Thoracic Outlet Syndrome

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Editors

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An old Hindi wise man told a story about six blind men meeting up with an elephant. Each blind man could feel only a part of the beast. One man felt a tusk and said that an elephant is similar to a spear. Another man touched a leg and said that an elephant is a big tree. Grabbing the trunk, one blind man claimed that the elephant is a big snake. With each blind man, the true nature of a whole elephant was misjudged because each one could only sense one part. The old Hindi wise man told us that truth is found by considering many different points of view.

In composing this book, we recognize that clinicians may view Thoracic Outlet Syndrome from many different perspectives. From the very beginning of this project, we hoped to incorporate as many of these different perspectives as we can, because it is our conviction that knowledge will arise out of a process of consensus while we try to reconcile the differences. In so doing, we honor the old Hindi wise man and the elephant.

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Karl A. Illig: *Thanks to those who taught me that asking questions about what we do is fun, and to those who instilled within me a fairly unusual passion for the thoracic outlet and the patients who suffer from problems within it: Seymour Schwartz, Jim DeWeese, and Jim Adams, Harry Sax and Jim Peacock, Dave Feliciano, Dick Green, and Ken Ouriel. Thanks to several whose friendship has made an academic journey fun: Mike Singh, Joe Serletti, Walt Pegoli, Cinny Shortell, and Peter Knight. Thanks also to David Smith and Smitty, two new friends and colleagues who have provided amazing support and a wonderful and warm place to work. Finally, huge thanks to my co-editors and to all the authors of this volume; in addition to the knowledge I learned from each of you I count among you a mentor equally as valuable as any.*

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Julie Ann Freischlag: *My experience with thoracic outlet syndrome began with Herb Machleder. Every Tuesday we would operate together when I was a vascular fellow at UCLA – his knowledge of the disease and his philosophy about the process of care for these patients was extraordinary – and I thank him to this day for the experience and mentorship. From my point of view this book is dedicated to all of our patients with this disease so that they receive better care and to our trainees who we hopefully will give the same teaching that Herb gave to me.*

Sheldon E. Jordan: *My experience with thoracic outlet syndrome began with Herb Machleder. He simply rose above the noise of controversy. In a clear, compassionate, and inquisitive fashion he approached the patients individually and as members of a population in need. He was remarkably unbiased, creative, and eclectic in his quest for better treatment of these patients. He is my hero.*

Dean M. Donahue: *I would like to dedicate this to the people who have taught me the most about TOS: my patients. I admire the courage you show dealing with this condition. I would like to thank my colleagues, who fortunately, are also my friends. You have inspired and encouraged me to reach for your lofty standards. I would like to acknowledge a very hard working office staff: Patricia Guerriero, Kathy Cocozella and Julie Garrity. You fight the TOS battle in the trenches every day. Mostly, I want to thank my entire family, especially my amazing wife Julie, and awesome children Trevor, Abby, Ally and Emily. This was only accomplished because of their love, understanding, and support.*

Peter I. Edgelow: *It has been an honor to assist in the birth of this text on Thoracic Outlet Syndrome. I owe much to Dr. Ronald Stoney, M.D., who introduced me to TOS by inviting me to observe surgery. What I learned led me to research the literature to explain the problem that Dr. Stoney first clarified. I also acknowledge the work of Dr. Herman Kabat, M.D., the originator of the Physical Therapy technique called Proprioceptive Neuromuscular Facilitation (PNF). His observation of weakness in the ulnar innervated thumb muscles and the reversal of this weakness following proprioceptive stimulation to the neck flexors filled in a gap in conservative treatment. Over the past 20 years, success with patients plus studies on the effects of trauma secondary to MVAs has provided an evidence base to support conservative care as clarified in the text. Lastly but by no means least, a grateful thanks to my wife Margaret for her editorial expertise and to our daughter Gillian who is the model for the DVD that demonstrates the exercises.*

Foreword

After a century of contributions to the Medical Literature, new ideas about neurovascular compression syndromes had apparently run aground. By the 1970s there was little of consequence in the contemporary literature, no ongoing investigative efforts, and except for a colorful monograph by artist Frank Netter, virtually no Medical School teaching of the subject. It was all too obvious that clinical understanding of "Thoracic Outlet Syndrome" was inadequate to meet the rising number of patients with these unique disorders.

