Musculoskeletal chest wall pain

Adel G. Fam,* MD, FRCPC, MRCP, FACP
Hugh A. Smythe,† MD, FRCPC

The musculoskeletal structures of the thoracic wall and the neck are a relatively common source of chest pain. Pain arising from these structures is often mistaken for angina pectoris, pleurisy or other serious disorders. In this article the clinical features, pathogenesis and management of the various musculoskeletal chest wall disorders are discussed. The more common causes are costochondritis, traumatic muscle pain, trauma to the chest wall, "fibrositis" syndrome, referred pain, psychogenic regional pain syndrome, and arthritis involving articulations of the sternum, ribs and thoracic spine. Careful analysis of the history, physical findings and results of investigation is essential for precise diagnosis and effective treatment.

Diverses altérations des muscles et du squelette de la paroi thoracique et du cou causent assez souvent des douleurs qui donnent le change pour une angine de poitrine, une pleurésie ou quelque autre maladie grave. Les auteurs passent en revue la symptomatologie, la pathogénèse et le traitement de ces altérations. Il s'agit le plus souvent d'une costochondrite, d'un traumatisme musculaire ou autre, d'une soi-disant "fibrosite", d'une douleur rapportée, d'un syndrome douloureux thoracique d'origine psychogène, ou d'une arthrite des articulations du sternum, des côtes et des vertèbres dorsales. L'étude minutieuse de l'anamnèse, des signes cliniques et des résultats d'examens complémentaires est indispensable au diagnostic différentiel précis d'une douleur thoracique et à son traitement efficace.

From the divisions of rheumatology, departments of medicine, University of Toronto, Sunnybrook Medical Centre and the Wellesley Hospital, Toronto

*Associate professor of medicine, University of Toronto
†Professor of medicine, University of Toronto

Reprint requests to: Dr. Adel G. Fam, Division of Rheumatology, Sunnybrook Medical Centre, 2075 Bayview Ave., Toronto, Ont. M4N 3M5

Pain in the chest is a common symptom of diverse causes. It may have its origin in the thoracic wall, intrathoracic structures, neck or areas below the diaphragm.[1-3] Musculoskeletal abnormalities are often unsuspected causes of chest pain. Their exact prevalence is unknown, but they have been noted in up to 10% of patients presenting with chest pain.[4] Recently there has been some renewed interest in these disorders and their importance in the differential diagnosis of chest pain.[3-8] There is also newer knowledge of referred pain syndromes involving the chest wall and other areas.[9]

As rheumatologists we are often asked to evaluate patients presenting with chest pain of possible musculoskeletal origin. This article outlines the essential diagnostic features, pathogenesis and management of painful chest wall syndromes. Knowledge of these disorders and new clinical assessment techniques can spare the patient needless anxiety and unnecessary investigations.

Disorders of the shoulders, cervical spine and thoracic outlet region can cause referred pain to the chest region, and a discussion of these disorders is included when relevant.

Essential anatomy

The ribs articulate posteriorly with the bodies and transverse processes of the thoracic vertebrae at the costovertebral and costotransverse joints respectively[10] (Fig. 1). These are true diarthroidal, synovial-lined joints. The 2nd to 10th ribs articulate by two hemifacets with two adjacent vertebrae and the intervertebral disc in between. An intra-articular ligament divides the joint and binds the head of the rib to the intervertebral disc. The 1st, 11th and 12th ribs are more mobile, and each articulates by a single facet with the body of its own vertebra.

The ribs are united to the costal cartilages by synchondroses (costochondral articulations)[10] (Fig. 2). The first to seventh ribs are vertebrosternal, or "true", ribs; that is, their costal cartilages join the sternum (at chondrosternal or sternocostal joints). The remaining five pairs are "false" ribs. Of these, the cartilages of the 8th, 9th and 10th ribs articu-

late with the cartilages immediately above them and so form a subgroup of vertebrochondral ribs. The 11th and 12th ribs, free at their cartilaginous ends, are termed vertebral, or "floating", ribs. The costal cartilage of the first rib articulates with the manubrium by a synchondrosis. The other six pairs of chondrosternal articulations are lined with synovial membrane, and each usually contains an intra-articular ligament[10] (Fig. 2). Obliteration of these joints is common in later years. Synovial-lined interchondral articulations may also exist between the fifth to ninth costal cartilages.[10]

The medial end of the clavicle articulates with the manubrium sterni and the first costal cartilage at the sternoclavicular joint (Fig. 2). An intra-articular fibrocartilaginous disc divides the joint into two synovial-lined cavities.[10,11]

The manubriosternal joint is a synchondrosis with a fibrocartilaginous disc uniting the manubrium with the body of the sternum. Resorption of the central portion of the disc and formation of a synovial-lined central joint occurs in approximately a third of adults.[10,12] Ossification of the disc and synostosis of the joint is seen in 10% of adults.[10,12]

The xiphisternal joint is a synchondrosis between the body of the sternum and the xiphoid cartilage.[10] Ossification of the joint is common in later years.

The thoracic region has a complex nerve supply.[13] The chest wall is largely supplied by the intercostal nerves. The shoulder girdle muscles originally develop in the lower cervical region and draw their innervation with them as they migrate to attach to the chest wall. Thus, pain of cervical origin may be appreciated by the patient as arising in the pectoral or periscapular region. Finally, the intrathoracic viscera and central diaphragm develop high in the cervical region and draw their nerve supply from cervical and thoracic segments and from dedicated autonomic nerves. Knowledge of these anatomic considerations is important in our understanding of pain referral syndromes involving the chest wall.

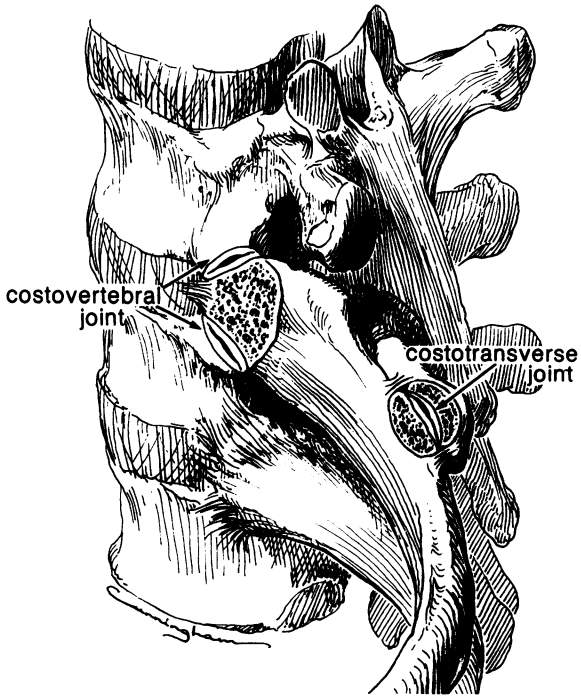

Fig. 1—Costovertebral and costotransverse joints.

General considerations

Precise diagnosis of skeletal chest wall syndromes rests upon a detailed history, a meticulous physical examination and a few rationally selected diagnostic studies.[2-4,6,8] As with any other clinical problem, assessment of chest wall pain starts with a complete history, which should take account of the onset, location, character, duration and modulating factors of pain. Musculoskeletal chest wall pain is often well localized and nagging in the affected site but may extend widely beyond the area of origin. The pain is typically increased by movements involving the affected part (Table I).

