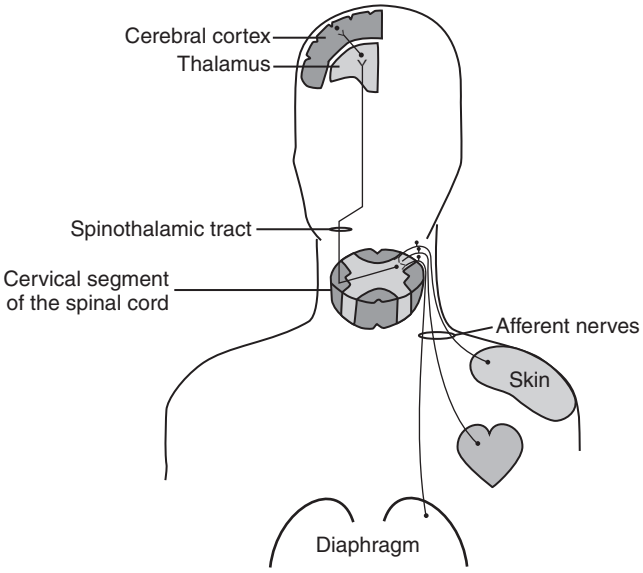


Figure 6 Schematic drawing of a somatic afferent nerve (shoulder), a phrenic nerve (diaphragm), and a cardiopulmonary afferent nerve all converging onto the same spinothalamic tract neuron.

Signs

The patient has a history of shoulder or chest pain (angina) on effort or exercise, such as a brisk walk or climbing stairs, not associated with movements of the shoulder.[19] Symptoms are relieved by rest.[19] The patient may have a resting pulse greater than 100 or less than 50 beats per minute.[36] Blood pressure consistently higher than 160/90 mm Hg is a positive sign.[36] Nitroglycerin provides immediate relief of symptoms. Physical examination of the shoulder is negative for reproduction of the patient's pain, although impairments may be discovered. The patient should be referred for electrocardiogram, blood test (increased creatine phosphokinase levels), treadmill with echocardiogram, or angiography.

Pericarditis

The heart, which is innervated by thoracic nerves T1 to T5, is capable of referring pain to the shoulder in cases of pericarditis.[4,36,60] *Pericarditis* is an inflammation of the sac surrounding the heart.[36,60] This disorder has numerous causes, including viral and bacterial infection, trauma, cancer, collagen vascular disease, uremia, cardiac surgery, myocardial infarction, radiation therapy, and aortic dissection.[19,36,60]

Symptoms

The patient usually has a sharp, burning pain in the chest or left shoulder.[36,50,60] Pain may be evoked by deep breathing, coughing, or lying flat and relieved by sitting up and leaning forward.[19,36,50,60] Other symptoms include fever, tachycardia, and dyspnea.[50] Symptoms of chronic pericarditis include

pitting edema of the arms and legs, serous fluid in the peritoneal cavity, enlarged liver, distended veins in the neck, and a decrease in muscle mass.[50]

Signs

Physical examination of the shoulder is negative for reproduction of the patient's pain, although impairments may be discovered. Patients often have a pericardial friction rub (the sound of two dry surfaces rubbing against each other), which has different characteristics than a heart murmur, noted during auscultation of the thorax.[19,50] Patients with chronic pericarditis demonstrate pulsus paradoxus, which is an exaggerated decline in blood pressure during inspiration.[50]

Bacterial Endocarditis

Bacterial endocarditis is another source of pain in the region of the shoulder.[60-62] It is an inflammation of the cardiac endothelium overlying a heart valve that is caused by a bacterial infection.[19,60] If left undiagnosed and untreated, bacterial endocarditis can be fatal.[61,62] The patient's history often indicates no trauma or previous occurrence of these symptoms. Pain is most common in the glenohumeral, sternoclavicular, or acromioclavicular joints, and symptoms are usually confined to one joint.[60-62] Symptoms are not caused by referred pain; therefore, the patient has a positive musculoskeletal examination of the involved joint. Articular involvement is thought to be secondary to deposition of large particulate masses (emboli) that contain immune complexes.[60-62] Risk groups for this illness include the following: patients with abnormal cardiac valves, congenital heart disease, and degenerative heart disease (calcific aortic stenosis); parenteral drug abusers; and those with a history of bacteremia.[60-62] Treatment is with antibiotics.[60-62]

Symptoms

Pain is often localized to one of the three true joints of the shoulder. Low back pain, which may mimic a herniated disk and sacroiliac joint pain, is often reported.[60] In approximately 25% of patients, musculoskeletal complaints are the first symptoms of this disease.[60-62] The patient may have an abrupt onset of intermittent shaking chills with fever.[50,60] The patient may also complain of dyspnea and chest pain with cold and painful extremities.[60] Other symptoms include pale skin, weakness, fatigue, night sweats, tachycardia, and weight loss.[19,50,60]

Signs

Palpation of the involved joint reveals warmth, redness, and tenderness.[60-62] Acute synovitis in a single joint, especially the metacarpophalangeal, sternoclavicular, or acromioclavicular joint, which is not commonly involved in other diseases, should raise suspicions of bacterial endocarditis.[61,62] The patient has a heart murmur, positive results of a blood test for anemia, elevated erythrocyte sedimentation rate (ESR), decrease in serum albumin levels, increase in serum globulin concentration, and microhematuria (blood in the urine).[61,62] Symptoms are relieved by antibiotics. Fever is present at some time during the illness.[60-62] Associated signs are dyspnea, peripheral edema, fingernail clubbing, enlarged spleen, anorexia, Roth's spots (small white spots in the retina, usually surrounded by areas of hemorrhage), petechiae (small purplish hemorrhagic spots on the skin), and Janeway's lesions (small red-blue macular lesions) on the palm of the hands or the soles of the feet.[50] Diagnosis may be difficult in older patients, who have a higher frequency of nonpathologic heart murmurs and are less likely to have a fever develop in response to infection.[60-62] A plain radiograph may show destructive changes within the joint (glenohumeral, acromioclavicular, or sternoclavicular) indicative of an infection.[61,62]

Vascular System

Aneurysm

An aneurysm within a subclavian vessel can result in pain at the shoulder.[30-32,50,55] This is a potentially dangerous arterial condition.[36] An *aneurysm* is an abnormal widening of the arterial wall caused by the destruction of the elastic fibers of the middle layer of that wall or by a tear in the inner lining of the arterial wall that allows blood to flow directly into the wall and subsequently widen it.[36] Aortic aneurysms can enlarge and compress pain-sensitive structures in the upper mediastinum and can lead to shoulder pain.[30] These aneurysms generally occur in older patients and slowly enlarge over many years.[36] Rapid morbidity or mortality is expected if an aneurysm ruptures.[36]

Symptoms

Pain in the shoulder may include throbbing and cramping. The patient may also report paresthesia, neck pain, or chest pain.[50] Other symptoms include night sweats, pallor, nausea, weight loss, Raynaud's phenomenon, diplopia, dizziness, and syncope.[50] Symptoms may be aggravated by an increase in activity level (climbing stairs, fast walk, or upper extremity repetitive motions) and relieved by rest.[32]

Signs

Physical examination of the shoulder, especially elevation above 90°, may give a false-positive response to a musculoskeletal test because of stress on the subclavian vessels. Upper extremity repetitive motions that stress the vascular system, but not the shoulders (e.g., elbow flexion and extension with the arms at the side), may help to distinguish this disorder. The patient has a prolonged capillary refill time for the fingers, systemic hypotension, and a weak or absent distal pulse (radial and ulnar arteries at the wrist).[50] Bilateral dilation of the pupils occurs late.[50] A plain radiograph of the chest may or may not allow visualization of the aneurysm.

Arterial Occlusion

Arterial occlusion is usually caused by atherosclerosis or compression of an artery, such as the subclavian artery in thoracic outlet syndrome. Arterial occlusion can manifest as a deep, constant pain in the shoulder, or it can lead to ischemic pain with exercise.[30,63]

Symptoms

Patients complain of pain in the region of the shoulder that may mimic nerve root compression.[64] Other symptoms include paresthesia, coldness, weakness, and fatigue in the involved extremity.[50,64]

Signs

Physical examination of the shoulder, especially elevation above 90°, may give a false-positive response to a musculoskeletal test because of stress on the subclavian vessels. Upper extremity repetitive motions that stress the vascular system, but not the shoulders (e.g., elbow flexion and extension with the arms at the side), may help to distinguish this disorder. Systolic blood pressure is higher, whereas diastolic blood pressure remains unchanged in the involved extremity.[50] The patient has a weak or absent distal pulse (radial and ulnar arteries at the wrist).[50,64] The extremity is cool and cyanotic, and it demonstrates a prolonged capillary refill time.[50] Tachycardia and angina pectoris may also be present.[50] Contrast angiography demonstrates arterial occlusion, which is best seen with the extremity elevated.[64] In the case of thoracic outlet syndrome, results of one of the following tests is abnormal: Adson's test; costoclavicular, hyperabduction, and pectoralis minor stress tests; and the 3-minute flap-arm test (Roo's test).[63-65]

Thrombophlebitis

Thrombophlebitis of the axillary and subclavian veins can also cause shoulder pain (Fig. 7).[30,55,66-69] *Thrombophlebitis* is an inflammation of a vein in the presence of a blood clot. This is a serious situation, because emboli may break free and travel to the lung, a potentially fatal condition. The risk

Figure 7 Thrombosis of the subclavian vein at the level of the thoracic outlet. (From Rohrer MJ: Vascular problems. In Pappas AM, editor: *Upper extremity injuries in the athlete,* New York, 1995, Churchill Livingstone.)

of pulmonary embolization for persons with subclavian thrombosis is approximately 12%.[66] DVT of the upper extremity is often caused by venous trauma from repetitive motions of the shoulder, referred to as *effort thrombosis,* in persons with an abnormal thoracic outlet.[66-68] The most common site of compression is near the clavicle, the costocoracoid ligament, and the first rib.[67,68] Repeated compression of the vein can lead to injury and inflammation, which then puts the vein at risk for the formation of a thrombus.[67,68] Other causes of venous thrombosis include the presence of indwelling venous catheters (central lines or pacemaker leads), local compression, radiation, and hypercoagulability.[66-68]

Symptoms

The patient usually complains of a dull pain in the shoulder and down the arm that may include paresthesia. Fever and chills may be present.[50] The patient may complain of cold and swollen fingers.[67] Patients with effort thrombosis complain of the sudden onset of swelling and cyanosis involving the entire arm.[66] These patients often report a history of upper extremity exertion such as weight lifting or prolonged repetitive motions.[66-68] Symptoms of shortness of breath (SOB), pleuritic chest pain, hemoptysis (expectoration of blood), or a new nonproductive cough suggest pulmonary embolus.[66]

Signs

Physical examination of the shoulder, especially elevation above 90°, may give a false-positive response to a musculoskeletal test because of stress on the axillary and subclavian vessels. Upper extremity repetitive motions that stress the vascular system, but not the shoulders (e.g., elbow flexion and extension with the arms at the side), may help to distinguish this disorder. Edema, coldness, and cyanosis may be noted in the fingers, hand, or upper arm.[50,66-69] Distention of the superficial veins is usually seen in the hand, upper arm, shoulder, or anterior chest wall.[66-69] Effort thrombosis is usually seen in young, healthy individuals with an athletic physique.[66,67] It is also seen frequently in hikers who carry backpacks.[66] Exertion of the involved extremity leads to a notable exacerbation of the pain and swelling.[66] The patient may have a loss of ROM at the shoulder. Conservative treatment usually consists of heat, elevation, and anticoagulation medication. The heat is used to dilate the veins so that the fluid may pass by the thrombus. Diagnostic tests include duplex ultrasound scanning and venography.[67] Thoracic outlet tests and arteriograms show no abnormalities.