Then, from the Basic Sciences, came a coherent view of the developmental anatomy of the Thoracic Outlet structures. Perhaps that was the spark that ignited the energy of a new generation of collaborative Neurologists, Physicians, Surgeons, and Radiologists to rethink the conceptual framework, integrate what was known, and create a new multidisciplinary forum for the generation of new knowledge. Clinical scholarship in this area flourished, guided by Peer Reviewed Research and Evidence Based Medicine. The result, from one perspective as a State Disability Examiner; "TOS disabled" Musicians were returning to their orchestras, Professional and Student Athletes to their teams. Workers returned to office, shop, and construction site. When viewed in the setting of just a few years past, these accomplishments cannot be overrated.

Thoracic Outlet Syndrome, the textbook, represents the first thorough compilation of what has come to be known of these disorders. And for this time in history, it has been put together in one elegant text.

It should be immediately apparent, when you review the roster of Editors, the list of 52 Authors from 27 cities and 20 University Medical Centers, that this is no Monograph, or idiosyncratic look at a subject, but the collective wisdom and experience of a diverse group of outstanding Clinicians and Clinical Scientists from the major medical and rehabilitative disciplines. From this perspective comes a comprehensive, cohesive, eminently literate account of the conceptual framework that encompasses the Thoracic Outlet disorders. The anatomic and physiologic fundamentals and the basis for the diagnostic and therapeutic algorithms are in detail.

The arrangement of the three sections (Neurogenic, Arterial, and Venous) and their major subdivisions of; Pathologic Anatomy/Physiology, Diagnosis, and Therapy, give the reader insight into the thoughtful pedagogic framework of the text. The management algorithms and therapeutic options cover a multitude of permutations, and practically every validated treatment variation.

All the "FAQs" are addressed: The myriad issues that accompany unexpected disability; Psychosocial, Vocational, Medico legal, even to Patient's assessments of their experiences, articulate and critical. One cannot help but sense the compassion, attention to detail, technical skill, and thoughtful rehabilitation that populates these pages. The clinician, from whatever discipline, comes away from this text with understanding, and fresh diagnostic and therapeutic confidence for dealing with what is now one of the most common disorders to encumber the modern workplace.

There has been an empty slot on the Reference Shelf, a hole in the Medical Curriculum, a space on the office desk, a 150 year lapse. The Editors and Authors of *Thoracic Outlet Syndrome* have filled that gap, with a textbook worthy of the task. Above all else, will be the improved care of a group of young men and women eager to be productive. It is hard to imagine there is a group among the healing sciences, from students to experienced clinicians and practitioners, who will not benefit from picking up and reading these pages.

CA, USA Herbert I. Machleder, MD

Preface

Thoracic outlet syndrome (TOS) is a condition estimated to affect as many as 80 of every 1,000 patients in the United States. While estimates vary widely based in part on lack of consensus as to the definition of the syndrome, between 2,500 and 3,000 first rib resections are performed yearly in this country.

What is TOS? In reality, *it is at least three separate conditions*. Neurogenic TOS (NTOS), by far the most common (perhaps 95 % of cases), refers to the condition where the brachial plexus is compressed at the scalene triangle or retropectoral space, and is manifest as local and extremity pain and neurologic symptoms often exacerbated by lifting the arms overhead. Venous TOS (VTOS), accounting for about 4 % of cases, refers to the situation where the subclavian vein is compressed by the structures making up the costoclavicular junction, and presents as acute or chronic venous thrombosis or injury or occasionally intermittent positional obstruction. Finally, arterial TOS (ATOS), the rarest form of the condition, refers to the situation where arterial injury occurs as the result of abnormal bony or ligamentous structures at the outlet, and presents as occlusion of or embolization from an abnormal artery in this area. To further the confusion regarding terminology, VTOS and ATOS are sometimes lumped together as "vascular" TOS, and many patients with NTOS will have easily reproducible arterial abnormalities shown by history or physical exam.