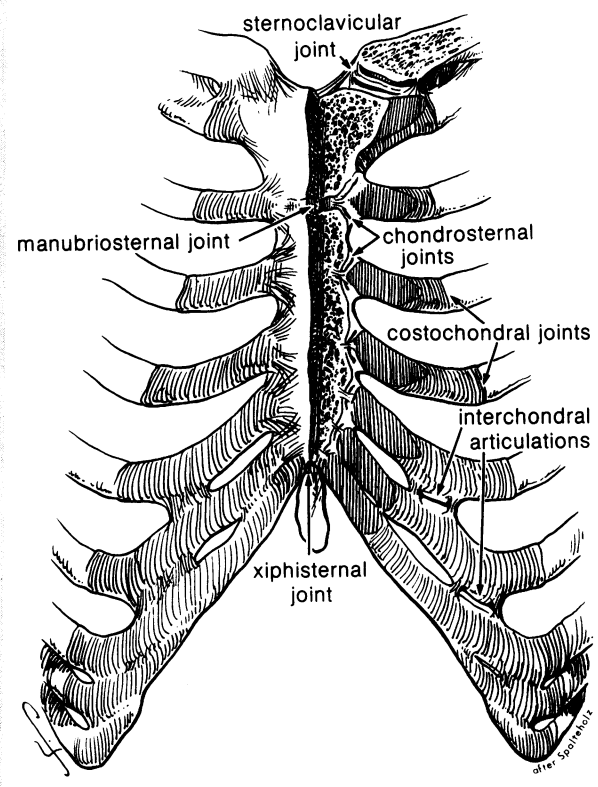

Fig. 2—Anatomy of anterior chest wall.

Thorough evaluation of the ribs, intercostal spaces, muscles, sternum, sternoclavicular joints, and cervical and thoracic spine is essential for accurate evaluation. The dominant feature of most thoracic skeletal disorders is the presence of local tenderness. Although some chest walls are simply tender for no obvious reason, the demonstration that localized tenderness can be duplicated by pressure on the chest or by movement and is completely relieved by lidocaine infiltration is strong evidence for a skeletal origin for the pain. However, in rare instances chest wall tenderness

may be due to underlying severe pleurisy or pericarditis.

Chest wall pain may occur either as a primary condition or coincidental to another disorder capable of causing chest pain, as in costochondritis occurring in association with cardiac disease. In other instances the presence of a skeletal abnormality may modify the radiation of pain produced by another disorder, as in radiation of anginal pain to the shoulder in a patient with coexisting subacromial bursitis. This coexistence of two different types of pain in the same patient is a frequent source of error in diagnosis and calls for careful analysis of so-called benign skeletal pain, particularly in middle-aged and elderly individuals.[2-4]

Pain arising from the musculoskeletal structures of the shoulder, cervical spine or thoracic spine may be referred to areas in the chest wall with the same nerve supply. This referred pain is generally segmental or regional in distribution and "deep" in location (i.e., sclerotomal rather than dermatomal).[9] The areas to which pain is referred often have secondary reflex changes including deep or myofascial tenderness, cutaneous hyperalgesia and circulatory disturbances.[9,14] Familiarity with the sites at which tenderness is likely to occur and determination of the distribution of these tender points are important in the differential diagnosis. A small number of tender points of asymmetric distribution grouped in a single region suggests a referred pain syndrome.[9] A large number of tender sites spread widely and symmetrically, associated with diffuse aching and stiffness and nonrestorative sleep, suggests "fibrositis" syndrome.[9] The clustering of tender points regionally in referred pain syndromes gave rise to such terms as "localized fibrositis" and "regional pain syndromes" (e.g., "scapulocostal syndrome" and "sternalis syndrome") of older literature.[15-17]

Initial investigation in patients presenting with chest wall pain includes hematologic and chemical screening tests, chest radiography and electrocardiography. Additional diagnostic studies, including radiography of the ribs, cervical spine or thoracic spine, conventional tomography, computed tomography,[18] skeletal scintigraphy or bone biopsy, are sometimes required.

Table II provides a classification of musculoskeletal conditions associated with chest pain based upon the site of origin of the pain and the predominant location. In some of these disorders, such as costochondritis, "fibrositis" syndrome and precordial catch syndrome, information regarding cause, underlying abnormality and mechanism of origin of the pain is fragmentary and not fully understood. While it is not possible to give details on all of these conditions, the following is a summary of the more common causes.

Table I—General features of musculoskeletal chest wall pain

Onset: often insidious, with history of minor or repetitive trauma or unaccustomed physical activity.
Pain: often sharp, nagging and localized to the affected site but may radiate widely.
Positional component: pain brought on by changes in position, turning of the chest, deep breathing or movements of the shoulder girdle.
Presence of local chest wall tenderness.
Modulating factors: duplication of pain by movements involving the painful area or chest wall palpation; relief by local application of heat, use of salicylates or infiltration of lidocaine.

Table II—Classification of painful musculoskeletal chest wall syndromes

Chest wall pain of local origin
Arising from the ribs and their articulations
• Tietze's syndrome and costochondritis
• Rib trauma and painful rib swelling
• Slipping rib syndrome
• Costovertebral arthritis
Arising from the sternum and its articulations
• Tietze's syndrome and costochondritis
• Sternoclavicular arthritis
• Manubriosternal arthritis
• Painful xiphoid syndrome
Arising from the myofascial structures
• Traumatic muscle pain
• Precordial catch syndrome
• Epidemic myalgia
Arising from the thoracic spine, spinal cord and spinal nerves
• Thoracic spine: thoracic disc disease, costovertebral arthritis, diffuse idiopathic skeletal hyperostosis, ankylosing spondylitis, metabolic bone disease, metastases etc.
• Spinal cord: spinal tumour, syringomyelia
• Thoracic nerves: thoracic herpes zoster, compression by herniated disc or tumour etc.
Chest wall pain of remote origin
• Fibrositis syndrome
• Psychogenic regional pain syndrome
• Referred pain from cervical spine, shoulders and thoracic outlet

Chest wall pain of local origin
1. Pain arising from the ribs and their articulations

Tietze's syndrome and costochondritis

In 1921 Tietze[19] described a benign condition characterized by painful, nonsuppurative swelling of the cartilaginous articulations of the anterior chest wall. True Tietze's syndrome is rare.[7,8,20] Another clinical syndrome associated with pain and tenderness of the costochondral junctions but not with swelling is costochondritis[5,7,8] (Table III).

Tietze's syndrome commonly affects young people of either sex.[19-23] The cause is unknown, but a traumatic pathogenesis has been suggested.[20-23] There is no occupational, racial or geographic predisposition, although clustering of cases has been reported.[24,25] In the few reported pathological studies, findings varied from there being no ab-

normalities present to swelling and degeneration of costal cartilage associated with minor inflammatory changes in the perichondrium.[20-22]

The disorder has a predilection for the upper ribs, particularly the second and third costochondral junctions.[19-23] The chondrosternal, manubriosternal, sternoclavicular and xiphisternal articulations are less commonly affected. Lesions are unilateral and single in more than 70% of cases. Multiple lesions usually affect neighbouring articulations on the same side. Pain in the anterior chest wall is the chief symptom. There is often a history of excessive coughing during the course of an upper respiratory tract infection.[20-22] The pain is of variable intensity. It is usually localized to the involved synchondrosis but may radiate widely over the chest wall. Coughing, deep breathing and prone lying may accentuate the pain. The affected costal cartilage is tender and swollen. Heat and erythema are absent, and there are no constitutional disturbances.