Additional diagnostic tests, which may be indicated for certain vascular disorders, include Allen's test of the radial and ulnar arteries at the wrist, Doppler ultrasonic flow detector, systolic blood pressure, pulse volume recording, angiography, and auscultation of the major arteries.[18,65]

Liver

The liver, which is segmentally innervated by thoracic nerves T7 to T9, can refer pain to the right shoulder through its contact with the central portion of the diaphragm (see Fig. 4).[4,17,32,55,70] Cancer of the liver is more common in

men and women who are more than 50 years old.[4] The liver is one of the most common sites of metastasis from primary cancers elsewhere in the body (colorectal, stomach, pancreas, esophagus, lung, and breast cancers).[70] *Hepatitis,* or inflammation of the liver, can range from the subclinical stage to the rapidly progressive and fatal stage.[17,70]

Symptoms

The referred pain is most often felt at the top or posterior portions of the right shoulder, that is, at the superior angle of the scapula, in the suprascapular region, or along the upper trapezius muscle.[30,31] The upper arm and anterior portions of the shoulder are not common areas of referred pain for the diaphragm. The region surrounding the diaphragm may be free of pain. Right shoulder pain may be acute or spasmodic.[4] The patient may also complain of headache, myalgia, and arthralgia.[17] Other symptoms include indigestion, nausea, vomiting, unexplained weight loss, and fatigue.[4,17,50,70] Pain from cancer of the liver may also be described as deep, gnawing, and poorly localized to the upper abdomen or back.[4]

Signs

The patient often notes no local tenderness during palpation of the diaphragm because the peripheral portion has not been traumatized. Full active and passive shoulder elevation in standing may cause pain because this motion changes the shape of the rib cage and subsequently puts tension on the diaphragm.[32] If the diaphragm is the primary source of the patient's referred shoulder pain, then AROM, PROM, and special tests of the shoulder with the patient seated and the thoracic spine in a slumped or flexed posture (to minimize stress on the diaphragm) should not increase the patient's pain. Shoulder pain may be reproduced or exacerbated, in cases with diaphragmatic irritation, by deep breathing, coughing, or sneezing.[32,36] However, the patient may have a mass in the upper right abdominal quadrant (liver) or an enlarged liver, or the liver may be tender to palpation.[4,17,50,70] Associated signs include jaundice, pale skin, purpura (red and purple hemorrhage into the skin), ecchymosis, spider angiomas (hemorrhagic pattern in the skin), palmar erythema, anorexia, and the accumulation of serous fluid in the peritoneal cavity.[17,50,70] The patient should be referred for a plain radiograph, diagnostic ultrasound, computed tomography (CT) scan, or magnetic resonance imaging (MRI) of the abdomen.[70]

Pancreas

The pancreas, which is segmentally innervated by thoracic nerves T6 to T10, can refer pain to the left shoulder through contact with the central portion of the diaphragm (see Fig. 13-4).[4,17,30,55] *Pancreatitis,* or inflammation of the pancreas, may be caused by heavy alcohol use, gallstones, viral infection, or blunt trauma.[17,44] Acute pancreatitis can be fatal.[44] Pancreatic cancer has been linked to diabetes, alcohol use, a history of pancreatitis, and a high-fat diet.[44] Cancer of the pancreas is more common in men and women older than 50 years of age.[4]

Symptoms

Shoulder pain is usually referred to the left scapula, supraspinous area, midepigastrium, or back.[17,44] Patients with a pancreatic abscess, cancer, or pancreatitis may complain of fever, weight loss, jaundice, tachycardia, nausea, or vomiting.[44,50] Patients with a pancreatic abscess may also report an abrupt rise in temperature, diarrhea, and hypotension.[50] Patients with pancreatic cancer may also complain of fatigue, weakness, and gastrointestinal bleeding.[50] A patient with pancreatitis often bends forward or bring the knees to the chest to relieve the pain.[44,50] These patients report an exacerbation of pain with walking or lying supine.[44] In addition, patients with pancreatitis complain of waxing and waning pain in the epigastric and left upper quadrant of the abdomen.[17] Pain is exacerbated by eating, alcohol intake, or vomiting.[17]

Signs

The patient often notes no local tenderness during palpation of the diaphragm because the peripheral portion has not been traumatized. Full active and passive shoulder elevation in standing may cause pain because this motion changes the shape of the rib cage and subsequently puts tension on the diaphragm.[32] If the diaphragm is the primary source of the patient's referred shoulder pain, then AROM, PROM, and special tests of the shoulder with the patient seated and the thoracic spine in a slumped or flexed posture (to minimize stress on the diaphragm) should not increase the patient's pain. Shoulder pain may be reproduced or exacerbated in cases with diaphragmatic irritation by deep breathing, coughing, or sneezing.[32,36] The patient may have an abdominal mass, enlarged liver or spleen, or tenderness in the epigastric area.[4,17,50] Diagnostic ultrasound, CT scan, or MRI may be necessary for an accurate diagnosis.

Gallbladder

The gallbladder, which is innervated by thoracic nerves T7 to T9, can refer pain to the right shoulder (see Figs. 13-2 and 13-3).[4,17,30-32,50,55,70] Afferent fibers (T6 to T11) from the gallbladder pass into hepatic and celiac plexuses and then enter the major splanchnic nerves, through which they pass to the sympathetic chain into the spinal cord.[27] Common diseases of the gallbladder include *cholecystitis* (inflammation) and *cholelithiasis* (stones).[4] Risk factors for cholelithiasis include age (increases with age), sex (more common in women), pregnancy, oral contraceptive use, obesity, diabetes, a high-cholesterol diet, and liver disease.[70] Gallbladder cancer is more common in men and women who are more than 50 years old. More specifically, it is most common in obese women who are more than 40 years of age.[4,17]

Symptoms

Cramping pain or a deep, gnawing, poorly localized pain in the back of the right shoulder may be the first symptoms of gallbladder involvement.[4,17,50,70] Pain is usually referred to

the right scapula.[4,17,70] Other symptoms include chronic epigastric or right upper abdominal pain after meals, nausea, vomiting, and fever.[17,50,70] Patients suffering with cholelithiasis, the passage of a stone through the bile or cystic duct, complain of sudden and severe paroxysmal pain, in addition to chills and restlessness.[50]

Signs

Physical examination of the shoulder is negative for reproduction of the patient's pain, although impairments may be discovered. Gallbladder cancer is characterized by weight loss, anorexia, or jaundice.[50,70] Patients with cholecystitis have fever, jaundice, tenderness over the gallbladder, and abdominal rigidity.[50,70] Cholelithiasis produces a low-grade fever.[17,50] Fatty or greasy foods exacerbate the symptoms of gallbladder disease.[4,70] The patient has tenderness, and occasionally a palpable mass, in the right upper abdominal quadrant.[17] The patient should be referred for a plain radiograph, diagnostic ultrasound, or CT scan.[70]

Kidney

Although pain referred from the kidney is rare, the kidney, which is innervated by thoracic nerves T10 to L1, may refer pain to the shoulder region (see Figs. -2 and 3).[4,32,71]
Several pathologic conditions must be considered with respect to the kidney, including cancer, perinephric abscess, and other disease processes such as kidney stones. Chronic kidney disease may be associated with poor calcium deposits in bone, which lead to a weak bone structure.[4] Associated disorders include pyelonephritis, nephritis, nephropathy, nephrotic syndrome, renal artery occlusion, renal failure, renal infarction, and renal tuberculosis.[50] Cancer of the kidney is most common between the ages of 55 and 60 years.[53] It can metastasize to the lung, brain, or liver.[53] Metastasis to bone occurs late in the disease process.[53]

Symptoms

Musculoskeletal pain is rarely the primary complaint. Some of the following symptoms may be noted: acute or spasmodic ipsilateral shoulder; lower abdominal, groin, low back, or flank pain; weakness, fatigue, or generalized myalgia; unexplained weight loss; nausea, vomiting, or chills; or painful, frequent, and urgent urination, with or without hematuria.[4,50,71,72] Kidney stones may produce severe cramping pain.[4]

Signs

Tenderness is noted at the costovertebral angle, and patients with inflammation have a fever.[50,71] Patients with a perinephric abscess have no tenderness over the renal areas of the back, and only mild distention is noted during abdominal palpation.[72] The ESR, white cell count, and temperature are all elevated.[72] A plain anterior-posterior KUB (view of the kidney, ureters, and bladder) radiograph demonstrates the following: (1) difficulty identifying the psoas stripe, (2) absence of the renal outline, and (3) curvature of the spine toward the side of the disease.[72] For all the diseases of the kidney discussed here, patients may benefit by referrals for intravenous pyelogram, diagnostic ultrasound, CT scan, or MRI.

Stomach

The stomach, which is segmentally innervated by thoracic nerves T6 to T10, can refer pain to the shoulder through contact with the central portion of the diaphragm (see Fig. 4).[4,30]
Risk factors for ulcer or gastritis include heavy alcohol use, smoking, and the use of nonsteroidal anti-inflammatory drugs (NSAIDs).[17,44] Cancer of the stomach is more common in men and women who are more than 50 years of age.[4]

Symptoms

Pain is most often felt in the right shoulder at the superior angle of the scapula, in the suprascapular region, and in the upper trapezius muscle.[30,31,44] The patient may also complain of epigastric or right upper abdominal quadrant pain.[17,44] Patients with cancer, an ulcer, or gastritis may complain of weight loss, night pain, or chronic dyspepsia (painful digestion), a sense of fullness after eating, heartburn, nausea, vomiting, and a loss of appetite.[17,44,50] Patients with stomach cancer may complain of a deep, gnawing, and poorly localized pain in the upper abdomen or back.[4] Persons with an ulcer may also complain of gastrointestinal bleeding and epigastric pain 1 to 2 hours after a meal that may occur with vomiting, fullness, or abdominal distention.[44,50] Patients with gastritis may also report belching, fever, malaise, anorexia, or bloody vomit.[50]

Signs

The patient often has no local tenderness during palpation of the diaphragm because the peripheral portion has not been traumatized. Full active and passive shoulder elevation in standing may cause pain because this motion changes the shape of the rib cage and subsequently puts tension on the diaphragm.[32] If the diaphragm is the primary source of the patient's referred shoulder pain, then AROM, PROM, and special tests of the shoulder with the patient seated and the thoracic spine in a slumped or flexed posture (to minimize stress on the diaphragm) should not increase the patient's pain. Full active and passive right shoulder elevation in standing may cause pain because this motion changes the shape of the rib cage and subsequently puts tension on the diaphragm.[32] Right shoulder pain may be reproduced or exacerbated by deep breathing, coughing, or sneezing.[32,36] The patient may have an abdominal mass or tenderness noted on palpation.[4,50] Abdominal CT scan or MRI may be necessary for an accurate diagnosis.

Colon or Large Intestine

The colon or large intestine, which is innervated by thoracic and lumbar nerves T11 to L1, can refer pain to the right shoulder, although this is a rare event (see Figs 2 and 3).[4,73]

The gastrointestinal tract has dual innervation. Certain afferent fibers join sympathetic nerves, and other afferent fibers that join parasympathetic nerves.[74] Pain from the gastrointestinal tract is predominantly mediated by afferent activity in sympathetic nerves, such as the splanchnic and hypogastric nerves.[74] These afferent nerve fibers have their cell bodies in thoracolumbar spinal ganglia, and their central projections enter the spinal cord at levels between T2 and L3.[74] Disorders relevant to this region include ulcerative colitis, irritable bowel syndrome, spastic colon, obstructive bowel disease, diverticulitis, and cancer. Colon cancer is the most frequently diagnosed cancer in the United States.[17] Cancer in this region is most common in men and women who are more than 50 years old.[4,53] Metastasis to the spine, liver, and lung is common.[17,53] Smoking, alcohol, NSAIDs, and caffeine may increase the risk of disease.[4] NSAIDs may also mask the symptoms.[4] Other risk factors include a prior history of inflammatory bowel disease, prior cancer of another organ, and benign polyps of the colon.[17]

Symptoms

Pain is referred to the right shoulder from the hepatic flexure of the colon.[73] Cramping pain is often described in the lower mid-abdominal region.[17,44,50] The patient may also note fluctuation of pain with eating habits, painful bowel movements, diarrhea, indigestion, nausea, vomiting, change in bowel habits, bloody stools, jaundice, and weight loss.[4,50] *Irritable bowel syndrome* is the most common gastrointestinal disorder in Western society.[44] Symptoms are aggravated or precipitated by emotional stress, fatigue, alcohol, eating a large meal with fruit, roughage, or high fat content.[44] In addition to the foregoing symptoms, the patient may have constipation, foul breath, and flatulence.[44]

The predominant symptoms of *ulcerative colitis* are rectal bleeding and diarrhea.[44] In *obstructive bowel disease,* the patient complains of constipation, rapid heart rate, and short episodes of intense, cramping pain.[50] *Diverticulitis,* an inflammation in the wall of the colon, produces constant left lower abdominal pain with radiation commonly to the low back, pelvis, or left leg.[17] Patients with cancer may note a change in the frequency of bowel movements, a sense of incomplete evacuation, bloody stools, unexplained weight loss, weakness, fatigue, exertional dyspnea, and vertigo.[17,50,53]

Signs

Physical examination of the shoulder is negative for reproduction of the patient's pain, although impairments may be discovered. Patients may exhibit signs of abdominal distention, abdominal tenderness, rectal bleeding, anorexia, and abnormal bowel sounds.[50] The primary diagnostic test is colonoscopy.

CASE STUDIES

The case studies in this lesson have been modified slightly for instructional purposes and to fit the format of the *Guide to Physical Therapist Practice.* The patients' names are fictitious.

CASE STUDY 1

Demographics

Robert is a 24-year-old, right-handed, white male college graduate whose primary language is English. He came to physical therapy on September 9, 2009, without a physician's diagnosis or referral and complaining of periodic left shoulder pain. He denied previous treatment of any kind for his current complaints.

Social History

He shares an apartment with two of his friends. Robert denies any cultural or religious beliefs that he thinks may affect his care. He has been unemployed for 3 months.

Living Environment

Robert lives in a three-bedroom apartment on the second floor. He denies the existence of any major obstacles in and around his apartment. He ascends and descends one flight of stairs every day. He does not use assistive devices of any kind for his activities of daily living (ADLs).

General Health Status

He states that he is in excellent health and has had no major life changes in the past year. The medical screening questionnaire that he completed did not produce any notable "red flags" to indicate visceral involvement (Fig. 8).

Social/Health Habits

Robert reports that he eats a healthy diet that excludes red meat. He takes a multivitamin and protein shake daily and denies any substantial intake of caffeine or tobacco. He drinks a few beers on the weekends. He states that he is a competitive racquetball and volleyball player. He lifts weights occasionally, but surfs on a regular basis.

Family History

Both his parents and all his grandparents are still alive. Both his father and his grandfather suffered heart attacks. His grandmother had a cerebrovascular accident (CVA). He notes that his mother and grandmother both suffer from rheumatoid arthritis.