TOS is perhaps the most common surgical condition that has not had a textbook specifically devoted to it. Several single-author monographs exist (and another is planned), notably Sanders' *Thoracic Outlet Syndrome*: *A Common Sequela of Neck Injuries* (Philadelphia: Lippincott, 1991) and Machleder's *Vascular Disorders of the Upper Extremity* (Hoboken: Wiley, 1999), but while seminal works these are both obviously directed at special cases of TOS and date from more than a decade ago. There are numerous reasons why a multidisciplinary, multi-author textbook is before you:

- TOS is a problem seen almost daily in most busy vascular surgery clinics and clinics of thoracic surgeons, neurosurgeons, and neurologist interested in this diagnosis.
- TOS is poorly understood by all but a handful of physicians.
- TOS is very poorly understood and hence very poorly diagnosed by the majority of primary care physicians, and almost unknown by the lay population.
- TOS is poorly treated by all but a handful of physicians and practitioners.

- Even by the "experts" – TOS is perhaps the most inconsistently treated and poorly assessed condition one can name:
  - There is little consensus as to pathophysiology.
  - There are no consistent diagnostic criteria to use.
  - There are no treatment algorithms consistently used by most clinicians.
  - There are no objective outcomes assessment tools, and thus trying to assess success or failure of treatment rests on very shaky ground.
  - As the condition is uncommon, almost no one has enough volume to truly assess what is helpful and what is not.

In short, and to summarize the problem in a few words, essentially no Level 1 evidence exists for anything we do in the treatment of this condition. It has been chilling for the editors to truly learn on what shaky ground we stand on when providing care for patients with TOS.

This textbook attempts to start the process of remedying this situation, by bringing together as many experts as possible who treat this disease and think and write about it critically. The book is divided into 13 parts. First is an overall summary of the problem, which includes reviews of terminology, embryology, and anatomy. Next, sections specifically addressing NTOS, VTOS, and ATOS each follow, each addressing specific anatomy and physiology, treatment pathways, and controversies and special questions we need to ask. Finally, a section most relevant to the condition as a whole is provided, which includes discussion of medicolegal and workman's compensation issues, psychological concerns, and "best practices" with regards to treating these patients – and essays, in their own words, by those affected by it. This book is designed as a clinical reference work. While it can certainly be read in its entirety (and should, by all who concentrate on this condition), it is designed to reside on a shelf in a busy surgical or neurologic clinic where individual chapters can be quickly referenced when a specific question arises in the course of daily practice. As such, we have tried to keep the chapters as short as possible, but in return some overlap and redundancy will be observed.

In summary, this condition can probably be best approached if we all "talk the same language," and this textbook is envisioned as a critical first step. The next task is probably to agree on unified diagnostic criteria and even treatment pathways so that we can begin to objectively assess what is the best possible care for these patients. Begun by the efforts of one of the authors (RT) using the Delphi process, we hope to accomplish this goal assisted by societal consensus statements, uniform registries, multi-institutional prospective randomized trials, and, ideally, "rare disease" funding.

TOS, while rare, is potentially a lifelong condition and is devastating to those affected. When coupled with the very poor state of knowledge and lack of interest by so many clinicians, the stage is set for suffering. We hope that the information that follows will help all to start to solve this problem.