Routine investigation does not show any abnormalities. There are no characteristic radiographic findings, and calcification of costal cartilages is not a feature of the syndrome.[20] A report of bone scanning in a case of Tietze's syndrome described abnormal accumulation of the radionuclide at the involved costochondral joints.[26] Similar scintigraphic findings were described in a patient with costochondritis.[27]

The diagnosis of Tietze's syndrome is made on clinical grounds after exclusion of other conditions affecting the costal cartilages, such as rheumatoid arthritis,[20] pyogenic arthritis,[28] tumours[29] and relapsing polychondritis.[30]

The disorder runs a self-limited course, with remissions and exacerbations.[19-23] The pain may cease spontaneously within a few weeks or months, although the cartilaginous swelling may persist for longer periods. Treatment consists of reassurance, local application of heat and use of salicylates or other nonsteroidal anti-inflammatory drugs. Local infiltration of the involved costal cartilage with a steroid or lidocaine, or both, or the use of an intercostal nerve block is indicated in refractory cases.[20-23]

The term costochondritis[5] is used interchangeably with costosternal syndrome[4] to denote a condition characterized by pain and tenderness at the costochondral or chondrosternal articulations without a notable swelling as in Tietze's syndrome. The condition is recognized under a variety of other labels: chest wall syndrome,[6] anterior chest wall syndrome[31] and costosternal chondrodynia.[32]

Costochondritis is a relatively frequent cause of anterior chest pain, both as a primary condition and in combination with coronary heart disease.[1,4-6,31,32] Pain involving the costochondral and chondrosternal regions is the main presenting complaint. Multiple lesions are present in 90% of cases. The second to fifth costal cartilages are the most frequent sites.[7,32] Pain in the upper costal cartilages is often mistaken for that of cardiac disease,[4,6,31,32] while pain in the lower costal cartilages may mimic that of intra-abdominal disease.[33] Diffuse tenderness over the involved costal cartilages, without swelling, is the principal physical sign. Certain movements of the chest and body may provoke the pain; examples are the "crowing rooster" maneuver (extension of the cervical spine and traction on the posteriorly extended arms) and traction on the adducted arm with the head rotated to the ipsilateral side.[6]

Little is known of the pathogenesis of costochondritis or of its relation to Tietze's syndrome. A traumatic cause has been proposed, but pathological abnormalities have not been described. The condition has been observed in association with "fibrositis" syndrome,[34] and referred pain from the cervical spine has been suggested.[9]

The disorder often runs a self-limited course, but recurrences are common. Treatment consists of reassurance and the use of analgesics. Support of the arch of the neck during sleep is important in patients with a cervical spine component.

Rib trauma and painful rib swelling

Trauma to the rib cage, with or without a fracture, is a common cause of chest wall pain. Pain is made worse by deep breathing and movement. There is point tenderness at the site of trauma, and a local swelling may be present. Radiographs will reveal about half to two thirds of all rib fractures. In other instances a fracture line is not seen, but a healing callus appears some weeks later.[35] Rib pain following a fall or an accident causes little problem in diagnosis. By contrast, rib pain from indirect or seemingly inconsequential trauma, such as sporting activities or a bout of coughing (tussive fracture in an elderly patient)[36] can easily be overlooked.

Table III—Tietze's syndrome and costochondritis*

Feature	Tietze's syndrome	Costochondritis
Frequency	Rare	More common
Age group most commonly affected	< 40 years	≥ 40 years
Number of sites affected	One in 70%	More than one in 90%
Costochondral junctions most commonly involved	Second and third	Second to fifth
Local swelling	Present	Absent
Associated conditions	Respiratory tract infections	Cervical strain syndrome, coronary heart disease, "fibrositis" syndrome

*Modified from reference 7.

Stress or insufficiency fractures involving the ribs and long bones occur in patients with rheumatoid arthritis, osteoporosis, osteomalacia and Paget's disease of bone.[37,38] Patients with long-standing deforming rheumatoid arthritis who have stiff shoulders may also have rib erosions involving the outer aspects of the second to sixth ribs near their angles.[39,40] The erosions are usually painless and are thought to be due to pressure from the scapula on the ribs and the development of a bursa in between.[39,40]

Metastases from carcinoma of the lung, breast, thyroid, kidney or prostate are the most frequent rib tumours.[1,41,42] They often present as either a painful rib swelling or a pathologic fracture. Primary neoplasms and tumour-like conditions are rare and include osteochondroma, multiple exostoses, chondrosarcoma, multiple myeloma and eosinophilic granuloma.[1,41,42]

The ribs are rarely the site of pyogenic (Fig. 3), tuberculous, syphilitic or fungal infections.[1]

Slipping rib syndrome

This is a less widely known cause of mechanical rib pain. It is characterized by pain at the lower costal margin, associated with increased mobility of the anterior end of a costal cartilage, most often that of the 10th rib and occasionally that of the 8th or 9th.[43-48] Loosening of the fibrous attachments binding the lower costal cartilages to one another allows a rib tip to curl upwards and override the inner aspect of the rib above, causing pressure on the intercostal nerve in between.

The condition has been variously described as slipping rib cartilages,[43,45,48] nerve nipping at the intercostal margin,[44] clicking ribs[46] and rib-tip syndrome.[47] The disorder is thought to be traumatic in origin. Many patients recall past injury to the affected side.[43] The onset is insidious, with intermittent unilateral pain in the anterior ends of the lower costal cartilages, usually for several months. Occasionally, severe, sharp pain is felt in the anterior costal margin and abdominal wall. A painful click is sometimes felt over the tip of the involved costal cartilage with certain movements.[46,47] The involved costal cartilage is tender and moves more freely than normal. The pain may be duplicated by hooking the fingers under the anterior costal margin and pulling the rib cage anteriorly.[48] This maneuver may also produce a palpable click of the cartilages slipping over one another.[48]

Recognition of the condition, reassurance and use of analgesics are sufficient therapy in most cases.[43-48] The patient can be taught to avoid movements and positions that provoke the pain. Strapping, local infiltration of lidocaine, intercostal nerve block or surgical excision of the affected rib cartilages is reserved for refractory cases.[44,46-48]

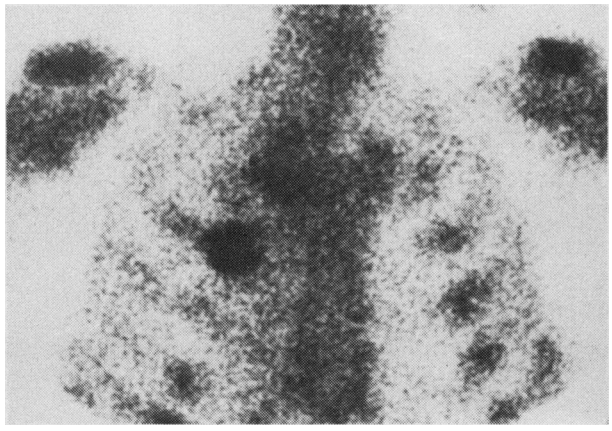

Fig. 3—Bone scintiscan of thorax in patient with pyogenic (*Pseudomonas*) osteomyelitis of anterior end of second right rib, showing increased uptake of radioactivity at infection site.

2. Pain arising from the sternum and its articulations

Sternoclavicular joint

Pain arising from the sternoclavicular joint may radiate to the anterior chest wall and thereby simulate pain of cardiac or pulmonary origin.[11] Shoulder shrugging aggravates the pain, and the sternoclavicular joint is tender. A local swelling and crepitus are usually present.