CASE STUDY 1—cont'd

Patient Questionnaire

Name Case Study #1 Date 02/15/92

	Yes		No
Age		24	
Height		5' 11"	
Weight (lbs)		165	
Fever and/or chills			X
Unexplained weight change			X
Night pain/disturbed sleep			X
Episode of fainting			X
Dry mouth (difficulty swallowing)			X
Dry eyes (red, itchy, sandy)			X
History of illness prior to onset of pain			X
History of cancer			X
Family history of cancer			X
Recent surgery (dental also)			X
Do you self inject medicines/drugs			X
Diabetic			X
Pain of gradual onset (no trauma)	X		
Constant pain	X		
Pain worse at night			X
Pain relieved by rest			X
Pulmonary			
History of smoking			X
Shortness of breath			X
Fatigue			X
Wheezing or prolonged cough			X
History of asthma, emphysema or COPD			X
History of pneumonia or tuberculosis			X
Cardiovascular			
Heart murmur/heart valve problem			X
History of heart problems			X
Sweating with pain			X
Rapid throbbing or fluttering of heart			X
High blood pressure			X
Dizziness (sit to stand)			X
Swelling in extremities			X
History of rheumatic fever			X
Elevated cholesterol level			X
Family history of heart disease	X		
Pain/symptoms increase with walking or stair climbing and relieved with rest			X
Pregnant women only			
Constant backache			
Increased uterine contractions			
Menstrual cramps			
Constant pelvic pressure			
Increased amount of vaginal discharge			
Increased consistency of vaginal discharge			
Color change of vaginal discharge			
Increased frequency of urination			

Figure 8 Patient questionnaire for Case Study 1.

Medical/Surgical History

- 2008: Muscle injury to the left side of his rib cage after a weekend volleyball tournament
- 2007: Muscle injury to the left side of his rib cage after a weekend volleyball tournament
- 2004: Low back muscle injury from racquetball

He denies a history of surgery. The only illness or other complaints he has had in the past year are related to the flu, which he had 6 to 9 months ago.

Current Condition(s)/Chief Complaint(s)

Robert comes to physical therapy complaining of periodic, severe (2/10 to 7/10), localized left shoulder pain at the acromioclavicular joint (Fig. 9). He reports a constant, low-intensity ache (2/10), which never goes away regardless of what he does. He is able, however, to produce a sudden and sharp pain with certain movements. The movements that consistently reproduce his pain are full flexion or full abduction of his shoulder overhead. He also reports sharp

Continued

CASE STUDY 1—cont'd

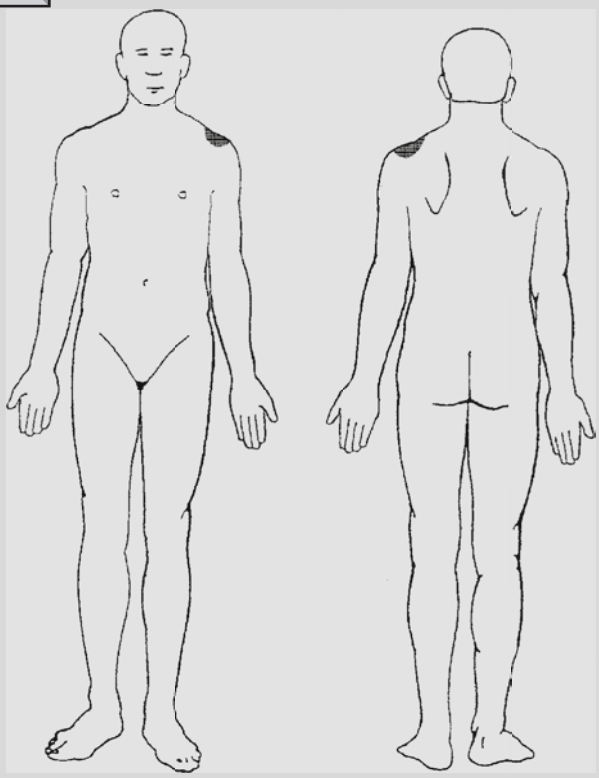


Figure 9 Pain diagram from a 24-year-old, right-handed man experiencing left shoulder pain.

pain with powerful or forceful movements, such as hitting a racquetball hard or spiking a volleyball. He is able to sleep on his left side without much difficulty. He denies neck pain, headaches, dizziness or vertigo, vision changes, tinnitus, nausea, upper extremity symptoms (radiating pain, weakness, or paresthesia), night pain, and SOB. He reports no change in his shoulder pain related to eating, associated with bowel or bladder activity, or during exertional activities (light jog) that do not directly involve his shoulder. He also denies having constitutional symptoms (fever, night sweats, nausea or vomiting, dizziness, fatigue, or unexplained weight loss). He states that the sharp pain is not constant and that he can get immediate relief if he rests his shoulder. He admits having shoulder pain if he laughs out loud or takes a deep breath. He is not sure whether coughing is a problem. He denies a history of a motor vehicle accident (MVA), fractures, or falls. His pain started 6 days ago. He denies any incidents of specific trauma. Nine days ago, he participated in a 2-day walleyball tournament (volleyball on a racquetball court); and 6 days ago, he was involved in two competitive racquetball league matches.

Functional Status/Activity Level

Before the onset of his shoulder pain, Robert was a competitive racquetball and volleyball player who played either sport three to four times a week. He also lifted weights occasionally and surfed on a regular basis. Robert scores 92 out of a possible maximum score of 100 on the Sharp Functional Activity Survey (Sharp FAS) for the neck and shoulder region (Sharp HealthCare, San Diego, 1998). He reports no difficulties performing all of his ADLs. He does state, however, that he has severe difficulty playing volleyball and racquetball at a competitive level because of the periodic sharp pains in his left shoulder.

Medications

Robert denies taking any medications, prescription or nonprescription, of any kind.

Other Clinical Tests

No clinical tests of any kind were performed on this patient in the past year. He has never had any imaging studies performed on his shoulder or neck. Robert did have radiographs taken of his low back in 1994, which he reported were read as normal.

Cardiovascular/Pulmonary System

Although it is well known that the heart and lungs can refer pain to the left shoulder, there is no indication that this patient's symptoms may be cardiopulmonary in origin. Robert is a very fit and very young (24-year-old) man with no risk factors and no specific symptoms of heart or lung disease. His medical screening questionnaire does not raise any red flags for the pulmonary and cardiovascular sections (see Fig. 8). Therefore, a physical examination of his cardiopulmonary system is deferred.

Integumentary System

Robert's skin appears healthy, with a good continuity of color and no significant changes in temperature. No joint effusion, soft tissue edema, or scars are noted.

Communication, Affect, Cognition, Learning Style

No known learning barriers are identified for this patient. Robert reports that he learns best when given a demonstration of the procedure or exercise. He does not show any deficits with regard to his cognition, orientation, or ability to communicate effectively.

Musculoskeletal System

Posture

In standing, he has good posture with only a slightly forward head and a slight increase in his lumbar lordosis.

CASE STUDY 1—cont'd

Range of Motion

Cervical Spine

AROM and PROM are within normal limits (WNL) and pain free.

Shoulder

Left shoulder AROM and PROM are WNL. Pain is reproduced at the end ROM in active flexion or abduction, with the patient standing. PROM, tested in the sitting position with the thoracic spine flexed, is pain free.

Scapula and Elbow

AROM and PROM are WNL and pain free.

Thoracic Spine

Thoracic AROM and PROM are minimally limited in flexion and extension. Sharp left shoulder pain, however, is noted with movement into the end range of active or passive flexion or extension.

Rib

Active deep inhalation reproduces the patient's left shoulder pain. Passive lower rib cage compression is normal.

Lumbar Spine

Moderate restriction of AROM is noted in the upper lumbar region during active flexion, and a mild, sharp angulation into extension is observed at approximately the L4-5 segment.

Muscle Performance

Symptoms are not reproduced during resisted testing in each of the shortened, middle, and lengthened ranges for muscles of the cervical and thoracic spine, shoulder, or rib cage. Specific myotome testing is deferred to save time and because the patient has no neurologic complaints.

Sensory Integrity

This part of the examination is deferred to save time. The patient denies having any neurologic symptoms.

Reflex Integrity

This part of the examination is deferred to save time. The patient denies having any neurologic symptoms.

Pain

The patient has no tenderness or reproduction of symptoms on palpation of musculoskeletal structures throughout the cervical and thoracic spine, chest, shoulder, and upper ribs. Palpation of the lymph nodes in the cervical, supraclavicular, and axillary regions is normal. Palpation of the abdomen indicates local pain and tenderness along the left anterior-lateral border of the diaphragm and costal margin, just under the rib cage. Palpation of this peripheral portion of the diaphragm does not reproduce the patient's shoulder pain. The central portion of the diaphragm is out of reach for palpation. Palpation of Robert's upper extremity pulses is deferred because he reports no symptoms during his history or on his medical screening questionnaire that suggest cardiovascular disease.

Special Tests

Musculoskeletal Structure	Test
Cervical spine (positive tests)	None
Cervical spine (negative tests)	Compression testing of the cervical spine in flexion, neutral, and extension (see Fig. 5-15)
	Cervical quadrant test in flexion and extension
	Valsalva's maneuver
Shoulder (positive tests)	None
Shoulder (negative tests)	Distraction and compression of the glenohumeral joint
	Hawkins' impingement sign
	Load and shift test (anterior and posterior instability)
	Distraction and compression of the acromioclavicular joint
	O'Brien's test (superior labrum anterior to posterior [SLAP])
	Crank test (labrum)
	Empty can test (supraspinatus tendon)
	Speed's test (biceps tendon)
Thoracic spine (positive tests: shoulder pain)	Thoracic quadrant test in flexion to the left
	Thoracic quadrant test in extension to the left
	Thoracic quadrant test in extension to the right
Thoracic spine (negative tests)	Segmental joint mobility and provocation testing (prone posterior to anterior glides) (see Fig. 5-22)
	T1 nerve root tension test (see Fig. 5-23)
Ribs (positive test: shoulder pain)	Coughing and deep inhalation
Ribs (negative tests)	Lateral compression testing of the middle and lower ribs (supine)
	Mobility and provocation testing of the first rib (see Fig. 5-25)
	Cervical rotation lateral flexion (CRLF) test (see Fig. 5-26)
	Mobility and provocation testing of ribs R2 to R5 anteriorly (see Fig. 5-25)

Joint Integrity and Mobility

Cervical Spine

Examination is deferred to save time because the patient has full cervical AROM without pain (will examine during a future appointment as needed).

Continued

CASE STUDY 1—cont'd

Shoulder

- Glenohumeral: Normal in all directions, with no complaints of pain
- Sternoclavicular: Normal in all directions, with no complaints of pain
- Acromioclavicular: Normal in all directions, with no complaints of pain
- Scapulothoracic: Normal in all directions, with no complaints of pain

Thoracic Spine

Slight hypomobility is noted in the middle and lower thoracic spine in extension, with muscle guarding and no pain.

Ribs

Slight hypomobility of R7 to R10 is observed on the left, with muscle guarding and no pain.

Neuromuscular System

Robert has no gross gait, locomotion, or balance disorders.

Imaging Studies: Radiographs

- Lumbar (2004): The films and the radiologist's report are not available.

Diagnosis

Musculoskeletal Pattern D: Impaired joint mobility, motor function, muscle performance, and ROM associated with connective tissue dysfunction.

This is a 24-year-old, right-handed male patient with signs and symptoms consistent with an extrinsic source of shoulder pain. Shoulder AROM at the end of range for flexion or abduction, which deforms the rib cage and can put stress on the diaphragm, is the only test of the shoulder that gives rise to pain. Results of all other tests of the shoulder—palpation, PROM, resisted testing, special tests, and specific mobility tests—are negative. This extrinsic source appears to be from an irritation of his central left hemidiaphragm, with subsequent referred pain to the left shoulder. Although end ROM of the thoracic spine, thoracic quadrant tests, coughing, and deep inhalation produce shoulder pain, motions that also deform the rib cage and produce stress on the diaphragm, no collaborative findings of thoracic or rib injury from resisted testing, palpation, special tests, or specific mobility testing of the thoracic spine and ribs are present.

In cases involving the diaphragm, suspicion of visceral disease or tumor-induced inflammation of the diaphragm is high. Even though no signs, symptoms, patient history, or family history suggest a possible medical disease involving the diaphragm, it must be part of the differential diagnosis.

Pain

The primary pain generator for this patient appears to be his left hemidiaphragm.

Strain

The biomechanical strains that may be exacerbating the pain and dysfunction are mild hypomobilities in the thoracic spine and ribs with possible lumbar instability. No physiologic strains or comorbidities are noted.

Brain

The patient has experienced his current pain episode for only 1 week. He is in the early stage of healing and has not demonstrated any signs of fear, anger, or frustration. He has no indication of a primary central sensitization disorder or adverse forebrain activity at this time.

Prognosis

Robert has a very good prognosis for returning to competitive volleyball and racquetball.

Intervention

Anticipated goals are as follows:

1. Robert's goal: "Get back to a competitive level of volleyball and racquetball."
2. The patient will be independent with his home exercise program (HEP).
3. Thoracic spine and rib mobility will return to WNL.
4. The patient will return to competitive volleyball and racquetball with minimal discomfort (3/10).