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Terminology of Thoracic Outlet Syndrome and Related Problems

Dean Donahue, Peter Edgelow, Julie Freischlag, Karl Illig, Sheldon Jordan, Robert Thompson

As in any field of medicine or scientific endeavor, those who deal with Thoracic Outlet Syndrome (TOS) and related problems must understand and agree upon a unified terminology. TOS can be confusing, and the plethora of descriptions, eponyms, tests, maneuvers, and the like often make things worse. In several cases ("true" versus "disputed" TOS, for example), inappropriate terminology can even give the impression that the syndrome does not exist or that patients are imagining their complaints. Finally, accurate terminology allows professionals and patients alike to economically communicate with each other.

The following chapter sets forth a "vocabulary" of TOS, to be used in this textbook and, ideally, in the real world as well.

Thoracic Outlet Syndrome (TOS)

One of several conditions manifested by signs and symptoms attributable to compression or entrapment of vessels or nerves at the level of the thoracic outlet. The designation "syndrome" implies the presence of disability that is significant to the patient. It is critical to differentiate neurogenic (NTOS), venous (VTOS), and arterial (ATOS) as these are three separate syndromes, are treated in different ways, and have different natural histories and outcomes.

Note that the terms "**True TOS**" and "**Disputed TOS**" are no longer helpful, are of historical interest only, and should not be used. These terms arose in the era when diagnosis of NTOS was less precise and outcomes less assured, and suggest that controversy exists as to whether NTOS exists if motor dysfunction or wasting are not present, a proposition not supported by contemporary practice.

Aberrant Fibrous Bands

Fibrotic structures that course through or across the neurovascular structures at the scalene triangle, resulting in abnormal displacement or entrapment of these structures.

Adson Maneuver

A physical exam maneuver performed to evaluate for positional subclavian artery compression in the thoracic outlet. The patient is seated with their head rotated toward the asymptomatic side and extended. The arm is

then extended and externally rotated during a single-breath hold while palpating the radial artery pulse at the wrist. The value of this test has been questioned because of a high frequency of positive results in asymptomatic individuals, and because it does not reliably demonstrate arterial wall changes characteristic of ATOS (i.e., subclavian artery aneurysms), and because it does not demonstrate or indicate brachial plexus nerve compression. In contrast, reproduction of upper extremity symptoms with arm elevation in the presence of a palpable radial pulse demonstrates that the symptoms are unrelated to arterial insufficiency, and more likely secondary to NTOS.

Anomalous First Rib

A true first rib (arising from T1) that exhibits an unusual shape or junction with the second rib.

Arterial TOS (ATOS)

Signs and symptoms attributed to "clinically significant" arterial compression within the thoracic outlet, such as subclavian artery occlusive lesions or aneurysms. ATOS is reserved for situations in which symptoms of arterial insufficiency or thromboembolism are dominant along with demonstrable structural pathology.

Axillary Artery Compression Syndrome

A form of ATOS characterized by arterial compression at the level of the humeral head or underneath the pectoralis minor muscle.

Axillosubclavian artery

The term encompassing the entire artery in the region of the thoracic outlet.

Brachial Plexus Neurolysis

A surgical technique used to mobilize the brachial plexus nerve roots from surrounding fibrous tissue, by operative dissection of scar tissue surrounding or interdigitating the nerves during thoracic outlet decompression. The term "neuroplasty" may also be used.

Brief Pain Inventory (BPI)

A well-validated and commonly used patient-reported survey form that incorporates scales for subjective pain as well as how the pain interferes with various functions. A whole-body diagram is used for mapping pain.

Cervical Rib

An anomalous extra rib arising from the C7 vertebra, which typically inserts onto the normal first rib, causing anterior displacement and/or compression of the brachial plexus and subclavian artery. Occurs in approximately 0.5 % of the general population and may be seen as either an incidental finding or in conjunction with one of the forms of TOS.

Cervicobrachial Syndrome

A constellation of neck and upper extremity signs and symptoms that may be attributable to musculoskeletal, neurologic, or vascular dysfunction of the neck, shoulder, or arm, not necessarily with a defined diagnosis. The designation "syndrome" implies the presence of disability that is significant to the patient. It is recognized that people may have minor signs and symptoms that may not be considered disabling,

and that multiple pathophysiological conditions may coexist (e.g., NTOS may coexist with shoulder impingement). The term "cervicobrachial syndrome" may be used to describe patients with regional problems and with several potentially identifiable diagnoses, particularly at the time of initial presentation. Whenever possible, this term "cervicobrachial syndrome" should be followed by a full listing of indentified specific diagnoses.