Leading causes of sternoclavicular joint arthritis include osteoarthritis[11,49] (Fig. 4), rheumatoid arthritis,[50] ankylosing spondylitis,[51] psoriatic arthritis[52] and infection.[11,53] Pain in the sternoclavicular joint may also result from traumatic dislocation or metastases.[54]

The recently recognized syndrome of "sternocostoclavicular hyperostosis" is manifested by bilateral chronic painful swelling of the clavicles, sternum and first ribs.[55-59] Radiologic abnormalities include hyperostosis, widening and increased bone density of the clavicles and sternum, ossification of the first costal cartilage and sternoclavicular synostosis.[55-59] Skeletal scintigraphy demonstrates increased activity in the involved bones. Histologic examination shows ossifying periostitis associated with general hyperostosis. Laboratory

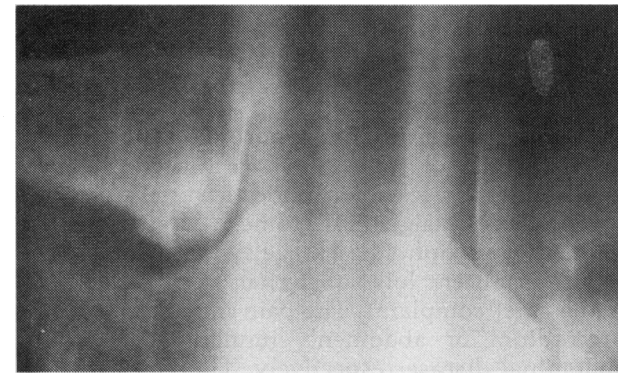

Fig. 4—Tomogram of right sternoclavicular joint in patient with osteoarthritis, showing subchondral cyst, sclerosis and osteophyte of clavicular head.

values are normal except for occasional elevation of the erythrocyte sedimentation rate and hypergammaglobulinemia.[55-60]

The condition follows a relapsing course. Bone enlargement and extension of the inflammatory process may lead to subclavian vein occlusion or thoracic outlet syndrome.[55,57,61]

The cause is unknown, although a relation to pustular psoriasis and psoriatic arthritis has been suggested.[59,60] The characteristic symmetric involvement of the clavicles, sternum and upper ribs, the presence of sternoclavicular synostosis and the normal serum alkaline phosphatase and urinary hydroxyproline levels distinguish this condition from Paget's disease of bone. Treatment is symptomatic, with the use of anti-inflammatory drugs including indomethacin and corticosteroids.[55-61] Radiotherapy is indicated in severe cases.

"Condensing osteitis of the clavicle" is another rare condition of unknown cause; it usually affects young women.[62,63] It is characterized by uni- or bilateral, often painful, expansion and sclerosis of the medial end of the clavicle without sternal hyperostosis or sternoclavicular synostosis.[62,63] Increased radionuclide uptake in the involved clavicle is seen with skeletal scintigraphy. Clinical features include pain on abduction of the arm and swelling of the medial end of the clavicle. Pain may radiate to the ipsilateral shoulder or subscapular region.

Histologic examination shows an ossifying periostitis, with increased thickness of cancellous bone.[62,63] There is often a history of stress to the sternoclavicular joint region, usually associated with heavy lifting.[62,63] Treatment is symptomatic, but surgical excision of the medial end of the clavicle is occasionally indicated.

Manubriosternal joint

Manubriosternal arthritis is an uncommon cause of upper sternal pain. It occurs in ankylosing spondylitis[64,65] (Fig. 5), rheumatoid arthritis[12,65,66] and psoriatic arthritis and is rarely caused by infection.[65] The resulting pain is either localized to the joint or radiates widely along the upper ribs to the shoulders, mimicking angina. It is associated with localized tenderness and often swelling of the joint.

Xiphoid cartilage and xiphisternal joint

The "painful xiphoid syndrome" refers to pain in the region of the xiphoid cartilage.[1,7,67,68] This rare condition is known under a variety of other names: xiphoidalgia syndrome,[1,69] hypersensitive xiphoid[70] and xiphoid cartilage syndrome.[71]

Intermittent low substernal or epigastric pain is the chief complaint. The pain may radiate to the precordium or abdomen, simulating cardiac or abdominal disease respectively. The xiphoid cartilage is tender, and pressure reduplicates the pain and its radiation.

There is little etiologic and pathological knowledge of the painful xiphoid syndrome. The condition is considered by some to represent Tietze's syndrome affecting the xiphisternal joint.[67] It often runs a self-limited course, without special treatment.[67-71] Local injection of a steroid or lidocaine, or both, or surgical excision of the xiphoid cartilage is reserved for severe cases.[67-71]

True arthritis of the xiphisternal synchondrosis is rare and is typically seen in ankylosing spondylitis (Fig. 5).

3. Pain arising from the myofascial structures

Traumatic muscle pain

Pain in the intercostal and accessory thoracic muscles is usually of traumatic origin.[1-3,72] There is often a history of unaccustomed or excessive muscular activity, such as lifting, painting a ceiling, chopping wood, coughing or exercising "untrained" muscles.[72,73] The onset is either gradual or sudden, with localized pain and tenderness over the "strained" muscles. The pain is made worse by maneuvers that tense or stretch the involved muscles; examples are pain in the pectoral region on resisted adduction of the shoulder from a strained pectoralis major muscle, pain in the third to fifth costochondral junctions on resisted internal rotation of the shoulder from a strained pectoralis minor muscle, and pain and tenderness between the spine and the scapula on bracing the shoulders backward from an injured rhomboid.

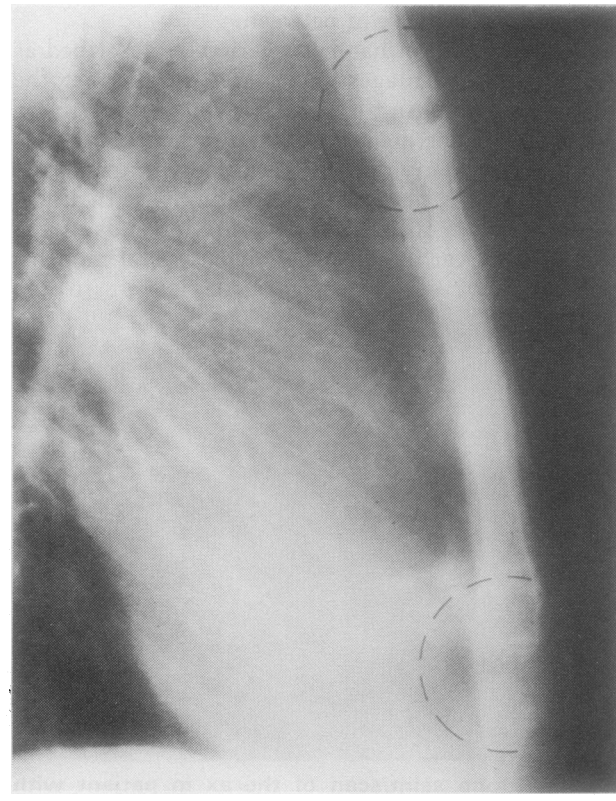

Fig. 5—Detailed lateral view of manubriosternal and xiphisternal joints in patient with ankylosing spondylitis, showing erosive changes.

The diagnosis of traumatic intercostal or accessory muscle pain is made from the history and physical findings. Treatment consists of reassurance, local application of heat, use of analgesics, rest of the injured muscles and avoidance of the repetitive activities responsible for the pain. Local injection of a steroid or lidocaine, or both, is indicated in severe cases.[72,73]

Precordial catch syndrome (chest wall twinge syndrome)

This is a rare, benign, self-limited disorder of unknown cause, characterized by episodes of very brief, sharp precordial pain.[7,74-76] It occurs in young, healthy individuals. Sharp pains, "stitches" or "catches" are felt in the anterior chest, usually in the left parasternal area or near the cardiac apex. Some patients report the onset while assuming a slouched or bent-over posture. The pains last from 30 seconds to 3 minutes. They are aggravated by deep breathing and are usually relieved by shallow respiration, moderate activity or assuming the correct posture. There is no associated local tenderness.

Little is known of the cause of this condition. An intercostal muscle spasm from faulty posture and origination of the pain from the parietal pleura have been postulated.[74-76] Treatment consists of reassurance and correction of any postural abnormality.