Robert receives a comprehensive treatment program incorporating the WOMEN (*w*isdom, *o*ptimism, *m*anual therapy, *e*xercise, and *n*utrition) plan of care concept. He was expected to achieve at least a 50% reduction in pain after 7 to 10 days. If not, the clinician was prepared to refer the patient to an internal medicine specialist for further medical evaluation. Fortunately, this patient is 90% improved with respect to his symptoms after 1 week. He is able to play racquetball at a competitive level after 2 weeks, with only minimal discomfort. At a 1-year follow-up with the patient, he reports that his left shoulder pain has not returned and he has reported no illnesses or adverse symptoms over the past year. Although it is difficult to verify the source of the patient's pain, the only structure that seems a likely candidate is his diaphragm. Instances of diaphragmatic inflammation from physical strain that is not related to surgery, viscera, or tumor are rare. Therefore, it is strongly suggested that with a similar patient presentation, serious consideration should be given to a differential diagnosis of visceral disease or musculoskeletal tumor.

CASE STUDY 2

Demographics

Lucy is a 66-year-old, right-handed Hispanic female college professor whose primary language is Spanish, although she is fluent in English. She is referred to physical therapy on August 27, 2007, from her primary care physician with a diagnosis of "frozen shoulder." She denies previous treatment of any kind for her current complaints.

Social History

Lucy lives at home with her husband of 34 years. She denies any cultural or religious beliefs that she thinks may affect her care. She is employed as a professor of biology at a local university. Her job requires her to reach overhead and to perform repetitive motions with her arm elevated, including writing on the chalkboard, lifting and carrying less than 10 lb, prolonged sitting, and prolonged standing. She has not missed any time from work because of her current complaints.

Living Environment

Lucy lives in a two-story house in which she ascends and descends one flight of stairs every day. She denies the existence of any major obstacles in and around her house. She does not use assistive devices of any kind for her ADLs.

General Health Status

Lucy rates her general health as fair. In the past year, both her sister and her father died of cancer. The medical screening questionnaire that Lucy filled out on her first visit indicated a family history of cancer (Fig. 13-10). Her grandmother died of throat cancer, her father died of prostate cancer, and her sister died of pancreatic cancer. Questioning her on her smoking habits uncovers that she is a 50-pack-year smoker (1 pack per day for 50 years). The miscellaneous questions of the medical screening questionnaire document a significant number of items that may not be related to somatic injury and dysfunction, including unexplained weight change, history of cancer, extensive family history of cancer, insidious onset of pain, constant pain, and pain that is worse at night—therefore raising a red flag. In addition, half of the questions under the pulmonary section of the questionnaire are answered "yes," again raising a red flag. The cardiovascular section is of only mild concern because the items checked are not strong indicators of cardiovascular disease. At this point, one should have concerns about the patient's pulmonary system and how this may relate to her family's history of cancer and her history as a heavy smoker. If her symptoms correlate with a known visceral disease, and the physical therapist is unable to provoke her symptoms and come up with a meaningful musculoskeletal explanation, then she will have to be referred for further medical evaluation.

Social/Health Habits

Lucy reports that she has smoked approximately one pack of cigarettes a day for the past 50 years (50-pack-year smoker). She takes a multivitamin pill daily, drinks one to two cups of coffee a day, and has two to three glasses of wine each week. She is not a vegetarian and eats at least two meals a day, usually skipping breakfast. Her normal physical activity level involves walking 5 days a week for approximately 40 minutes. She does not participate in sports or any other forms of physical exercise.

Family History

She reports that three members of her family have died of various forms of cancer, and congestive heart failure has been diagnosed in one other family member. Her parents are both deceased.

Medical/Surgical History

- 2007: Surgery to right temporomandibular joint (TMJ) 2 months ago for malignant melanoma
- 2005: Diagnosis of osteoporosis
- 2004: Fall onto right shoulder, no fracture; symptoms resolved in 4 months
- 1990: Lumbar disk surgery

In the past year, she has had episodes of chest pain, cough, SOB, pain at night, loss of appetite, weight loss, and nausea.

Current Condition(s)/Chief Complaint(s)

Lucy comes to physical therapy on August 27, 2007, with a diagnosis of "frozen shoulder." Her main complaint is constant, severe (7/10 to 9/10) right shoulder pain that radiates down her arm and along the ulnar border of her forearm and hand and includes the third through fifth digits (Fig. 11). Approximately 6 weeks before her evaluation, she reported an episode in which her whole right arm felt numb. This symptom has not returned. She does report, however, a periodic mild tingling sensation along the ulnar border of her right hand. On further discussion, she admits that she forgot to tell her physician about the tingling. She denies neck pain, headaches, chest pain, dizziness or vertigo, vision changes, tinnitus, nausea, and upper extremity weakness. She reports no change in her shoulder pain related to eating or bowel or bladder activity or during exertional activities (light jog) that do not directly involve her shoulder. Laughing, coughing, or taking a deep breath does not seem to alter her constant, severe pain. She also denies having constitutional symptoms (fever, night sweats, nausea or vomiting, dizziness, or fatigue). She denies a history of neck pain, fracture, or MVA. Other than what she has stated earlier, Lucy denies any other complaints or symptoms throughout the rest of

Continued

CASE STUDY 2—cont'd

Patient Questionnaire

Name Case Study #2 Date 5/31/95

	Yes		No
Age		66	
Height		5' 4"	
Weight (lbs)		85	
Fever and/or chills			X
Unexplained weight change	X		
Night pain/disturbed sleep			X
Episode of fainting			X
Dry mouth (difficulty swallowing)			X
Dry eyes (red, itchy, sandy)			X
History of illness prior to onset of pain			X
History of cancer	X		
Family history of cancer	X	(3)	
Recent surgery (dental also)	X		
Do you self inject medicines/drugs			X
Diabetic			X
Pain of gradual onset (no trauma)	X		
Constant pain	X		
Pain worse at night	X		
Pain relieved by rest			X
Pulmonary			
History of smoking	X		
Shortness of breath	X		
Fatigue			X
Wheezing or prolonged cough	X		
History of asthma, emphysema or COPD			X
History of pneumonia or tuberculosis			X
Cardiovascular			
Heart murmur/heart valve problem			X
History of heart problems			X
Sweating with pain	X		
Rapid throbbing or fluttering of heart	X		
High blood pressure			X
Dizziness (sit to stand)			X
Swelling in extremities			X
History of rheumatic fever			X
Elevated cholesterol level			X
Family history of heart disease	X	(1)	
Pain/symptoms increase with walking or stair climbing and relieved with rest			X
Pregnant women only			
Constant backache			
Increased uterine contractions			
Menstrual cramps			
Constant pelvic pressure			
Increased amount of vaginal discharge			
Increased consistency of vaginal discharge			
Color change of vaginal discharge			
Increased frequency of urination			

Figure 10 Patient questionnaire for Case Study 2.

her body. She states that her shoulder pain started gradually, with no trauma or overuse noted, sometime in January of 2007. Her pain is evoked by reaching into the back seat of her car from the driver's seat. She gets relief when she lies down on her right side.

Functional Status/Activity Level

Her normal physical activity level involves walking 5 days a week on her lunch hour for approximately 40 minutes. She does not participate in sports or any other forms of physical exercise. Lucy scores 66 out of a possible maximum

CASE STUDY 2—cont'd

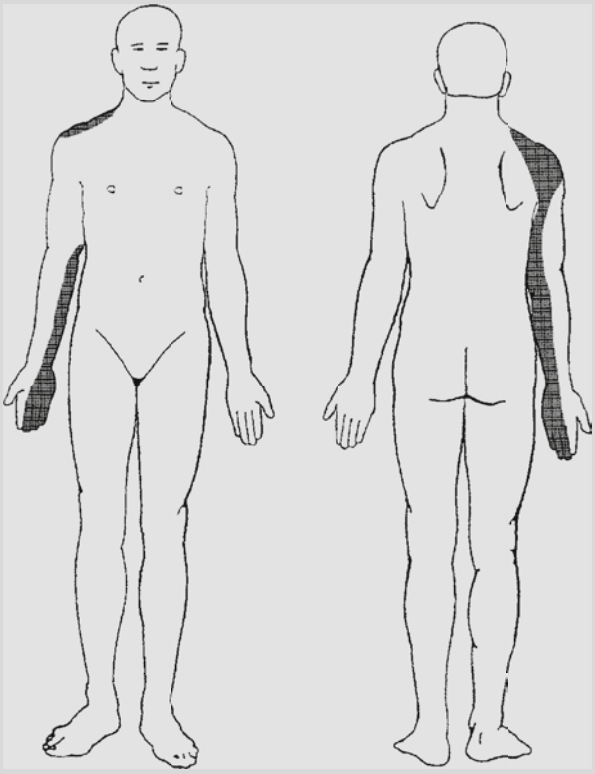


Figure 11 Pain diagram from a 66-year-old, right-handed woman with a diagnosis of "frozen shoulder."

score of 100 on the Sharp FAS for the neck and shoulder region. She reports moderate difficulties with her job, looking up or reaching overhead, dressing, and her domestic duties around the house.

Medications

- Prescription: alendronate (Fosamax) for osteoporosis
- Nonprescription: ibuprofen (Advil) and acetaminophen (Tylenol) daily for the past 6 months

Other Clinical Tests

- 2005: She underwent a CT bone density scan of the spine: T-score of −2.7 (osteoporosis).
- 2004: Cervical spine and right shoulder plain radiographs showed a "normal cervical spine" and a "normal right shoulder," according to the radiologist.

Cardiovascular/Pulmonary System

- Heart rate (resting): 75 beats per minute
- Respiratory rate (resting): 16 breaths per minute (shallow)
- Blood pressure: 130/80 mm Hg
- Edema: none

Integumentary System

Lucy's skin appears healthy, with good continuity of color and no significant changes in temperature. She has very mild swelling and a surgical scar around her right TMJ, and mild swelling is also noted in the right supraclavicular fossa. A well-healed, thin, white scar is noted in her lower lumbar spine.

Communication, Affect, Cognition, Learning Style

No known learning barriers are identified for this patient. She states that she learns best when given a diagram and a demonstration. Lucy does not display any deficits with regard to her cognition, orientation, or ability to communicate effectively.

Musculoskeletal System

Posture

In standing, she has a forward head, rounded and protracted shoulders, and moderately increased thoracic kyphosis. Her iliac crest is high on the right, with right genu recurvatum, collapsed arches bilaterally, and bilateral hallux valgus (right more than left).

Range of Motion

Cervical Spine

Active and passive extension and right rotation reproduce her shoulder pain. Both motions are limited by pain.

Shoulder

AROM and PROM are equally limited. Abduction and external rotation are moderately limited, with minimal limitations in internal rotation and flexion. Minimal shoulder pain, but no arm pain, is reproduced at end ROM in all directions.

Scapula and Elbow

AROM and PROM are WNL and pain free.

Thoracic Spine

Thoracic AROM and PROM are severely limited in extension and moderately limited in side bending and rotation. This patient's primary complaint is not reproduced.

Rib

Active deep inhalation is limited and accompanied by a cough and a dull ache in her shoulder. Gentle (because of Lucy's age and diagnosis of osteoporosis), passive middle and lower rib cage compression is performed, and she reports no pain (full PROM is not tested).

Lumbar Spine

Moderate restrictions in AROM are noted in all directions, without complaints of pain.

Muscle Performance

Shoulder pain and arm pain are reproduced with resisted testing of the cervical spine when the neck is held in extension (shortened position for the neck extensors and lengthened position for the neck flexors) or right side bending (shortened position for the scalenus and upper trapezius on the right and lengthened position for the

Continued

CASE STUDY 2—cont'd

scalenus and upper trapezius on the left). No reproduction of symptoms is elicited for all the cardinal directions tested in each of the shortened, middle, and lengthened ranges for muscles of the thoracic spine and shoulder. Manual muscle testing (isometric; 5/5 is WNL) of the upper extremities is as follows: right triceps (4/5), wrist flexion and extension (4/5), and the intrinsics of the hand (3/5).

Sensory Integrity

Her sensation to light touch and pinprick is decreased in the right C8 and T1 dermatomes.

Reflex Integrity

Her deep tendon reflexes (DTRs) are 2+ and equal at the biceps, brachioradialis, and triceps tendons. The right abductor digiti minimi tendon reflex is 1+. The scapulohumeral reflex (SHR) and Hoffmann's sign show normal results. Both these tests are upper motor neuron–mediated reflexes used to help rule out cervical central canal stenosis.

Pain

Palpation

Swelling and tenderness are noted in the right supraclavicular fossa and the right TMJ. No edema or skin discoloration is noted in the extremities. Palpation of the lymph nodes (sternocleidomastoid, supraclavicular, and axillary), arterial pulses (brachial and radial), and abdomen is normal.