Cervicobrachial Symptom Questionnaire (CBSQ)

A self-administered scale designed for evaluation of cervicobrachial syndrome. A total body diagram is included to test for widespread pain syndromes, and an oversized hand diagram is used to allow for precision in sensory maps. Questions have been added to screen for CRPS including allodynia, hyperalgesia, and for changes in color, temperature, and sweating.

Chemodenervation. Botulinum Toxin Chemodenervation

The use of intramuscular botulinum toxin injection to achieve synaptic block at cholinergic junctions, resulting in neuromuscular blockade with partial or complete paralysis of the targeted muscle(s). Effects are expected to last for several months. Conditions characterized by chronic excessive activation or spasm of muscles are often treated in this manner (see **Dystonia**). This approach has also been applied to NTOS.

Chiropractic

The health profession concerned with the diagnosis, treatment, and prevention of mechanical disorders of the musculoskeletal system, and the effects of these disorders on the functions of the nervous system and general health. There is an emphasis on manual treatments including spinal adjustment and other joint and soft-tissue manipulation.

Chronic Pain Syndrome

Pain that lasts beyond the usual expected duration for healing of an acute injury. Arbitrarily, time periods of 3 or 6 months have been used in the definition.

Complex Regional Pain Syndrome (CRPS)

A painful condition manifesting as regional pain (with or without other lesions described below) that appears to be disproportionate in time or intensity to the usual course of any known trauma or other lesion. Considered to be associated with local/regional overactivity of the sympathetic nerve system. A recent international symposium was held to achieve consensus as to additional signs and symptoms that are to be required for the diagnosis. This terminology replaces earlier terms in the present text, but it should be recognized that the previous terms Reflex Sympathetic Dystrophy (RSD) and/or Causalgia are often still used. The Budapest Criteria, used in this text, requires that symptoms must exist in three of four of the following categories: sensory symptoms (hyperesthesia or allodynia), vasomotor symptoms (skin color or temperature changes), symptoms related to sweating or edema, and symptoms from a category that includes motor (dystonia or weakness) or trophic (altered nail and hair growth and changes in skin texture).

Costochondritis
: A condition produced by inflammation of the costal cartilage connecting the ribs to the sternum. This causes symptoms of anterior chest pain occasionally radiating to the back, upper abdomen, or arm. May mimic or overlap symptoms of NTOS attributable to brachial plexus compression at the subcoracoid (pectoralis minor) space, distinguishable by tenderness to palpation and exacerbation of neurogenic upper extremity symptoms.

Costoclavicular Space
: The anatomic space between the first rib and clavicle, through which the subclavian vein passes.

Cumulative Trauma Disorder (CTD)
: An older term not used in this text. See **work-related musculoskeletal disorder**.

Disabilities of the Arm, Shoulder, and Hand (DASH)
: The DASH outcome measure is a 30-item, self-reported questionnaire designed and validated to measure physical function and symptoms in people with any of the several musculoskeletal disorders of the upper extremity.

"Disputed" TOS
: A term historically referring to patients with signs and symptoms of NTOS but no objective hand muscle weakness or atrophy or electrophysiological abnormalities on nerve conduction testing. Because this term carries the implication that such patients with NTOS do not have a valid or treatable diagnosis, this term has been discarded in contemporary practice.

Double-Crush Syndrome; Multiple-Crush Syndrome
: A condition in which peripheral nerve dysfunction may appear to be more evident or modified because of the cumulative effects of nerve compression at two or more points along its axonal course. Historically, discussions centered around the effects of compression on axonal transport mechanisms. More current discussions include reference to a variety of identified processes that produce sensitization of neural structures, working at a peripheral or central level of the neuraxis.