Epidemic myalgia (Bornholm's disease, epidemic pleurodynia, devil's grip)

This is an acute viral illness with prominent pain in the chest wall and epigastrium.[77,78] The usual cause is an infection with a group B coxsackievirus. Group A coxsackieviruses and echoviruses are occasionally implicated, particularly in sporadic cases.[78] This condition commonly affects the intercostal and upper abdominal wall muscles and, rarely, the pleura. After a nondescript prodrome of 1 to 10 days the patient is seized with severe, sharp pains in the lateral chest wall (particularly in adults) or the upper abdomen (particularly in children). The pain is intensified by breathing, coughing and other movements of the thorax. Paroxysms of intense pain are separated by symptom-free intervals. The involved muscles are tender. Although transient pleurisy with a pleural friction rub and a small effusion has been reported in up to 10% of cases in some epidemics, this feature has been totally absent in other outbreaks. Fever, headache and pharyngitis are frequent.

The illness usually lasts 3 to 7 days, but relapses may occur. Specific diagnosis is made by isolation of the virus from the throat or feces early in the disease or by demonstration of a rising titre of type-specific neutralizing antibodies. This self-limited illness usually requires only symptomatic treatment.

4. Pain arising from the thoracic spine, spinal cord and spinal nerves

Diseases of the thoracic spine, spinal cord and spinal nerves, including traumatic lesions, metabolic bone disease, infections, primary and metastatic tumours, juvenile kyphosis (Scheuermann's disease), thoracic disc disease, costovertebral arthritis, diffuse idiopathic skeletal hyperostosis and ankylosing spondylitis, may cause pain and local tenderness in the posterior chest wall. A detailed discussion of these disorders falls beyond the scope of this review. Only the last four entities will be described, and briefly.

Thoracic disc disease

Symptomatic thoracic disc disease is rare.[79,80] It usually occurs in the lower thoracic region, most commonly in men in their fifth decade.[79] Changes in the disc annulus fibrosus produce local thoracic back pain, which can be present for weeks or months before the disc herniates. Such pain may radiate anteriorly and is sometimes mistaken for cardiac pain.[81] Radiographs are usually abnormal, showing a narrowed, often calcified, thoracic disc.

Posterolateral disc protrusions may result in compression of a nerve root, producing unilateral dermatomal chest wall pain. Posterior thoracic disc herniations are more serious and can lead to cord compression and spastic paraplegia.

The diagnosis of thoracic disc protrusions is often difficult when pain is the sole manifestation. In the absence of neurologic dysfunction the condition may be confused with ankylosing spondylitis in its early stages, costovertebral joint syndrome or metastatic tumours. The diagnosis can be confirmed by myelography or computed tomography. Early recognition and prompt surgical intervention are important to prevent irreversible neurologic damage.[79,80]

Costovertebral arthritis

Costovertebral and costotransverse arthritis occurs in osteoarthritis,[82,83] ankylosing spondylitis[64] and, rarely, other arthritides.

Costovertebral osteoarthritis is an uncommon cause of thoracic backache. The pain is often increased by deep breathing, coughing or chest compression.[82] The anatomic characteristics and increased mobility of the 1st, 11th and 12th costovertebral joints account for the higher frequency of degenerative arthritis in these joints. Arthritis of the first costovertebral joint is a rare cause of thoracic outlet syndrome.[83] The diagnosis is confirmed by radiographic demonstration of joint space narrowing, subchondral bony sclerosis, and marginal osteophytes or intra-articular loose bodies.

Treatment is symptomatic, with use of analgesics and physical therapy. Intra-articular corticosteroid injection is indicated in refractory cases.[82,83]

Diffuse idiopathic skeletal hyperostosis

Diffuse idiopathic skeletal hyperostosis, or Forestier's disease, is a relatively common disorder of middle-aged and elderly individuals, particularly men.[84-86] It is characterized clinically by pain and stiffness in the thoracolumbar spine and radiographically by spinal hyperostosis, particularly in the thoracic region, resulting in linear ossification and bridging osteophytosis.[84-86] The pain is generally mild, dull and nonradiating. It is aggravated by inactivity and exposure to cold and dampness.

Physical findings in the thoracic spine include a slight increase in dorsal kyphosis, minimal reduction in the range of movement and chest expansion, and occasionally local tenderness. Patients may have similar symptoms in the cervical and lumbar spine. Radiographic features include flowing, undulating anterior ossification of four or more contiguous thoracic vertebrae, radiolucency between the deposited bone and the underlying vertebral bodies, and relative preservation of the intervertebral disc height. The absence of sacroiliitis, true syndesmophytes and apophyseal joint ankylosis distinguishes diffuse idiopathic skeletal hyperostosis from ankylosing spondylitis.

Treatment is symptomatic, with use of salicylates or other analgesics.

Ankylosing spondylitis

Involvement of the costovertebral, costotransverse and thoracic apophyseal joints is common in ankylosing spondylitis and is associated with pain in the thoracic spine and limitation of chest expansion.[64] The pain of spondylitis may radiate anteriorly in a girdle distribution along one or more segments. Coincidental involvement of the sternoclavicular, chondrosternal, manubriosternal or xiphisternal articulations produces pain in the anterior chest wall. Sacroiliitis and other signs of ankylosing spondylitis are usually present.

Chest wall pain of remote origin

"Fibrositis" syndrome

"Fibrositis" (fibromyalgia or myofascial syndrome) is a disorder characterized by diffuse musculoskeletal pain associated with multiple discrete tender points.[34,87-96] The chest wall is a common site for fibrositic pain. The condition often begins in the third or fourth decade, although persons of any age can be affected. Females outnumber males in a ratio greater than 5:1.[88,92,94,96]

In the past the term "fibrositis" was applied to any pain of muscular or fascial origin. It was used interchangeably with interstitial muscular rheumatism,[89] interstitial myofibrositis,[89,97] tension myalgia[98] and nonarticular rheumatism.[87] At present the term diffuse "fibrositis",[34,87,88,91-96] or fibromyalgia,[92] is reserved for a specific clinical entity characterized by diffuse, widespread musculoskeletal aching, pain and stiffness, undue fatigue and a large number of specific tender points, often associated with disturbed sleep[34,87-96] (Table IV).

Pain, aching and stiffness of multiple, often shifting, areas of the musculoskeletal system, including the chest wall and periscapular regions, are the most common symptoms. Fluctuation of pain from day to day is common. Accentuation of symptoms by cold, damp weather, poor sleep, fatigue, mental stress, inactivity, excessive exercise or exposure to air-conditioning is characteristic. Relieving factors include local application of heat, massage, warm, dry weather, moderate exercise and vacations. Nonrheumatic complaints are frequent and include tiredness, anxiety, tension headaches, numbness and irritable bowel syndrome. Symptoms suggesting sleep disturbance are common: sleep is nonrestful, and most patients feel unrefreshed, stiff and achy on rising.[34,87-96] Psychologic symptoms are frequent and include anxiety, fear and resentment.[91-101] These patients often have a compulsive, perfectionistic personality, demanding of themselves and of others.