Special Tests

Cervical spine (positive tests: reproduction of symptoms)	Cervical quadrant test in extension to the right or flexion to the left (see Fig. 19) Compression testing of the cervical spine positive only in extension (see Fig. 15) Upper limb neurodynamic testing (ULNT) brachial plexus and median nerve and ulnar nerve bias techniques
Cervical spine (negative tests)	Cervical quadrant test in flexion to the right or extension to the left ULNT radial nerve bias technique Thoracic outlet syndrome Valsalva's maneuver
Shoulder (positive tests: reproduction of symptoms)	Hawkins' impingement sign
Shoulder (negative tests)	Distraction and compression of the glenohumeral joint Load and shift test (anterior and posterior instability) Distraction and compression of the acromioclavicular joint O'Brien's test (SLAP) Crank test (labrum) Empty can test (supraspinatus tendon) Speed's test (biceps tendon)
Thoracic spine (positive tests: reproduction of symptoms)	T1 nerve root tension test (see Fig. 23)
Thoracic spine (negative tests)	Segmental joint mobility and provocation testing (prone posterior-anterior glides) (see Fig. 22) Thoracic quadrant tests
Ribs (positive test)	Mobility and provocation testing of the right first rib: local pain and muscle guarding (see Fig. 25) CRLF test: limited mobility on the right (see Fig. 26)
Ribs (negative tests)	Mobility and provocation testing of ribs R2 to R5 anteriorly (Fig. 25) Lateral compression testing of the middle and lower ribs (supine) Coughing and deep inhalation

Joint Integrity and Mobility

Cervical spine

Loss of segmental mobility is present in all directions throughout the middle and lower cervical spine. Severe limitations are evident, with pain and muscle guarding from C6 to T1 in extension, right side bending, and right rotation. The result of the disk shear test at C5-6 is positive (see Fig. 16).

Shoulder

- Glenohumeral: Normal in all directions except distraction, which causes muscle guarding and pain
- Sternoclavicular: Normal in all directions, with no complaints of pain
- Acromioclavicular: Normal in all directions, without a primary complaint of pain
- Scapulothoracic: Normal in all directions, without a primary complaint of pain

Thoracic Spine

The patient has severe hypomobility at all levels in extension, and the upper segments are associated with local pain and muscle guarding.

Ribs

The patient has slight hypomobility of R1 on the right, with pain.

Neuromuscular System

Lucy has no gross gait, locomotion, or balance disorders.

Imaging Studies

- Cervical (2004): A review of Lucy's cervical spine radiographs reveals the following: mild DDD at C5-6 and DJD at C5-6 and C6-7.
- Shoulder, right (2004): A review of her shoulder radiographs reveals the following: WNL with a type II acromion.

CASE STUDY 2—cont'd

Diagnosis

Suspicions are raised of a possible disorder that is not musculoskeletal because of the insidious onset of symptoms, age of the patient, constant pain, night pain, family history of cancer, patient history of cancer, pulmonary symptoms, and 50-pack-year smoking history.

Musculoskeletal Pattern F: Impaired joint mobility, motor function, muscle performance, ROM, and reflex integrity associated with spinal disorders; or Neuromuscular Pattern F: Impaired peripheral nerve integrity and muscle performance associated with peripheral nerve injury. Also, Musculoskeletal Pattern A: Primary prevention/risk reduction for skeletal demineralization; and Musculoskeletal Pattern B: Impaired posture.

Pain

The primary pain generator for this patient appears to be her right C8 or T1 nerve root or nerve.

Strain

The physiologic strains that may be exacerbating the pain and dysfunction are heavy smoking, osteoporosis, and signs of possible pulmonary disease or dysfunction. The biomechanical strains are poor posture and hypomobility in the cervical and thoracic spine and the ribs.

Brain

The patient has experienced her symptoms only for a few weeks, and she has no overt signs of anger, frustration, hopelessness, depression, or denial. No indication of a primary central sensitization disorder or adverse forebrain activity is present at this time.

Prognosis

Prognosis is uncertain and depends on the presence or absence of visceral disease.

Plan of Care

Anticipated goals are as follows:

1. Lucy's goal: "Get rid of the pain!"
2. The patient will have minimal restrictions, less than a 15° loss, with active and passive shoulder abduction and external rotation.
3. Active and passive thoracic extension will improve so that the restrictions are no longer severe.
4. The patient will have minimal difficulty (3/10) with her job and domestic duties.
5. The Sharp FAS score will be 85/100 without the dependence on pain medication.
6. The patient will be independent, with a comprehensive HEP.

Intervention

Lucy's primary physician is contacted and made aware of concerns regarding her pulmonary status. She receives five treatments (WOMEN) of physical therapy while waiting for her follow-up visit with her physician. Minimal progress is made during this initial course of physical therapy. Following a chest radiograph and further medical examination, Pancoast's tumor is diagnosed in her right lung. After radiation treatment and surgery to remove the cancerous tumor from her lung, Lucy reports a moderate decrease in her complaints of neck and right upper extremity symptoms. This patient does not have Horner's syndrome.

CASE STUDY 3

Demographics

Joe is a 48-year-old, obese, left-handed, white male. He is referred to physical therapy on May 12, 2006, by his primary care physician with a diagnosis of "shoulder pain—bursitis." He received approximately six treatments from a chiropractor without relief. The treatments consisted of massage and ultrasound to his shoulder, followed by a chiropractic adjustment to his cervical spine at each visit.

Social History

Joe is recently divorced and has 50% custody of his two children, whom he sees mainly on weekends. He denies any cultural or religious beliefs that he thinks may affect his care. He is employed as an architect, a job that requires him to sit for a prolonged time. He occasionally has periods of driving and prolonged standing at construction sites. He lifts and carries up to 20 lb, but rarely has to reach over his head and normally does not perform repetitive motions. He does, however, spend hours at a time on his computer. He has not missed any time from work because of his current complaints.

Living Environment

He lives in a two-bedroom condominium on the fourth floor and has the choice of stairs or an elevator when he comes and goes. He denies the existence of any major obstacles in and around his house. He does not use any assistive devices for his ADLs.

General Health Status

Joe rates his general health as good. In the past year, he went through a painful and costly divorce, a beloved family pet died, and he moved into a condominium in a different

Continued

CASE STUDY 3—cont'd

part of town. The medical screening questionnaire, which Joe fills out on his first visit, is notable in the pulmonary and cardiovascular sections (Fig. 12). At the time of his evaluation, he is a 33-pack-year smoker and has a history of heart problems (palpitations and tachycardia), and both his father and grandfather died prematurely of heart attacks.

Social/Health Habits

Joe reports that he has smoked an average of one pack of cigarettes a day since he was 15 years old (33-pack-year smoker). He drinks one to two cups of coffee in the morning, and has a couple of beers or other type of alcohol usually just once during the week. He is not a vegetarian, does not skip any meals, does not take any vitamins or

Patient Questionnaire

Name Case Study #3 Date 12/11/94

	Yes		No
Age		48	
Height		5' 10"	
Weight (lbs)		245	
Fever and/or chills			X
Unexplained weight change			X
Night pain/disturbed sleep			X
Episode of fainting			X
Dry mouth (difficulty swallowing)			X
Dry eyes (red, itchy, sandy)			X
History of illness prior to onset of pain			X
History of cancer			X
Family history of cancer			X
Recent surgery (dental also)			X
Do you self inject medicines/drugs			X
Diabetic			X
Pain of gradual onset (no trauma)	X		
Constant pain			X
Pain worse at night			X
Pain relieved by rest	X		
Pulmonary			
History of smoking	X		
Shortness of breath	X		
Fatigue	X		
Wheezing or prolonged cough			X
History of asthma, emphysema or COPD			X
History of pneumonia or tuberculosis			X
Cardiovascular			
Heart murmur/heart valve problem			X
History of heart problems	X		
Sweating with pain	X		
Rapid throbbing or fluttering of heart			X
High blood pressure	X		
Dizziness (sit to stand)			X
Swelling in extremities			X
History of rheumatic fever			X
Elevated cholesterol level	X		
Family history of heart disease	X		
Pain/symptoms increase with walking or stair climbing and relieved with rest	X		
Pregnant women only			
Constant backache			
Increased uterine contractions			
Menstrual cramps			
Constant pelvic pressure			
Increased amount of vaginal discharge			
Increased consistency of vaginal discharge			
Color change of vaginal discharge			
Increased frequency of urination			

Figure 12 Patient questionnaire for Case Study 3.

CASE STUDY 3—cont'd

supplements, and usually eats at a fast food restaurant several times a week. Joe does not participate in regular physical activity or sports other than playing "catch" with his sons on the weekends.

Family History

His mother is still alive and in reasonably good health. His grandmother died of a pulmonary embolus, at the 65 years of age, following hip surgery. Both his father (56 years old) and grandfather (46 years old) died prematurely of heart attacks. Diabetes and rheumatoid arthritis appear to "run" in his family.

Medical/Surgical History

- 2005: Arthroscopic surgery to the right knee: lateral meniscectomy, still stiff and painful, according to the patient
- 2005: Fall and sprain of left shoulder; resolved in 3 months
- 2004: Diagnosis of high cholesterol (345 mg/dL)
- 2000: Diagnosis of non–insulin-dependent (type 2) diabetes mellitus
- 1997: Lumbar disk surgery

In the past year, he has reported fatigue, SOB, sweating with pain, difficulty sleeping, chest pain, and dizziness without vertigo or blackouts.

Current Condition(s)/Chief Complaint(s)

Joe is a 48-year-old, obese, left-handed man who comes to physical therapy on May 12, 2006, with a diagnosis of "shoulder pain—bursitis" and complaining of periodic moderate (0 to 6/10) pain in his left shoulder (Fig. 13). He states that the pain is not constant and does not radiate down his arm. He does admit that his left hand "tingles" every once in a while. He denies neck pain, headaches, nausea, tinnitus, dizziness or vertigo, vision changes, upper extremity numbness, and upper extremity weakness. He also denies chest pain, but admits to muscle soreness in his chest after playing "catch" with his sons. He denies a change in symptoms after eating a greasy meal, bowel movement, coughing, or laughing or during a deep inhalation. He also reports no change in his shoulder pain related to eating or bowel and bladder activity. He notes that exertional activity—climbing four flights of stairs to his condominium—gives him SOB, fatigue, and an ache in his left shoulder. He denies having the following constitutional symptoms: fever, night sweats, nausea or vomiting, dizziness, or unexplained weight loss. Other than what is reported here, he denies any other complaints or symptoms throughout the rest of his body. Joe reports that his symptoms started 2 days after an afternoon of throwing and catching a football with his sons approximately 2 months ago. He reports that his shoulder pain is made worse by activities such as waxing his car or carrying groceries. He states that his symptoms change with his activity level, but not with changes in his posture. He notes that, with repeated overhead use, he has shoulder pain and fatigue, which is quickly resolved if he stops that particular activity.

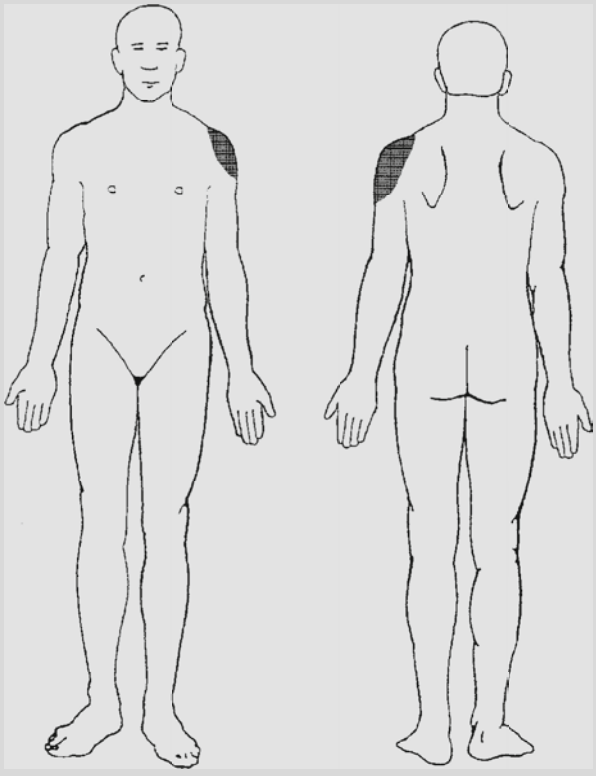


Figure 13 Pain diagram from a 48-year-old, left-handed man with a diagnosis of "shoulder pain—bursitis."

Functional Status/Activity Level

Joe does not participate in regular physical activity or sports other than playing "catch" with his sons on the weekends. He used to use the four flights of stairs up to his condominium as a source of exercise; however, he had to give that up a couple of months ago because of SOB and significant fatigue. Joe reports that he can throw 8 or 10 good passes with the football without pain. Then his shoulder rapidly fatigues and begins to ache. He states that he can lift 10 lb or more over his head without difficulty, but he has problems with repeated overhead activities such as painting his garage or washing and drying his camper. He has difficulty carrying groceries if his car is parked too far away from the grocery store, and he has noted fatigue and shoulder pain if he vacuums more than one room of his condominium. Joe scores 73 out of a possible maximum score of 100 on the Sharp FAS for the neck and shoulder region. He reports no difficulties with sleeping, looking up or reaching overhead, driving, dressing, personal care, or work.

Continued

CASE STUDY 3—cont'd

Medications

- Prescription: atorvastatin (Lipitor) for high cholesterol and insulin for type 2 diabetes mellitus
- Nonprescription: acetaminophen (Tylenol)

Other Clinical Tests

According to his last physician visit 2 weeks ago, Joe's blood glucose level was WNL. His cholesterol level was high, but much improved at 250 mg/dL. No imaging studies have been performed on Joe's cervical or thoracic spine or shoulder. In 1997, he had a plain radiograph of his lumbar spine followed by an MRI scan (films and the radiologist's report are not available). In 2005, he also had a plain radiograph and MRI scan of his right knee (films and the radiologist's report are not available).