Dysesthesia
: An unpleasant feeling of electrical sensation, pins and needles, or tingling.

Dystonia
: A condition of postural disturbance, usually associated with pain, caused by abnormal activation or spasm of a muscle or muscle group. Electromyographic examination of affected muscles will demonstrate excessive activity of the recorded motor action potentials. The latter will differentiate postural disturbances or pain that may result from muscle shortening or contracture.

Elevated Arm Stress Test (EAST)
: A timed, repetitive hand opening and closing activity with the hands held with the elbows flexed and shoulders abducted 90°. A positive test is scored (and time noted) if the patient experiences discomfort related to pain, sensory changes, or progressive weakness and fatigue that reproduces symptoms concordant with the patient's condition. Commonly performed for either 1 min (with an endpoint of symptom reproduction) or for 3 min (with an endpoint of inability to continue).

Effort Thrombosis of the Subclavian Vein (Paget-Schroetter Syndrome)
: VTOS presenting with sudden, spontaneous, arm swelling and cyanotic discoloration, caused by thrombosis of the axillary-subclavian vein at the level of the first rib or costoclavicular space. Essentially an upper extremity deep vein thrombosis caused by mechanical compression injury to the subclavian vein at this location, often seemingly associated with a history of upper extremity "effort" caused by heavy lifting or overhead activity. The condition was originally described by Sir James Paget (1875) and Leopold von Schroetter (1884), and later summarized in a series of 320 cases by Sir E. S. R. Hughes in 1949.

Ergonomic
: Pertaining to the biomechanics of work-related activities.

External Venolysis
: Thorough surgical removal of the fibrous tissue sheath, distinct from the adventitia of the vein, which commonly surrounds the subclavian vein in patients with VTOS. In many cases, external venolysis is associated with re-expansion of the underlying vein, which may be otherwise normal in diameter and consistency to palpation.

Fibromyalgia
: A clinical syndrome characterized by the presence of chronic widespread pain in combination with fatigue, non-restorative sleep, and cognitive change along with a variety of bodily complaints. The American College of Rheumatology has recently updated diagnostic criteria for this disorder.

Gilliat-Sumner Hand
: Atrophy (wasting) of the hand muscles, along with electrophysiological abnormalities on nerve conduction studies, attributed to chronic compression of the brachial plexus nerve roots by a cervical rib or anomalous fibrous band at the level of the thoracic outlet. Originally described by Gilliat et al. in 1970.

Interventional Pain Management
: Techniques having in common percutaneous or minimally invasive approaches for the control of acute or chronic pain.

Katz Diagram
: A validated and commonly used instrument, first used for carpal tunnel syndrome, which can be used for a patient to map out areas of paresthesias or sensory loss in the hand and arm.

Maximal Medical Improvement (MMI)
: The situation at a point in time after treatment where further substantial improvement in subjective complaints and functional status is not anticipated. Specifically used in adjucating worker's compensation claims to define when treatment for a given condition has come to a conclusion.

Myofascial Pain
: Regional pain with the presence of palpably firm areas of muscle which are tender. When the firm areas of muscle are needled or firmly percussed there is an experience of pain which may extend to a more distant location ("**trigger points**"). Muscle twitches may also be seen during percussion or needling of the muscle area.

Neurogenic Pain; Neuropathic Pain
: Pain initiated or caused by a primary lesion, dysfunction, or transitory perturbation in the peripheral or central nervous system.

Neurogenic TOS (NTOS)
: The category of Thoracic Outlet Syndrome caused by compression and/or irritation of neural elements of the brachial plexus, either at the level of the supraclavicular scalene triangle and/or the infraclavicular subcoracoid (pectoralis minor) space.

Neurography
: Imaging of nerves. Specifically used to describe functional imaging, typically using contrast-enhanced magnetic resonance techniques, to elucidate and localize areas of nerve dysfunction.

