THORACIC OUTLET SYNDROME

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HETEROGENEOUS GROUP OF DISORDERS

ALL HAVE IN COMMON COMPRESSION OF ONE OR MORE NEUROVASCULAR ELEMENTS WITHIN SOME POINT OF THE THORACIC OUTLET

CERVICAL RIBS FIRST REPORTED BY GALEN 2ND CENTURY AD

GRUBER (1869) DESCRIBED.

SHORT TO COMPLETE RIBS.

INCOMPLETE RIBS WITH FIBROUS BANDS.

BONE FROM CERVICAL RIB CONNECTED TO THE FIRST RIB.

THOMAS AND CUSHING (1903) JOHN HOPKINS HOSPITAL

DESCRIBED “CERVICAL RIB SYNDROME”.

- A BRACHIAL PLEXOPATHY FROM COMPRESSION FROM A CERVICAL RIB.

DESCRIBED THE FIRST OPERATION FOR TREATMENT.

WILBOURN (1984) – CLEVELAND CLINIC

A) VASCULAR FORM – SUBCLAVIAN OR AXILLARY
   (i) ARTERIAL VASCULAR TOS
   (ii) VENOUS VASCULAR TOS

B) NEURAL FORM
   (i) TRAUMATIC NEUROVASCULAR TOS
   (ii) TRUE NEUROLOGIC TOS
   (iii) NON-SPECIFIC TOS

WILBOURN

NON-SPECIFIC TOS

VARIANT OF SCALENUS ANTICUS SYNDROME

(A) LOWER PLEXUS TYPE (80%)

(B) UPPER PLEXUS TYPE (20%)

NON SPECIFIC THORACIC OUTLET SYNDROME CONTROVERSY

FERRANTE MUSCLE AND NERVE 2012

1. SOME REPORTS OF HIGH INCIDENCE – UP TO 8% IN SOME STUDIES.
2. FREQUENT BILATERAL OCCURRENCE.
3. LACK OF AGREED CLINICAL FEATURES.
4. DISAGREEMENT ABOUT WHETHER IT IS A NEUROVASCULAR DISORDER OR SOLELY NEUROLOGIC ONE.
5. LACK OF ADEQUATE EMG OR VASCULAR IMAGING ABNORMALITIES TO CONFIRM DIAGNOSIS.
6. DIAGNOSIS BY PHYSICIANS WITH LACK OF EXPERTISE IN THE DIAGNOSIS OF THE PERIPHERAL NERVOUS SYSTEM.
7. DEBATED SURGICAL INTERVENTION OUTCOMES FOR TREATMENT.

THORACIC OUTLET SYNDROME MAY ALSO BE ASSOCIATED WITH OTHER DISORDERS

- CTS
- VAGUE PAIN COMPLAINTS
- PSYCHIATRIC ISSUES
- PERSONAL INJURY LITIGATION AND POTENTIAL FOR SECONDARY GAIN

ANATOMY OF THE THORACIC OUTLET

SUPRACLAVICULAR FOSSA TO AXILLA.

INFERIOR ASPECT OF THE THORACIC CAGE COVERED BY THE DIAPHRAGM

THORACIC INLET – UPPER THORACIC CAGE

(A) INTERSCALENE TRIANGLE
- ANTERIOR AND MIDDLE SCALENES AND 1ST RIB

(B) COSTOCLAVICULAR SPACE
- BETWEEN CLAVICLE AND 1ST THORACIC RIB

(C) SUBCORACOID SPACE
- BENEATH PECTORALIS MINOR TENDON

CERVICAL RIBS

THE SEVENTH CERVICAL VERTEBRA IS TRANSITIONAL
THE SUPERIOR SURFACE IS LARGER THAN THE INFERIOR
ELONGATION MAY BE LARGE ENOUGH TO BECOME A RIB

0.5-2% POPULATION
MOST FREQUENT ON THE LEFT
THREE TIMES COMMONER IN WOMEN
CAN PRODUCE NEUROLOGIC AND ARTERIAL TOS

(ROOS 1996
MACKINNON 1996)

SUPRACLAVICULAR PLEXUS

- UPPER PLEXUS (C5/C6)
- MIDDLE PLEXUS (C7)
- LOWER PLEXUS (C8/T1)