Cardiovascular/Pulmonary System

- Heart rate (resting): 80 beats per minute
- Respiratory rate (resting): 18 breaths per minute
- Blood pressure: 135/88 mm Hg
- Edema: none

Integumentary System

Joe's skin appears healthy, with good continuity of color and no significant changes in temperature. White, well-healed scars are noted around the right knee and the lower lumbar spine. No swelling is noted.

Communication, Affect, Cognition, Learning Style

No known learning barriers are identified for this patient. He states that he can remember things best if they are clearly explained to him with a good rationale and if he is allowed to take notes. Joe does not reveal any deficits with regard to his cognition, orientation, or ability to communicate effectively.

Musculoskeletal System

Posture

In standing, he has a slightly forward head, a flat thoracic and lumbar spine, a protruding belly (obese), slight genu valgum bilaterally, and bilateral pes planus.

Range of Motion

Cervical Spine

AROM and PROM are WNL and pain free.

Shoulder

AROM and PROM are WNL and pain free.

Scapula and Elbow

AROM and PROM are WNL and pain free.

Thoracic Spine

AROM and PROM are pain free. Mild to moderate limitations are noted in flexion.

Rib

AROM and PROM are WNL and pain free.

Lumbar Spine

AROM is painful and limited in extension and left side bending. Pain is localized to the lower lumbar spine.

Muscle Performance

No reproduction of symptoms is elicited for all the cardinal directions tested in each of the shortened, middle, and lengthened ranges for muscles of the cervical and thoracic spine and left shoulder. Manual muscle testing (isometric; 5/5 is WNL) of the upper extremities is WNL (5/5).

Sensory Integrity

Upper extremity light touch and pinprick sensation is WNL.

Reflex Integrity

Upper extremity DTRs are equal and brisk (2+). The SHR and Hoffman's sign are normal.

Pain

Palpation

No reproduction of symptoms is elicited on palpation of musculoskeletal structures throughout the cervical and thoracic spine, chest, shoulder, and upper ribs. No edema or skin discoloration is noted in the extremities. Palpation of the lymph nodes (sternocleidomastoid, supraclavicular, and axillary), arterial pulses (brachial and radial), and the abdomen is normal.

Special Tests

Musculoskeletal System	Test
Cervical spine (positive tests: reproduction of symptoms)	Thoracic outlet syndrome: Roo's 3-minute flap arm test reproduces left shoulder pain
Cervical spine (negative tests)	Compression testing of the cervical spine in flexion, neutral, and extension (see Fig. 15)
	Thoracic outlet syndrome: Adson's test, costoclavicular test, and pectoralis minor stress test
	Cervical quadrant test in flexion and extension (see Fig. 19)
	ULNT = 3
	Valsalva's maneuver
Shoulder (positive tests)	None
Shoulder (negative tests)	Distraction and compression of the glenohumeral joint
	Hawkins' impingement sign
	Load and shift test (anterior and posterior instability)
	Distraction and compression of the acromioclavicular joint
	O'Brien's test (SLAP)
	Crank test (labrum)
	Empty can test (supraspinatus tendon)
	Speed's test (biceps tendon)

CASE STUDY 3—cont'd

Musculoskeletal System	Test
Thoracic spine (positive tests)	None
Thoracic spine (negative tests)	Segmental joint mobility and provocation testing (prone posterior-anterior glides) (see Fig. 22) T1 nerve root tension test (see Fig. 23) Thoracic quadrant tests
Ribs (positive test)	None
Ribs (negative tests)	Mobility and provocation testing of ribs R2 to R5 anteriorly (see Fig. 25) Mobility and provocation testing of the right first rib (see Fig. 25) CRLF test (see Fig. 26) Lateral compression testing of the middle and lower ribs (supine) Coughing and deep inhalation

Joint Integrity and Mobility

Cervical Spine

Examination is deferred (full gross AROM and PROM without pain; will examine segmental mobility at a future appointment as needed).

Shoulder

- Glenohumeral: Normal in all directions, with no complaints of pain
- Sternoclavicular: Normal in all directions, with no complaints of pain
- Acromioclavicular: Normal in all directions, with no complaints of pain
- Scapulothoracic: Normal in all directions, with no complaints of pain

Thoracic Spine

Examination is deferred to save time (will examine at a future appointment as needed).

Ribs

Results are normal for first ribs bilaterally, with no complaints of pain.

Neuromuscular System

Joe has no gross gait, locomotion, or balance disorders.

Imaging Studies

No imaging studies are taken of this patient's cervical or thoracic spine or shoulder.

Diagnosis

Cardiovascular/Pulmonary Pattern D: Impaired aerobic capacity/endurance associated with cardiovascular pump dysfunction or failure.

Joe's symptoms do not appear to be musculoskeletal in origin. Except for positive Roo's test for thoracic outlet syndrome with a vascular bias, the patient's symptoms are not reproduced during a thorough musculoskeletal examination. A return to the interview process reveals that the patient periodically feels a tightness or pressure on his chest at the same time he feels the shoulder pain. Both symptoms rapidly go away when he sits down and relaxes. Of concern was the number of "yes" answers on his medical screening questionnaire in the sections for pulmonary and cardiovascular disease. He also has risk factors related to cardiovascular disease, such as his age (48 years old), sex (male), diet (fast food), smoking (33-pack-year history), high cholesterol, diabetes, and family history (father and grandfather died of myocardial infarction). In addition, he notes that exertional activities give him SOB, fatigue, and a shoulder ache. Finally, he has reported cardiovascular type symptoms in the past year: SOB, fatigue, sweating with pain, chest pain, and dizziness.

Pain

The primary pain generator in this case appears not to be musculoskeletal in origin. A diagnosis of cardiovascular disease must be excluded.

Strain

The biomechanical strain that may be exacerbating Joe's pain and dysfunction is restricted mobility in the thoracic spine. The physiologic strains that may be exacerbating his pain are smoking, obesity, lack of regular exercise, and signs of possible cardiopulmonary disease.

Brain

Because his symptoms are not chronic, a primary central sensitization disorder was not suspected initially. However, because most of his musculoskeletal examination is negative, the possibility of a central sensitization disorder must be reexamined if he has no visceral disease or medical condition to explain his symptoms. Joe does not exhibit any overt signs of fear, anger, or frustration. He has, however, had several recent and significant life-changing events (divorce, move to a new residence, death of a pet). To facilitate the rehabilitation process, Joe may benefit from a referral for counseling.

Prognosis

Prognosis is uncertain and depends on the presence of visceral disease.

Intervention

The patient is referred back to his primary care physician for follow-up to rule out cardiopulmonary disease. Subsequently, myocardial ischemia, with associated angina pectoris, is diagnosed. His shoulder symptoms disappear immediately with the use of nitroglycerin.

CASE STUDY 4

Demographics

Vinaka is a 64-year-old, right-handed Fijian female interpreter who speaks fluent English, French, and several Fijian dialects. She is referred on March 16, 2007, by a physical therapist at another facility, for a consultation and second opinion on her right shoulder pain. She denies previous treatment of any kind for her current complaints.

Social History

She is married with five adult children and six grandchildren. Vinaka states that she comes from a very modest culture with strict religious beliefs. If she were to receive ongoing care, then she would feel more comfortable with a female therapist. Because of the nature of her job as an interpreter, she spends approximately 6 months in Fiji, 3 months in Europe, and 3 months in the United States each year.

Living Environment

In Fiji, she lives in a modest one-story, two-bedroom house. In Europe, she lives in a one-bedroom apartment on the second floor, and in the United States, she divides her time between a two-bedroom condominium on the first floor and a one-bedroom apartment on the third floor. She denies the existence of any major obstacles in and around any of her living quarters, except for the stairs leading up to her apartments. She does not use any assistive devices for her ADLs.

General Health Status

Vinaka states that she is in very good health for her age. In the past year, she learned that her sister was diagnosed with cancer. She has had no other major life changes, and she states that she enjoys the amount of traveling her job requires. The medical screening questionnaire, which Vinaka fills out on her first visit, is notable for the general and cardiovascular sections (Fig. 14). Specifically, the patient questionnaire reveals recent surgery, fever, SOB, and a prosthetic cardiac valve. On further questioning, this patient admits to an episode of chest pain 2 weeks ago, but she relates this to muscle soreness from washing her windows.

Social/Health Habits

Vinaka reports that she has never used tobacco products. She drinks a cup of decaffeinated coffee in the morning and has approximately three sodas with caffeine throughout the day. She does not drink alcohol. She takes a multivitamin supplement, extra calcium, fish oil tablets, and glucosamine sulfate. She is not a vegetarian, but she avoids red meat in favor of chicken or seafood and has a limited intake of dairy products. Vinaka does not participate in any sports or regular forms of physical activity other than her daily walks between 1 and 2 miles.

Family History

Vinaka's grandfather died, at the age 65, of a myocardial infarction and her grandmother died, at the age of 77, following her second CVA in 2 years. Her mother died of breast cancer at the age of 69 years; her father died of a massive myocardial infarction at age 73 years; non-Hodgkin's lymphoma was diagnosed in her 62-year-old sister; and her brother, 66 years old, received coronary artery bypass surgery, involving four arteries, 10 years ago.

Medical/Surgical History

- 2007: Surgery (August) root canal
- 2007: Surgery (March) implant of a prosthetic heart valve
- 2000: Diagnosis of high blood pressure/hypertension
- 2000: Diagnosis of high cholesterol (300 mg/dL)
- 1989: Hysterectomy

In the past year, she has reported fatigue, SOB, swelling in the extremities, heart palpitations, difficulty sleeping, nausea, and dizziness without vertigo or blackouts.

Current Condition(s)/Chief Complaint(s)

Vinaka, a 64-year-old, right-handed woman, comes to physical therapy on September 3, 2007, with a complaint of constant, severe (7/10 to 10/10) right shoulder pain. She reports that she has had a low-grade fever for the past 2 weeks. She denies neck pain, headaches, chest pain, dizziness or vertigo, vision changes, tinnitus, nausea, radiating arm pain, upper extremity paresthesia, and upper extremity weakness. She denies a history of right shoulder pain, neck pain, falls, fractures, or MVA. She reports no change in her shoulder pain related to eating, bowel or bladder activity, coughing, laughing, or deep inspiration or during exertional activities (e.g., long walks) that do not directly involve her shoulder. She also denies having the following constitutional symptoms: night sweats, nausea or vomiting, dizziness, fatigue, or unexplained weight loss. Other than what she reports here, she denies any other complaints or symptoms throughout the rest of her body. She reports the sudden onset, without trauma, of right shoulder and upper trapezius pain approximately 1 month before her initial evaluation (Fig. 15).

Functional Status/Activity Level

Vinaka does not normally participate in any sports or regular forms of physical activity other than her daily walks between 1 and 2 miles. She works full time as an interpreter, which involves a lot of traveling (planes, trains, and automobiles), prolonged standing, and a moderate degree of sitting. Her job does not require her to stress her shoulders or upper extremities to any significant degree. However, she is required to carry a briefcase and a suitcase when traveling, and this does put stress on her shoulder. She cannot sleep on her right side and has moderate

CASE STUDY 4—cont'd

Patient Questionnaire

Name Case Study #4 Date 9/16/93

	Yes		No
Age		64	
Height		5' 5"	
Weight (lbs)		125	
Fever and/or chills	X		
Unexplained weight change			X
Night pain/disturbed sleep			X
Episode of fainting			X
Dry mouth (difficulty swallowing)			X
Dry eyes (red, itchy, sandy)			X
History of illness prior to onset of pain	X		
History of cancer			X
Family history of cancer	X		
Recent surgery (dental also)	X		
Do you self inject medicines/drugs			X
Diabetic			X
Pain of gradual onset (no trauma).... sudden onset	X		
Constant pain			X
Pain worse at night			X
Pain relieved by rest	X		
Pulmonary			
History of smoking			X
Shortness of breath	X		
Fatigue			X
Wheezing or prolonged cough			X
History of asthma, emphysema or COPD			X
History of pneumonia or tuberculosis			X
Cardiovascular			
Heart murmur/heart valve problem	X		
History of heart problems	X		
Sweating with pain			X
Rapid throbbing or fluttering of heart			X
High blood pressure	X		
Dizziness (sit to stand)			X
Swelling in extremities	X		
History of rheumatic fever			X
Elevated cholesterol level	X		
Family history of heart disease	X		
Pain/symptoms increase with walking or stair climbing and relieved with rest			X
Pregnant women only			
Constant backache			
Increased uterine contractions			
Menstrual cramps			
Constant pelvic pressure			
Increased amount of vaginal discharge			
Increased consistency of vaginal discharge			
Color change of vaginal discharge			
Increased frequency of urination			

Figure 14 Patient questionnaire for Case Study 4.

difficulties with all ADLs (reaching overhead, driving, dressing, personal care, lifting or carrying, and domestic duties) because of pain in her right shoulder. Vinaka scores 63 out of a possible maximum score of 100 on the Sharp FAS for the neck and shoulder region.