Occupational Therapy (OT)
: The health profession that facilitates functional participation in the actions and activities that individuals want and need to do during daily life, particularly through the therapeutic use of everyday and work-related activities.

Pain Management
: The medical discipline that uses interventional, pharmaceutical, psychological, and rehabilitative techniques for the control of acute or chronic pain.

Paresthesia(s)
: The feeling of electrical sensation, tingling, or pins and needles which is indicative of nerve stimulation or dysfunction (see "**dysesthesia**").

Pectoralis Minor Block
: An injection of local anesthetic and/or other agents into the pectoralis minor muscle in an attempt to diagnose, evaluate, or treat pathologic brachial plexus nerve compression in this area.

Pectoralis Minor Syndrome
: A form of NTOS manifested by signs and symptoms attributable to compression or entrapment of the brachial plexus nerves at the level of the pectoralis minor tendon, as it passes from the chest wall to the coracoid process.

Pectoralis Minor Tenotomy
: A surgical procedure used to treat pectoralis minor syndrome, in which the tendon of the pectoralis minor muscle is divided close to its insertion on the coracoid process.

Peripheral Neuropathy
: Dysfunction of nerves outside of the spinal cord, i.e., peripheral nerves.

Persistent Neurogenic TOS
: Disabling symptoms of NTOS that have not improved despite previous treatment, typically assessed at least 3 months after an operative procedure. Distinguished from "**recurrent neurogenic TOS**," in which symptoms are improved for a period of at least 3 months after an operative procedure but subsequently return at a later interval.

Phalen's Test
: A physical exam maneuver in which the patient holds the wrists in complete and forced flexion (pushing the dorsal surfaces of both hands

together) for 30–60 s. A positive result (symptoms in the median nerve distribution) is predictive of carpal tunnel syndrome.

Physical Medicine and Rehabilitation (PMR)
: The discipline of medicine that focuses on the evaluation and treatment of musculoskeletal problems, including long-term rehabilitation for acute and/or chronic problems.

Physical Therapy (PT)
: The health profession that focuses on treatment techniques to promote the ability to move, reduce pain, restore function, and prevent disability.

Quality-of-Life (QOL)
: The concept of the benefit or quality of a person's life as a whole. Semi-objectively assessed by measuring functional health and general well being, most commonly by self-administered patient questionnaires, such as the SF-36 form.

Recurrent Neurogenic TOS
: Return of symptoms attributable to NTOS after a period of remission, typically for at least 3 months, following a particular form of treatment.

Reflex Sympathetic Dystrophy (RSD)
: An older term for the condition now classified as complex regional pain syndrome.

Repetitive Motion Disorder, Repetitive Trauma Disorder
: Older terms for **work-related musculoskeletal disorder**.

Scalene Block
: An injection of local anesthetic and/or other agents into the anterior scalene muscle in an attempt to diagnose, evaluate, or treat pathologic brachial plexus nerve root compression in this area. Typically performed with electromyographic monitoring and radiographic- or ultrasound-guided needle tip placement. Unless otherwise specified, may also include injection into the middle scalene, pectoralis minor, and/or subclavius muscles.

Scalenectomy
: Surgical procedure in which the anterior and middle scalene muscles are excised as part of an operation for thoracic outlet decompression. Distinguished from "scalenotomy" which refers to a procedure in which the insertion of the scalene muscle(s) is divided from the first rib but the muscle is not excised.

Sensitization
: A process related to the peripheral or central nervous system which results in regional or generalized pain that appears to be disproportionate in time or intensity to the usual course of any known trauma or other lesion. **Allodynia** is the experience of pain when a person is stimulated in a manner which is not usually experienced as painful (e.g., pain with light touch). **Hyperesthesia** is the experience of excessive pain when stimulated in a manner that would produce only minimal pain in a normal individual.

SF-36
: A well validated and widely used self-administered or interview-assisted questionnaire that is used to measure and monitor functional health and general well being. Short forms are sometimes substituted for the original 36 item scale (i.e., SF-24, SF-12).