Patients with "fibrositis" have no objective signs of inflammation and have unrestricted movement of joints. The fibrositic tender points, also known as "trigger points", "fibrositic points" or "myalgic spots" are the hallmark of the syndrome.[34,87-96] Although there is no histologically definable local abnormality, the locations of the tender points are remarkably consistent among different patients.[34,87-96] Local pressure on a tender point may cause pain at a distant site, or "area of reference", analogous to the distant action of a gun when its trigger is pulled. However, such distant, referred pain is not always produced, and the term "tender point" is therefore preferred.[92,94] Common locations of tender points in the chest wall include the midpoint of the upper fold of the trapezius, the origin of the pectoralis from the second rib lateral to the costochondral junction, the origin of the supraspinatus near the medial border of the scapula, and within the muscle belly of the rhomboid, levator scapula and infraspinatus.[34,91-96]

"Fibrositis" is a common cause of chest wall pain, both as a primary condition and coincidental to other disorders,[102] such as osteoarthritis, cervical and lumbar disc disease, rheumatoid arthritis,[100] malignant disease[92,93] and hypothyroidism.[103] Am-

Table IV—"Fibrositis" syndrome: diagnostic features

Diffuse, widespread musculoskeletal aching, pain and stiffness, particularly in the neck, shoulder and upper back.
Modulation of pain by weather, activity, fatigue and psychologic factors.
Multiple discrete areas of localized tenderness at specified sites (tender points).
Disturbed, nonrestful sleep, with tiredness, aching and stiffness upon awakening.
Frequent association with tension headache, irritable bowel syndrome and psychiatric disturbances.
Normal results of laboratory and radiographic studies in primary "fibrositis".

plification of symptoms by the "fibrositic" mechanism is common in these conditions.[9]

The exact role of sleep disturbance in the pathogenesis of "fibrositis" is not entirely clear.[34,91,94,104] Patients with "fibrositis" often display a decrease in stages 3 and 4 slow-wave spontaneous sleep, with intrusion of a rapid α-rhythm.[34,91,104] No disturbance of rapid-eye-movement (REM) sleep is found. It is unclear whether this is a primary etiologic factor or the result of chronic pain and disability. However, studies have shown that deprivation of stage 4 non-REM sleep in normal subjects can induce musculoskeletal aching and tenderness and electroencephalographic abnormalities comparable to those of "fibrositis".[34,104,105]

A role for referred pain in the pathogenesis of "fibrositis" is suggested by a number of observations. Most fibrositic pain is in the areas of reference of the lower cervical and lumbar spine. Patients with cervical spinal lesions will have local tenderness in the neck but very often also have referred tenderness in the trapezius, paraspinal and periscapular muscles. It is no accident that these are the same sites found to be tender in the "fibrositis" syndrome. This suggests that mechanical stresses in the cervical spine (and the lumbar spine) may play a role in the production of symptoms in at least some patients with "fibrositis".[9]

Finally, primary psychogenic disturbances such as anxiety, stressful life situations and depression have also been proposed as important contributing factors in "fibrositis".[91-96,99-101]

Management of diffuse "fibrositis" requires a great deal of understanding and patience on the part of the physician and patient. Treatment consists of reassurance, patient education, supportive psychotherapy and measures to relieve pain.[87-96] All explanations begin with the reassurance that the pain is real and not imaginary or neurotic in origin. Moderate doses of safe analgesics, physical therapy, including local application of heat, and exercises are helpful in some patients. Attention to mechanical problems in the neck (and low back) can yield major benefit. Patients who lack restorative sleep may respond to a tricyclic drug such as amitriptyline (10 to 50 mg in the evening).[91-95] However, daytime drowsiness may be a limiting factor in some patients. A number of other therapeutic modalities have been reported, but convincing evidence for their efficacy is lacking. These include local injection of a steroid or lidocaine, or both, or "dry-needle" probing of tender points,[87,88,92,106-108] use of an ethyl chloride spray,[15-17] transcutaneous electrical nerve stimulation,[109] acupuncture,[110] and biofeedback and relaxation therapy.[111]

Psychogenic regional pain syndrome

The chest wall is a common site for psychogenic regional pain syndrome.[112-115] The disorder is commoner in women than men, in young and middle adult life. Symptoms often change in location and intensity from visit to visit, but the distress tends to be concentrated in a single region, defined by its psychologic significance to the patient. Patients often use dramatic terms to describe their "severe" symptoms (e.g., "tearing pain through the chest wall", "pain that burns like fire" and "stabbing pain, like a knife cutting through"). The paradoxic association of tenderness and numbness is common. Nonrheumatic complaints are frequent and include constipation, tension headaches, weakness and fatigue. Patients often appear tense, hostile, nervous, apprehensive, anxious or depressed. Findings on physical examination are nonspecific and inconsistent. Poorly localized musculoskeletal tenderness, of nonanatomic distribution, is usually present. Change of physical findings by suggestion is also common. Patients often overreact, with facial grimacing, withdrawal and a "touch-me-not" response.[113-115]

The diagnosis of psychogenic rheumatism depends on the characteristic functional nature of the complaints, the absence of organic disease and the presence of anxiety, depression, neurosis or other specific psychiatric disorders.[113-115] Psychogenic regional pain syndrome can be distinguished from "fibrositis" syndrome by a number of features. Patients with "fibrositis" have specific complaints with a definite pattern. The presence, location and consistency of tender points is an important feature. They often relate their symptoms to changes in the "external" environment, including weather, humidity, heat, cold, rest, exercise and medication. Conversely, patients with psychogenic regional pain syndrome have bizarre, widespread, poorly localized and exaggerated complaints. They are at the mercy of their "internal" environment: symptoms vary with mood swings, worry and distraction.[115] They often exhibit signs of a psychiatric or emotional disorder such as depression, anxiety or psychoneurosis.

Psychogenic rheumatism is more difficult to treat than "fibrositis" syndrome, and patients usually require psychiatric treatment.[113-115]

Conclusion

Pain in the chest may be the presenting feature of a diverse number of musculoskeletal chest wall disorders. The more common causes include costochondritis, local direct or indirect trauma, "fibrositis", referred pain syndrome and psychogenic regional pain syndrome. The pain can be mistaken for angina pectoris, pleurisy or other more serious disorders. Information about onset, location, character, duration and modulating factors of the pain and other symptoms, a meticulous physical examination of the ribs, intercostal spaces, muscles, sternum, sternoclavicular joints and spine, and a few carefully selected investigations will establish the diagnosis in most cases. Knowledge and understanding of the underlying

pathogenetic mechanisms of these musculoskeletal disorders is important for optimal management.