Medications

- Prescription: hydrochlorothiazide (Lotensin) for hypertension, ibuprofen (NSAID), and fluvastatin (Lescol) for high cholesterol
- Nonprescription: acetaminophen (Tylenol)

Continued

CASE STUDY 4—cont'd

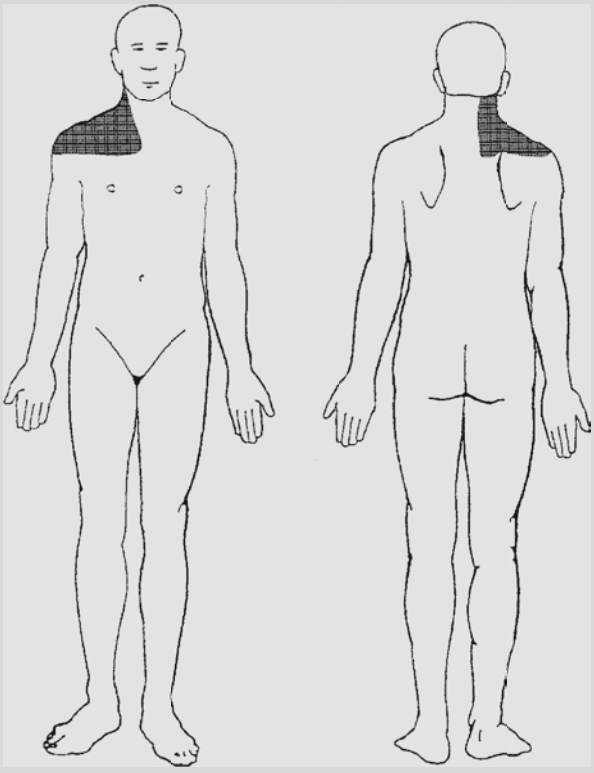


Figure 15 Pain diagram from a 64-year-old, right-handed woman with a diagnosis of "right shoulder pain."

Other Clinical Tests

At her last visit to her primary care physician 2 months ago, her blood pressure was 125/85 mm Hg, and her total cholesterol was 245 mg/dL. Vinaka has had no imaging studies, other than those at the dentist's office, in the past 10 years.

Cardiovascular/Pulmonary System

- Heart rate (resting): 75 beats per minute
- Respiratory rate (resting): 15 breaths per minute
- Blood pressure: 130/90 mm Hg
- Edema: mild bilateral ankle edema

Integumentary System

Vinaka's skin appears generally healthy. The area surrounding her right sternoclavicular joint is slightly swollen, warm, red, and tender. A well-healed surgical scar is noted across her sternum. Mild bilateral ankle edema is noted.

Communication, Affect, Cognition, Learning Style

No known learning barriers are identified for this patient. She states that she can remember things best if they are written down clearly and, in the case of home exercises, if she is also given a chance to perform them under supervision for the first time. Vinaka does not reveal any deficits with regard to her cognition, orientation, or ability to communicate effectively.

Musculoskeletal System

Posture

In standing, she has a slightly forward head, slight scoliosis (concave right through the midthoracic spine), and an elevated and slightly winging left scapula. She also has a high left iliac crest high, left posterior superior iliac spine, left gluteal, and left popliteal fossa, as well as a pronated left foot with moderate hallux valgus.

Range of Motion

Cervical Spine

AROM and PROM are limited slightly in flexion and left side bending with complaints of a "stretching ache" in the region of the right upper trapezius only during left side bending. The patient is able to perform pain-free cervical left side bending, through a full ROM, with the right scapula passively elevated and the upper trapezius placed on slack.

Shoulder

Active and passive flexion, extension, abduction, horizontal adduction, and horizontal abduction reproduce pain. AROM in these directions is minimally limited. PROM is WNL.

Scapula

Active and passive elevation, depression, protraction, and retraction also reproduce the patient's complaints of pain. AROM is mildly limited in all directions. PROM is WNL.

Elbow

AROM and PROM are WNL and pain free.

Thoracic Spine

AROM and PROM are pain free. In general, moderate limitations are noted in left side bending, right rotation, and extension.

Rib

AROM and PROM are WNL and pain free for general inhalation and exhalation and passive compression. First rib mobility on the right is slightly hypomobile, but pain free.

Lumbar Spine

AROM is pain free, but limited in all directions.

Muscle Performance

No reproduction of symptoms is elicited for all the cardinal directions tested in each of the shortened, middle, and lengthened ranges for muscles of the cervical and thoracic spine and right shoulder. Because this patient reports no history of upper extremity symptoms suggestive of neurogenic injury or irritation, specific manual muscle testing is deferred on the myotomes of the upper extremity.

Sensory Integrity

Tests are deferred because no neurogenic symptoms are reported and also to save time.

Reflex Integrity

Tests are deferred because no neurogenic symptoms are reported and also to save time.

CASE STUDY 4—cont'd

Pain

Palpation

The right sternoclavicular joint is slightly swollen, warm, red, and exquisitely tender. A palpable band of tender tissue is noted in the right upper trapezius muscle. Palpation of the lymph nodes (sternocleidomastoid, supraclavicular, and axillary), arterial pulses (brachial and radial), and abdomen is normal. No petechiae or Janeway's lesions are present on her skin. Ankle edema is noted bilaterally.

Special Tests

Musculoskeletal System	Test
Cervical spine (positive tests: reproduction of symptoms)	Cervical quadrant test in flexion left: "stretch" pain in the right upper trapezius) Cervical quadrant test in extension left: pain in right sternoclavicular joint (see Fig. 19)
Cervical spine (negative tests)	Compression testing of the cervical spine in flexion, neutral, and extension (see Fig. 15) Cervical quadrant test in flexion right and extension right (see Fig. 19) Valsalva's maneuver
Shoulder (positive tests: pain at the sternoclavicular joint)	Hawkins' impingement sign Acromioclavicular joint compression (horizontal adduction of humerus)
Shoulder (negative tests)	Distraction and compression of the glenohumeral joint Load and shift test (anterior and posterior instability) O'Brien's test (SLAP) Crank test (labrum) Empty can test (supraspinatus tendon) Speed's test (biceps tendon)
Thoracic spine (positive tests)	None
Thoracic spine (negative tests)	Segmental joint mobility and provocation testing (prone posterior-anterior glides) (see Fig. 22) Thoracic quadrant tests
Ribs (positive test)	Mobility and provocation testing of right first rib: hypomobile with local tenderness (see Fig. 25) CRLF test: hypomobile on the right (see Fig. 26).
Ribs (negative tests)	Mobility and provocation testing of ribs R2 to R5 anteriorly (see Fig. 25) Lateral compression testing of the middle and lower ribs (supine) Coughing and deep inhalation

Joint Integrity and Mobility

Cervical Spine

The cervical spine is severely hypomobile at C6 in extension, left side bending, and left rotation, but without pain. It is mildly hypermobile at C5 in extension and left rotation, also without pain. The result of the disk shear test is positive at C5 (see Fig. 16).

Shoulder

- Glenohumeral: Normal in all directions, without pain
- Sternoclavicular: Hypomobile, mild in all directions, with pain
- Acromioclavicular: Normal in all directions, without pain
- Scapulothoracic: Normal in all directions, without pain

Thoracic Spine

The thoracic spine is mildly hypomobile from T1 to T4 for left side bending and right rotation, without pain, and is severely hypomobile from T1 to T7 in extension, also without pain.

Ribs

The patient has rib hypomobility, mild for the right first rib, without complaints of shoulder pain.

Neuromuscular System

Vinaka has no gross gait, locomotion, or balance disorders.

Imaging Studies

No imaging studies are taken of this patient's cervical or thoracic spine or shoulder.

Diagnosis

Musculoskeletal Pattern E: Impaired joint mobility, motor function, muscle performance, and ROM associated with localized inflammation.

This patient's signs and symptoms are consistent with an irritable, and probably inflamed, right sternoclavicular joint. She demonstrates classic signs of inflammation: pain, tenderness, swelling, warmth, and redness. Because of the multiple "yes" answers in the cardiovascular section of her medical screening questionnaire, and because of her history of prosthetic valve surgery, recent surgery, recent illness, SOB, fever, chest pain, and the sudden onset of pain without trauma, the plan is to refer her back to her primary care physician to rule out cardiac symptoms and disease. If nothing else, this is thought to be a musculoskeletal problem with comorbid cardiac disease.

Pain

The primary pain generator for this patient appears to be her right sternoclavicular joint.

Strain

The biomechanical strains that may be exacerbating her pain and dysfunction at the sternoclavicular joint are poor posture, segmental instability of the cervical spine, and hypomobilities in the first rib and thoracic spine. The physiologic strain that may be exacerbating her pain and dysfunction is the possibility of heart disease.

Continued

CASE STUDY 4—cont'd

Brain

The patient has experienced her symptoms only for a few weeks, and she has no overt signs of anger, frustration, hopelessness, depression, or denial. No indication of a primary central sensitization disorder or adverse forebrain activity is present at this time.

Prognosis

Prognosis is uncertain and depends on the presence of visceral disease and whether the visceral disease is comorbid or the primary generator of her symptoms.

Intervention

Anticipated goals are as follows:

1. Vinaka's goal: "Learn an exercise program I can do on my own."
2. Cervical AROM will return to WNL.
3. The patient will have minimal restrictions for thoracic spine motion.
4. The patient will have minimal difficulty (3/10) with ADLs.
5. The Sharp FAS score will be 85/100 without dependence on pain medication.
6. The patient will be independent, with a comprehensive HEP.

Because Vinaka was referred for a consultation and second opinion, treatment is not initiated. She is referred back to her primary care physician with concerns regarding her cardiac status. A report is sent to her primary physical therapist with a recommendation to hold physical therapy until after Vinaka sees her physician. After a referral to a rheumatologist and then a cardiac specialist, bacterial endocarditis is eventually diagnosed. After a week on antibiotics, her right shoulder pain is minimal (3/10), and she is scheduled to begin physical therapy elsewhere.

CASE STUDY 5

Demographics

Alex is a 51-year-old, right-handed, obese, African American female patent attorney whose primary language is English. She is referred for physical therapy by her primary care physician on September 24, 2008, with a diagnosis of "right shoulder strain." She denies previous treatment of any kind for her current complaints.

Social History

Alex is single, never married, and lives with her partner. She denies any cultural or religious beliefs that she thinks may affect her care. She works as a patent attorney, which involves prolonged sitting and long periods on her computer. She has minimal physical stress, however, in terms of lifting, carrying, and overhead activities.

Living Environment

She lives in a two-story, three-bedroom house. She denies the existence of any major obstacles in and around her house. She denies the use of assistive devices during her ADLs.

General Health Status

Alex reports that she is in "pretty fair" health. She states she started her own law firm 6 months ago and has only recently been able to keep her work week to less than 60 hours. The medical screening questionnaire, which Alex fills out on her first visit, is notable for the general and gastrointestinal sections (Fig. 16). Further questioning reveals that she has had a low-grade fever for the 3 weeks before her evaluation in physical therapy. In addition, she also admits to having occasional upper abdominal and right shoulder blade pain after meals.

Social/Health Habits

Alex reports that she stopped smoking 10 years ago. Before then, she had smoked a half to a full pack of cigarettes a day for approximately 26 years. She drinks two to three cups of coffee and two to three cans of soda with caffeine a day. She drinks a beer or glass of wine 3 to 4 nights a week. She takes a multivitamin and extra calcium. She is not a vegetarian, eats red meat several times a week, dairy products daily, and shellfish occasionally. Lately, she has been avoiding greasy or fried foods. Her only form of exercise—she does not participate in athletic activities or sports—is walking on a treadmill for 20 minutes three times a week.

Family History

Her father died at the age of 71 years of progressive heart failure. Her mother is still alive, but diabetes, lupus, and rheumatoid arthritis have been diagnosed. Her sister, who is 54 years old, has fibromyalgia.

Medical/Surgical History

2007: Arthroscopic decompression of right shoulder (August)
2006: Diagnosis of hepatitis

CASE STUDY 5—cont'd

Patient Questionnaire

Name Case Study #5 Date 5/21/95

	Yes		No
Age		51	
Height		5' 3"	
Weight (lbs)		175	
Fever and/or chills	X		
Unexplained weight change	X		
Night pain/disturbed sleep	X		
Episode of fainting			X
Dry mouth (difficulty swallowing)			X
Dry eyes (red, itchy, sandy)			X
History of illness prior to onset of pain			X
History of cancer			X
Family history of cancer	X	(1)	
Recent surgery (dental also)	X		
Do you self inject medicines/drugs	X		
Diabetic	X		
Pain of gradual onset (no trauma)			X
Constant pain			X
Pain worse at night	X		
Pain relieved by rest			X

Gastrointestinal

Difficulty in swallowing			X
Nausea	X		
Heartburn			X
Vomiting			X
Food intolerances	X		
Constipation			X
Diarrhea	X		
Change in color of stools			X
Rectal bleeding			X
History of liver or gallbladder problems	X		
History of stomach or GI problems	X		
Indigestion	X		
Loss of apetite			X
Pain worse when lying on your back			X
Pain change due to bowel/bladder activity			X
Pain change during or after meals	X		

Figure 16 Patient questionnaire for Case Study 5, modified to show notable portions of both pages.

2003: MVA with diagnosis of cervical sprain and strain and whiplash; resolved

1996: Diagnosis of non–insulin-dependent (type 2) diabetes mellitus

In the past year, Alex has complained of joint pain, difficulty sleeping, nausea, indigestion, diarrhea, unexplained weight change, headaches, and fever.