Spurling's Test
: A physical exam maneuver involving ipsilateral rotation and extension of the neck and downward pressure on the head, which produces pain and paresthesias from the neck to the ipsilateral limb, associated with degenerative cervical spine disease.

Subclavius Muscle
: The muscle originating on the undersurface of the clavicle and inserting on the first rib by terminating in the costoclavicular ligament. This muscle may contribute to subclavian vein compression in VTOS.

Subclavius Muscle Block
: An injection of local anesthetic and/or other agents into the subclavius muscle in an attempt to diagnose, otherwise evaluate, or treat pathologic compression of the brachial plexus nerve roots in this area.

Sympathectomy
: Surgical procedure involving removal of a part of the cervical sympathetic chain, usually from the level of the stellate ganglion to the T3 sympathetic ganglion, used to treat sympathetic hyperactivity as a component of NTOS or CRPS. Aside from its use in these conditions, sympathectomy is most frequently performed for palmar and/or axillary hyperhydrosis.

Tenotomy
: A term used to describe surgical division of a muscle or its tendon, distinguished from procedures involving resection of the muscle.

Thoracic Outlet
: The general term for the anatomic region beginning at the base of the neck, behind the clavicle and overlying the first rib, and extending to the subcoracoid (beneath the insertion of the pectoralis minor) space. The principal nerves and blood vessels to the arm pass through the thoracic outlet. Several distinct spaces are considered to exist within the thoracic outlet, where compression of different structures may occur at different locations, including the scalene triangle, the costoclavicular space, and the subcoracoid space. Occasionally the term "**thoracic inlet**" is used to denote the venous portion of this area (constoclavicular junction), but this term is confusing and should be avoided.

Tinel's Sign
: A physical exam maneuver used to detect an irritated peripheral nerve. Light tapping (percussing) over the nerve (such as over the carpal tunnel or the cubital canal) elicits a sensation of tingling or "pins and needles" in the distribution of the nerve if it is inflamed or irritated at that location.

Upper Limb Tension Test (ULTT)
: A physical examination technique involving a series of sequential provocative maneuvers designed to place components of the brachial plexus on tension in an attempt to reproduce symptoms of NTOS. Sometimes referred to as the "straight-leg raising test" for the arm, it was first described by R. L. Elvey in 1979.

Vascular TOS
: A general term for venous and/or arterial TOS.

Venous TOS (VTOS)
: Intermittent positional obstruction or thrombotic occlusion of the axillo-subclavian vein at the level of the first rib. Thrombotic occlusion is also referred to as subclavian vein **effort thrombosis** or **Paget-Schroetter syndrome**.

Whiplash injury
: Generally refers to an acute injury to the soft tissues of neck (as opposed to the bones) caused by sudden flexion and extension movements.

Winged Scapula
: Any abnormal scapular position in relation to the chest wall. Medial or posterior winging of the scapula results from paralysis and/or atrophy of the serratus anterior muscle secondary to injury and/or dysfunction of the long thoracic nerve, and is characterized by an inability to keep the scapula close to the chest wall during arm elevation and abduction and subsequent weakness and inability to perform these movements. Lateral winging of the scapula results from weakness of the trapezius and/or rhomboid muscles.

Workers Compensation
: The system that has been developed under government supervision to provide treatment to workers who have been injured on the job site or in the course of employment-related duties.

Workplace Injury
: An injury that occurs while at work and in the course of employment-related duties.

Work-Related Musculoskeletal Disorders (WMSDs)
: Any musculoskeletal disorder caused by chronic physical workplace stress. These disorders can be caused by activities which are frequent and repetitive or by activities that involve sustained awkward postures. This term unites syndromes such as repetitive motion injuries, repetitive strain or stress injuries, cumulative trauma disorders, occupational cervicobrachial disorders, occupational overuse syndromes, regional musculoskeletal disorders, etc.

Contents

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