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References

1. Wehrmacher WH: The painful anterior chest wall syndromes. *Med Clin North Am* 1958; 38: 111–118
2. Braunwald E: Chest pain and palpitation. In Petersdorf RG, Adams RD, Braunwald E et al (eds): *Harrison's Principles of Internal Medicine*, 10th ed, McGraw, New York, 1983: 25–31
3. Levene DL: *Chest Pain: an Integrated Diagnostic Approach*, 1st ed, Lea & Febiger, Philadelphia, 1977
4. Wolfe E, Stern S: Costosternal syndrome: its frequency and importance in differential diagnosis of coronary heart disease. *Arch Intern Med* 1976; 136: 189–191
5. Calabro JJ: Costochondritis [C]. *N Engl J Med* 1977; 296: 946–947
6. Epstein SE, Gerber LH, Borer JS: Chest wall syndrome: a common cause of unexplained cardiac pain. *JAMA* 1979; 241: 2793–2797
7. Calabro JJ, Jeghers H, Miller KA et al: Classification of anterior chest wall syndromes [C]. *JAMA* 1980; 243: 1420–1421
8. Flynn KT: Musculoskeletal chest wall pain. *Nurse Pract* 1981; 6: 18–23
9. Smythe HA: Fibrositis and other diffuse musculoskeletal syndromes. In Kelley WN, Harris ED, Ruddy S et al (eds): *Textbook of Rheumatology*, 1st ed, Saunders, Philadelphia, 1981: 485–493
10. Arthrology. In Williams PL, Warwick R (eds): *Gray's Anatomy*, 36th ed, Churchill Livingstone, Edinburgh, 1980: 419–503
11. Yood RA, Goldenberg DL: Sternoclavicular joint arthritis. *Arthritis Rheum* 1980; 23: 232–239
12. Kormano M: A microradiographic and histological study of the manubriosternal joint in rheumatoid arthritis. *Acta Rheum Scand* 1970; 16: 47–59
13. Gilbert JAL: The diagnosis of chest pain. *Medicine North Am* 1980; 1: 23–33
14. Kellgren JH: Observations on referred pain arising from muscle. *Clin Sci* 1938; 3: 174–190
15. Travell J, Rinzler SH: The myofascial genesis of pain. *Postgrad Med* 1952; 11: 425–434
16. Berges PU: Myofascial pain syndromes. *Postgrad Med* 1973; 53: 161–168
17. Pace JB: Commonly overlooked pain syndromes responsive to simple therapy. *Postgrad Med* 1975; 58: 107–113
18. Gouliamos AD, Carter BL, Emami B: Computed tomography of the chest wall. *Radiology* 1980; 134: 433–436
19. Tietze A: Über eine eigenartige Häufung von Fällen mit Dystrophie der Rippenknorpel. *Berl Klin Wochenschr* 1921; 58: 829–831
20. Kayser HL: Tietze's syndrome; a review of the literature. *Am J Med* 1956; 21: 982–989
21. Landon J, Malpas JS: Tietze's syndrome. *Ann Rheum Dis* 1959; 18: 249–253
22. Levey GS, Calabro JJ: Tietze's syndrome: report of two cases and review of the literature. *Arthritis Rheum* 1962; 5: 261–269
23. Dunlop RF: Tietze revisited. *Clin Orthop* 1969; 62: 223–225
24. Gill GV: Epidemic of Tietze's syndrome [C]. *Br Med J* 1977; 2: 499
25. Harkonen M: Tietze's syndrome [C]. Ibid: 1087–1088
26. Sain AK: Bone scan in Tietze's syndrome. *Clin Nucl Med* 1978; 3: 470–471
27. Miller JH: Accumulation of gallium-67 in costochondritis. *Clin Nucl Med* 1980; 5: 362–363
28. Talucci RC, Webb WR: Costal chondritis: the costal arch. *Ann Thorac Surg* 1983; 35: 318–321
29. O'Neal LW, Ackerman LV: Cartilaginous tumors of ribs and sternum. *J Thorac Surg* 1951; 21: 71–108
30. Arkin CR, Masi AT: Relapsing polychondritis: review of current status and case report. *Semin Arthritis Rheum* 1975; 5: 41–62
31. Prinzmetal M, Massumi RA: The anterior chest wall syndrome — chest pain resembling pain of cardiac origin. *JAMA* 1955; 159: 177–184
32. Carabasi RJ, Christian JJ, Brindley HH: Costosternal chondrodynia: a variant of Tietze's syndrome? *Dis Chest* 1962; 41: 559–562
33. Scobie BA: Costochondral pain in gastroenterologic practice [C]. *N Engl J Med* 1975; 295: 1261
34. Smythe HA, Moldofsky H: Two contributions to understanding of the "fibrositis" syndrome. *Bull Rheum Dis* 1977/78; 28: 928–931
35. Annotation on rib pain. *Br Med J* 1976; 1: 358–359
36. Mitchell JB: Cough fracture. *Br Med J* 1951; 2: 1492–1493
37. Daffner RH: Stress fractures: current concepts. *Skeletal Radiol* 1978; 2: 221–229
38. Fam AG, Shuckett R, McGillivray DC et al: Stress fractures in rheumatoid arthritis. *J Rheumatol* 1983; 10: 722–726
39. Park W, Ward D, Ball J et al: Rheumatoid disease and rib defects. *Ann Rheum Dis* 1971; 30: 466–475
40. Anderson IF, Corrigan AB, Champion GD: Rib erosions in rheumatoid arthritis. *Ann Rheum Dis* 1972; 31: 16–21
41. Condon WB, Harper FR: Tumors of the chest wall. *Dis Chest* 1950; 17: 741–755
42. Pascuzzi CA, Dahlin DC, Clagett OT: Primary tumors of the ribs and sternum. *Surg Gynecol Obstet* 1957; 104: 390–400
43. Holmes JF: A study of the slipping-rib-cartilage syndrome. *N Engl J Med* 1941; 224: 928–932
44. Stevenson FH: Nerve nipping at the intercostal margin. *Lancet* 1951; 2: 969–970
45. Blackman NS: Slipping rib syndrome with review of related anterior chest wall syndrome. *NY State J Med* 1963; 63: 1670–1675
46. Mynors JM: Clicking rib [C]. *Lancet* 1973; 1: 674
47. McBeath AA, Keene JS: The rib-tip syndrome. *J Bone Joint Surg [Am]* 1975; 57: 795–797
48. Heinz GJ, Zavala DC: Slipping rib syndrome. Diagnosis using the "hooking maneuver". *JAMA* 1977; 237: 794–795
49. Arlet J, Ficat P: Osteo-arthritis of the sterno-clavicular joint. *Ann Rheum Dis* 1958; 17: 97–100
50. Kalliomaki JL, Viitanen S-M, Virtama P: Radiological findings of sternoclavicular joints in rheumatoid arthritis. *Acta Rheum Scand* 1968; 14: 233–240
51. Reuler JB, Girard DE, Nardone DA: Sternoclavicular joint involvement in ankylosing spondylitis. *South Med J* 1978; 71: 1480–1481
52. Baker H, Golding DN, Thompson M: Psoriasis and arthritis. *Ann Intern Med* 1963; 58: 909–925
53. Bayer AS, Chow AW, Louie JS et al: Sternoarticular pyoarthrosis due to gram-negative bacilli: report of eight cases. *Arch Intern Med* 1977; 137: 1036–1040
54. Murray GC, Persellin RH: Metastatic carcinoma presenting as monoarticular arthritis: a case report and review of the literature. *Arthritis Rheum* 1980; 23: 95–100
55. Kohler H, Uehlinger E, Kutzner J et al: Sternocostoclavicular hyperostosis: painful swelling of the sternum, clavicles and upper ribs. Report of two new cases. *Ann Intern Med* 1977; 87: 192–194
56. Resnick D: Sternocostoclavicular hyperostosis. *AJR* 1980; 135: 1278–1280
57. Resnick D, Vint V, Poteshman NL: Sternocostoclavicular hyperostosis. *J Bone Joint Surg [Am]* 1981; 63: 1329–1332
58. Jirik FR, Stein HB, Chalmers A: Clavicular hyperostosis with enthesopathy, hypergammaglobulinemia and thoracic outlet syndrome. *Ann Intern Med* 1982; 97: 48–50