Current Condition(s)/Chief Complaint(s)

Alex, a 51-year-old, right-handed, obese woman, comes to the office on September 24, 2008, with a diagnosis of "right shoulder strain." She complains of a periodic, severe (0 to 8/10), deep, and generalized ache across the back of her right shoulder (Fig. 17). She reports that her right shoulder pain is worse at night. After asking her directly, she does admit that there seems to be an exacerbation of her right shoulder pain an hour or so after lunch. Alex reports that she often has lunch with clients at a local restaurant. Her lunchtime meals vary from hamburger with fries, fried chicken, and mashed potatoes to the occasional soup and salad. She denies neck pain, headaches, TMJ dysfunction, chest pain, dizziness or vertigo, vision changes, tinnitus, radiating right arm pain, paresthesia in the right upper extremity, and right upper extremity weakness. She reports no change in her right shoulder pain related to bowel and bladder activity or during prolonged walks or climbing stairs. She admits to having the following constitutional symptoms: fever, unexplained weight change, night pain, indigestion, diarrhea, and nausea. She denies night sweats, vomiting, dizziness, and fatigue. Alex reports the sudden onset of a severe ache in her right shoulder

Continued

CASE STUDY 5—cont'd

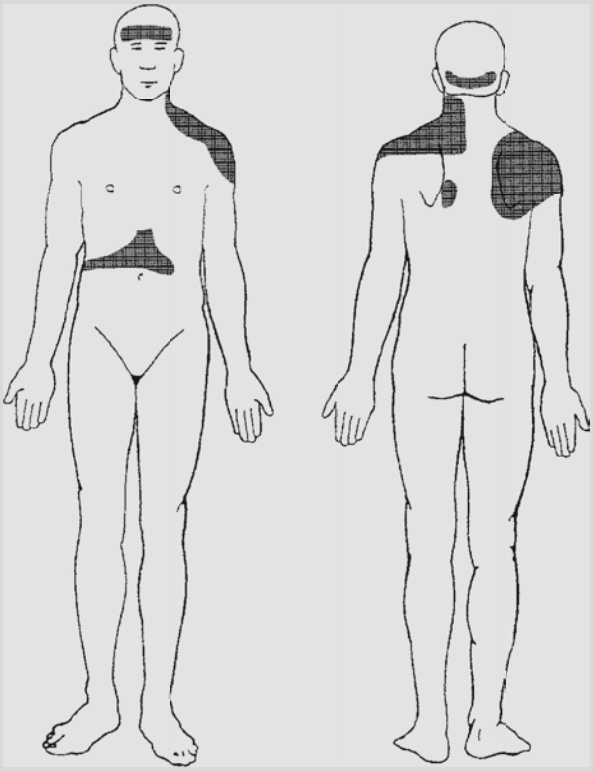


Figure 17 Pain diagram from a 51-year-old, right-handed woman with a diagnosis of "right shoulder strain."

after a day of housecleaning 2 weeks ago. She also admits to a long history (5 years) of headaches, neck pain, and left shoulder pain with tingling in her left hand. The symptoms in her neck and left shoulder do not change after cleaning her house, and they remain mild in intensity. The pain in her left shoulder is not the same as the pain in the right. The left shoulder pain is sharp, shooting, and localized. She does admit to an occasional ache in her right shoulder blade during the past 2 months before she came to physical therapy. She denies a history of falls or fractures. Other than what she reports here, she denies any other complaints or symptoms throughout the rest of her body.

Functional Status/Activity Level

Alex's only form of exercise—she does not participate in athletic activities or sports—is walking on a treadmill for 20 minutes three times a week. She scores 58 out of a possible maximum score of 100 on the Sharp FAS for the neck and shoulder region. She reports severe difficulty looking up or reaching overhead; moderate difficulty with sleeping, driving, dressing, personal care, lifting or carrying, and domestic duties; and minimal difficulty with leisure activities and work. She is working full time and has not had to miss any time from work because of her neck and shoulder complaints.

Medications

- Prescription: celecoxib (Celebrex, an NSAID), hydrocodone and acetaminophen combination (Vicodin) for pain, carisoprodol (Soma) for insomnia, and amitriptyline (Elavil) for depression
- Nonprescription: aluminum hydroxide and magnesium hydroxide combination (Maalox) as needed

Other Clinical Tests

She has regular tests for blood glucose levels. Her most recent test was 3 weeks ago and was reported as WNL. A mammogram last year was reported as normal according to the patient. A review of a plain radiograph of her cervical spine that was taken 4 years ago shows mild to moderate degenerative changes throughout her cervical spine. A review of a plain radiograph of her right shoulder taken last week reveals no significant abnormalities.

Cardiovascular/Pulmonary System

Although it is well known that the heart and lungs can refer pain to the left shoulder and can cause indigestion and nausea, the right shoulder is not a common area of the body for referred cardiac pain and symptoms. No clear indication existed that this patient's symptoms may be cardiopulmonary in origin. Her medical screening questionnaire does not raise any red flags in the pulmonary or cardiovascular sections (see Fig. 16). Therefore, a specific cardiopulmonary physical examination is deferred.

Integumentary System

Alex's skin appears healthy, with good continuity of color and no significant changes in temperature. No swelling is present. White, well-healed surgical scars are noted around her right shoulder.

Communication, Affect, Cognition, Learning Style

No known learning barriers are identified for this patient. She states that she can remember things best if they are explained clearly and she is given a good rationale to back up the advice or instruction. Alex does not reveal any deficits with regard to her cognition, orientation, or ability to communicate effectively.

Musculoskeletal System

Posture

In standing, she has a slightly forward head, exaggerated lumbar lordosis, and bilateral pes planus.

Range of Motion

Cervical Spine

Active and passive cervical extension, left side bending, and left rotation reproduce neck and left shoulder pain. No reproduction of right shoulder pain is elicited.

CASE STUDY 5—cont'd

Shoulder (Right)
AROM and PROM of the right shoulder do not reproduce pain, although mild restrictions are noted with flexion, abduction, and external rotation.

Scapula and Elbow (Right)
AROM and PROM are WNL and pain free.

Thoracic Spine
AROM and PROM are pain free. Moderate limitations are noted in upper thoracic left side bending and extension.

Rib
AROM and PROM are WNL and pain free for general inhalation and exhalation and passive compression. First rib mobility on the left is slightly hypomobile.

Lumbar Spine
AROM is pain free, with a moderate limitation in flexion and extension and a mild limitation in all other directions.

Muscle Performance
No reproduction of right shoulder pain is elicited for all the cardinal directions tested in each of the shortened, middle, and lengthened ranges for muscles of the cervical and thoracic spine, and right shoulder. Left cervical and shoulder symptoms are reproduced with resisted testing when the cervical spine is extended, the side is bent to the left, or the spine is rotated left. Specific manual muscle testing (isometric; (5/5 is WNL) of the upper extremities is WNL (5/5).

Sensory Integrity
Increased sensitivity to light touch and pinprick is noted in the left C6 dermatome.

Reflex Integrity
Hyperreflexia (3+) is noted for the left brachioradialis DTR. The biceps brachialis, triceps, and abductor digiti minimi are equal (2+) bilaterally. The SHR test result is negative. Hoffmann's sign shows a positive result on the left.

Pain
Palpation
Mild tenderness, without reproduction of significant shoulder pain, is noted in the left upper trapezius, left middle trapezius, left rhomboids, and right infraspinatus muscle belly. Palpation of the lymph nodes (sternocleidomastoid, supraclavicular, and axillary) is normal. Palpation of the abdomen indicates rigidity and exquisite tenderness in the right upper abdominal quadrant. No joint effusion or soft tissue edema is noted. Palpation of her upper extremity pulses is deferred because her symptoms and medical screening questionnaire do not indicate the possibility of cardiovascular disease.

Special Tests

Musculoskeletal System	Test
Cervical spine (positive tests; none of the rib provocational tests reproduce right shoulder pain)	Cervical quadrant test in extension left: left cervical and left shoulder pain with "tingling" in the left hand (see Fig. 19) Compression testing of cervical spine in extension only: left cervical and left shoulder pain only (see Fig. 15) Cervical quadrant test in flexion right: left cervical and left shoulder pain only Valsalva's maneuver: left shoulder pain
Cervical spine (negative tests)	None
Shoulder right (positive tests)	None
Shoulder right (negative tests)	Distraction and compression of the glenohumeral joint Hawkins' impingement sign Load and shift test (anterior and posterior instability) Distraction and compression of the acromioclavicular joint O'Brien's test (SLAP) Crank test (labrum) Empty can test (supraspinatus tendon) Speed's test (biceps tendon)
Thoracic spine (positive tests)	None
Thoracic spine (negative tests)	Segmental joint mobility and provocation testing (prone posterior-anterior glides) (see Fig. 22) Thoracic quadrant tests
Ribs (positive test; none of the rib provocational tests reproduce right shoulder pain)	Mobility and provocation testing: left first rib tender and hypomobile (see Fig. 25) CRLF test: hypomobile on the left (see Fig. 26) Coughing: left cervical and left shoulder pain
Ribs (negative tests)	Mobility and provocation testing of ribs R2 to R5 anteriorly (see Fig. 25) Lateral compression testing of the middle and lower ribs (supine) Deep inhalation

Joint Integrity and Mobility
Cervical Spine
Tests are deferred to save time. Previous portions of the evaluation have not implicated the cervical spine as a source of the right shoulder pain.

Continued

CASE STUDY 5—cont'd

Shoulder (Right)

- Glenohumeral: Hypomobile, mild in all directions, with muscle guarding and no pain
- Sternoclavicular: Hypomobile, mild in distraction and inferior glide, with no pain
- Acromioclavicular: Normal in all directions, with no pain
- Scapulothoracic: Normal in all directions, with no pain

Thoracic Spine

Tests are deferred to save time. The rationale is the same as noted for the cervical spine.

Ribs

The patient has rib hypomobility, mild for the left first rib, with muscle guarding.

Neuromuscular System

Alex has no gross gait, locomotion, or balance disorders.

Imaging Studies

- Cervical (2004): A review of the films reveals the following: mild DDD at C3-4 and C4-5 and moderate DDD at the C5-6 and C6-7 levels with mild posterior vertebral osteophytes. Facet DJD at same levels and degrees noted in the previous sentence. Moderate foraminal stenosis at left C5-6 and mild stenosis at left C4-5. A loss of the normal cervical spine lordosis is observed. Incidentally noted is an incomplete ponticulus ponticus on the posterior arch of the atlas.
- Shoulder, right (2008): A review of the films reveals the following: normal shoulder with a type I acromion.

Diagnosis

Alex's right shoulder symptoms do not appear to be musculoskeletal in origin. Although mild chronic joint dysfunction is noted in the right shoulder girdle, this patient's signs and symptoms are inconsistent with an active orthopedic problem of the right shoulder. The cervical and thoracic spine and ribs do not appear to be a source of her right shoulder symptoms. Of concern is the patient's history of diabetes, hepatitis, fever, shoulder pain associated with greasy meals (lunch), and the exquisite tenderness in the right upper abdominal quadrant. The left shoulder and hand symptoms are thought to be secondary to mild and chronic left cervical radiculopathy (Musculoskeletal Pattern F: Impaired joint mobility, motor function, muscle performance, ROM, and reflex integrity associated with spinal disorders).

Pain

The primary pain generator in this case appears not to be musculoskeletal in origin.

Strain

The biomechanical strains that may be exacerbating Alex's pain and dysfunction are her chronic neck and left upper extremity symptoms and the restricted mobility in her thoracic spine. The physiologic strains that may be exacerbating her pain and dysfunction are diet (excessive caffeine, red meat, shellfish, and dairy) and signs of possible gastrointestinal disease.

Brain

Because she has had chronic neck and left upper extremity symptoms and the physical examination of her right shoulder is mostly negative, Alex is likely to have a component of central sensitization aggravating her right shoulder symptoms, especially if her symptoms cannot be attributed to a visceral disease or medical condition. Although she does not exhibit any overt signs of fear, anger, or frustration, Alex is under a lot of stress at work and is working long hours. The patient may benefit from a referral for pain and stress management.

Prognosis

Prognosis is uncertain and depends on the presence of visceral disease and whether the visceral disease is comorbid or the primary generator of her symptoms.

Intervention

Alex is referred back to her primary care physician to rule out any gastrointestinal problems. Cholecystitis secondary to gallstones is diagnosed in the patient. Her gastrointestinal symptoms and right shoulder pain are reduced approximately 50% on a controlled diet. The right shoulder blade pain does not disappear, however, until after a cholecystectomy. She continues to report chronic neck and left upper extremity symptoms, but she is not referred back for physical therapy to address these symptoms.

SUMMARY

The best way to determine whether the patient's symptoms may be caused by visceral disease is first to eliminate all possible musculoskeletal tissue as a source of the symptoms. This process requires skill, confidence, and experience in performing a thorough history and comprehensive physical evaluation. If the physical therapist cannot reproduce the patient's symptoms or has difficulty identifying a tissue in lesion, or if the patient does not respond to treatment, then ruling out a visceral pathologic condition becomes imperative. A patient who is referred to physical therapy with an orthopedic diagnosis, but who demonstrates signs and symptoms of visceral disease, can be saved from severe morbidity—and sometimes death—by early referral to the appropriate level of medical care. Of course, many physical therapy patients have known comorbid visceral disease (i.e., both orthopedic and visceral problems). A positive musculoskeletal examination does not eliminate the possibility of an unrelated viscus injury or disease. Comorbid

visceral disease is important to identify because it most likely puts a strain on the healing and rehabilitation of the orthopedic injury or impairment and should therefore changing the normal plan of care and prognosis accordingly.

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