59. Fallet GH, Arroyo J, Vischer TL: Sternocostoclavicular hyperostosis: case report with a 31-year followup. *Arthritis Rheum* 1983; 26: 784–790
60. Sonozaki H, Kewashima M, Hongo O et al: Incidence of arthro-osteitis in patients with pustulosis palmaris et plantaris. *Ann Rheum Dis* 1981; 40: 554–557
61. Haenel LC, Bradway WR, Constantini PJ: Thrombophlebitis complicating sternocostoclavicular hyperostosis. *Postgrad Med* 1980; 68: 113–118
62. Brower AC, Sweet DE, Keats TE: Condensing osteitis of the clavicle: a new entity. *Am J Roentgenol Radium Ther Nucl Med* 1974; 121: 17–21
63. Cone RO, Resnick D, Goergen TG et al: Condensing osteitis of the clavicle. *AJR* 1983; 141: 387–388
64. Good AE: The chest pain of ankylosing spondylitis. Its place in the differential diagnosis of heart pain. *Ann Intern Med* 1963; 58: 926–937
65. Parker VS, Malhotra C, Ho G Jr et al: The sternomanubrial joint (SMJ) in rheumatic diseases. *Arthritis Rheum* 1981; 24 (suppl 108): S75
66. Sebes JI, Salazar JE: The manubriosternal joint in rheumatoid arthritis. *AJR* 1983; 140: 117–121
67. Jelenko C III: Tietze's syndrome at the xiphisternal joint. *South Med J* 1974; 67: 818–820
68. Oren BG: Pain at the xiphisternal joint. *N Engl J Med* 1966; 274: 1035–1036
69. Lipkin M, Fulton LR, Wolfson EA: Xiphoidalgia syndrome. *N Engl J Med* 1955; 253: 609–610
70. Annotation on "the hypersensitive xiphoid". *Lancet* 1955; 2: 1182
71. Palmer E: Xiphoid cartilage syndrome [C]. *Am Fam Physician* 1966; 33: 127
72. Travell J, Rinzler SH: Pain syndromes of the chest muscles: resemblance to effort angina and myocardial infarction, and relief by local block. *Can Med Assoc J* 1948; 59: 333–338
73. Morgan-Hughes JA: Painful disorders of muscle. *Br J Hosp Med* 1979; 360: 362–365
74. Miller AJ, Texidor TA: "Precordial catch", a neglected syndrome of precordial pain. *JAMA* 1955; 159: 1364–1365
75. Stegman D, Mead B: The chest wall twinge syndrome. *Nebr State Med J* 1970; 55: 528–533
76. Sparrow MJ, Bird EL: "Precordial catch": a benign syndrome of chest pain in young persons. *NZ Med J* 1978; 88: 325–326
77. Huebner RJ, Risser JA, Bell JA et al: Epidemic pleurodynia in Texas; a study of 22 cases. *N Engl J Med* 1953; 248: 267–274
78. Dolin R: Epidemic pleurodynia. In Wyngaarden JB, Smith LH (eds): *Cecil Textbook of Medicine*, 16th ed, Saunders, Philadelphia, 1982: 1665–1666
79. Love JG, Schorn VG: Thoracic-disc protrusions. *JAMA* 1965; 191: 91–95
80. Benjamin MV, Ransohoff J: Thoracic disc disease. In Rothman RH, Simeone FA (eds): *The Spine*, 2nd ed, Saunders, Philadelphia, 1982: 500–507
81. Hamberg J, Lindahl O: Angina pectoris symptoms caused by thoracic spine disorders. Clinical examination and treatment. *Acta Med Scand* 1981; (Chest Pain suppl): 84–86
82. Nathan H, Weinberg H, Robin GL et al: The costovertebral joints; anatomical-clinical observations in arthritis. *Arthritis Rheum* 1964; 7: 228–240
83. Weinberg H, Nathan H, Magora F et al: Arthritis of the first costovertebral joint as a cause of thoracic outlet syndrome. *Clin Orthop* 1972; 86: 159–163
84. Forestier J, Lagier R: Ankylosing hyperostosis of the spine. *Clin Orthop* 1971; 74: 65–83
85. Harris J, Carter AR, Click EN et al: Ankylosing hyperostosis. 1. Clinical and radiological features. *Ann Rheum Dis* 1974; 33: 210–215
86. Resnick D, Shapiro RF, Wiesner KB et al: Diffuse idiopathic skeletal hyperostosis (DISH) (ankylosing hyperostosis of Forestier and Rotes-Querol). *Semin Arthritis Rheum* 1978; 7: 153–187
87. Traut EF: Fibrositis. *J Am Geriatr Soc* 1968; 16: 531–538
88. Kraft GH, Johnson EW, LaBan MM: The fibrositis syndrome. *Arch Phys Med Rehabil* 1968; 49: 155–162
89. Simons DG: Muscle pain syndromes — part I. *Am J Phys Med* 1975; 54: 289–311
90. Idem: Muscle pain syndromes — part II. *Am J Phys Med* 1976; 55: 15–42
91. Smythe HA: "Fibrositis" as a disorder of pain modulation. *Clin Rheum Dis* 1979; 5: 823–832
92. Yunus M, Masi AT, Calabro JJ et al: Primary fibromyalgia (fibrositis): clinical study of 50 patients with matched normal controls. *Semin Arthritis Rheum* 1981; 11: 151–171
93. Sheon RP, Moskowitz RW, Goldberg VM: Fibrositis syndrome. In Sheon RP, Moskowitz RW, Goldberg VM (eds): *Soft Tissue Rheumatic Pain: Recognition, Management, Prevention*, Lea & Febiger, Philadelphia, 1982: 241–252
94. Campbell SM, Clark S, Tindall EA et al: Clinical characteristics of fibrositis. I. A "blinded", controlled study of symptoms and tender points. *Arthritis Rheum* 1983; 26: 817–824
95. McCain GA: Fibromyositis. *Mod Med Can* 1983; 38: 197–206
96. Bennett RM: Fibrositis: Does it exist and can it be treated? *J Musculoskel Med* 1984; 1: 57–72
97. Awad EA: Interstitial myofibrositis: hypothesis of the mechanism. *Arch Phys Med Rehabil* 1973; 54: 449–453
98. Stonnington HH: Tension myalgia. *Mayo Clin Proc* 1977; 52: 750–751
99. Payne TC, Leavitt F, Garron DC et al: Fibrositis and psychologic disturbance. *Arthritis Rheum* 1982; 25: 213–217
100. Wolfe F, Cathey MA, Kleinheksel SM et al: Psychological status in primary fibrositis and fibrositis associated with rheumatoid arthritis. *J Rheumatol* 1984; 11: 500–506
101. Ahles TA, Yunus MB, Riley SD et al: Psychological factors associated with primary fibromyalgia syndrome. *Arthritis Rheum* 1984; 27: 1101–1106
102. Wolfe F, Cathey MA: Prevalence of primary and secondary fibrositis. *J Rheumatol* 1983; 10: 965–968
103. Wilke WS, Sheeler LR, Makarowski WS: Hypothyroidism with presenting symptoms of fibrositis. *J Rheumatol* 1981; 8: 626–631
104. Moldofsky H, Scarisbrick P, England R et al: Musculoskeletal symptoms and non-REM sleep disturbance in patients with "fibrositis syndrome", and healthy subjects. *Psychosom Med* 1975; 37: 341–351
105. Moldofsky H, Scarisbrick P: Induction of neurasthenic musculoskeletal pain syndrome by selective sleep stage deprivation. *Psychosom Med* 1976; 38: 35–44
106. Kraus H: Trigger points. *NY State J Med* 1973; 73: 1310–1314
107. Cooper AL: Trigger-point injection: its place in physical medicine. *Arch Phys Med Rehabil* 1961; 42: 704–709
108. Lewit K: The needle effect in the relief of myofascial pain. *Pain* 1979; 6: 83–90
109. Loeser JD, Black RG, Christman A: Relief of pain by transcutaneous stimulation. *J Neurosurg* 1975; 42: 308–314
110. Waylonis GW: Long-term follow-up on patients with fibrositis treated with acupuncture. *Ohio State Med J* 1977; 73: 299–302
111. Peck CL, Kraft GH: Electromyographic biofeedback for pain related to muscle tension. *Arch Surg* 1977; 112: 889–895
112. Boland EW: Psychogenic rheumatism. The musculoskeletal expression of psychoneurosis. *Ann Rheum Dis* 1947; 6: 195–203
113. Reynolds MD: Clinical diagnosis of psychogenic rheumatism. *West J Med* 1978; 128: 285–290
114. Rotes-Querol J: The syndromes of psychogenic rheumatism. *Clin Rheum Dis* 1979; 5: 797–805
115. Beetham WP Jr: Diagnosis and management of fibrositis syndrome and psychogenic rheumatism. *Med Clin North Am* 1979; 63: 433–439