CUTANEOUS DOMAIN OF THE LOWER PLEXUS

- ULNAR

  MEDIAL ANTEBRACHIAL CUTANEOUS (TO FOREARM)

  MEDIAL BRACHIAL CUTANEOUS (TO THE UPPER ARM)

  MEDIAN SENSORY TO THE THIRD DIGIT

ARTERIAL VASCULAR TOS

ANY AGE AND GENDER

COMMONER IN YOUNG ADULTS

USUALLY UNILATERAL

WILBURN CLEVELAND CLINIC 2001

OBSTRUCTION OF ARTERIAL FLOW WITH COMPRESSION:

1) BETWEEN ANTERIOR SCALENE MUSCLE
2) CERVICAL RIB
3) PROTUBERANT BONY PROCESS
4) DEFORMED 1ST THORACIC RIB

RESULTS IN:-

TURBULENT BLOOD FLOW

ANEURYSM

THROMBUS FORMATION

ARTERIAL VASCULAR TOS

FIRST DESCRIBED 1821 – SIR ASTLEY COOPER

COMPRESSION LEADS TO

- DECREASED BLOOD FLOW
- DECREASED CAPILLARY REFILL
- EXTREMITY COOLNESS
- REDUCED OR ABSENT DISTAL PULSE WHICH MAY ONLY OCCUR WITH UPPER EXTREMITY ELEVATION

MINOR COMPRESSION LEADS TO

- VAGUE PAIN
- FATIGUE
- COOLNESS
- LOSS OF COLOUR
- RAYNAUD'S PHENOMENON
- RARELY THROMBOSIS AND EMBOLISM TO DISTAL DIGIT OR VERTEBRAL CAROTID ARTERIES.

VENOUS VASCULAR TOS

RARE SPONTANEOUS THROMBOSIS SUBCLAVIAN OR AXILLARY VEIN

TYPICALLY UNDERLYING COMPRESSIVE ANOMALY

SUDDEN ONSET

ADULT ONSET OFTEN AFTER PROLONGED LIMB EXERTION

EITHER GENDER

UNILATERAL

MAY BE ONLY PARTIAL AND PRODUCED WITH LIMB POSITION

FIRST DESCRIBED J. PAGET 1875

PRESENTS WITH

- PAIN FROM CONCOMITANT NEUROLOGIC SIGNS SECONDARY TO THE PRIMARY VASCULAR CAUSE
- VARIABLE CYANOSIS
- DILATED VENOUS COLLATERALS TO THE SHOULDER AND UPPER CHEST

TRAUMATIC NEUROVASCULAR TOS

RARE

UNILATERAL

FOLLOWING CLAVICULAR TRAUMA USUALLY MID SHAFT FRACTURE

MORE COMMON IN ADULT MEN

SECONDARY NERVE AND VASCULAR FACTORS

USUALLY SUPRACLAVICULAR TRACTION INJURY

MAY BE ONLY VASCULAR OR NEURAL SIGNS

MAY BE DELAYED ONSET

MOST VULNERABLE AREAS

1. PROXIMAL AXILLARY VESSELS
2. CORDS OF BRACHIAL PLEXUS ESPECIALLY MEDIAL PRODUCING SENSORY ABNORMALITIES
   a) MEDIAL ARM (MEDIAL BRACHIAL CUTANEOUS NERVE)
   b) MEDIAL FOREARM (MEDIAL ANTEBRACHIAL CUTANEOUS NERVE)
   c) MEDIAL HAND AND ULNAR DIGITS (ULNAR NERVE)

MECHANISMS OF INJURY

A) COMPRESSION OR LACERATION BY FRACTURE FRAGMENTS
B) VASCULAR LACERATION HAEMATOMA OR ANEURYSM
C) IATROGENIC – FRACTURE MANIPULATION
(TIGHT FIGURE OF 8 BANDAGE)
A) DELAYED NEUROVASCULAR INJURY
- EXCESSIVE CALLUS FORMATION
- NON-UNION OF CLAVICLE

MEDIAL CORD HAS MOTOR C8/T1 FIBRES, THEREFORE INVOLVES ALL ULNAR INNERVATED MUSCLES AND ALL MEDIAN INNERVATED MUSCLES
EXCEPT PRONATOR TERES
FLEXOR CARPI RADIALIS (LATERAL CORD)

C8 RADIAL MOTOR NERVE FIBRES ARE SPARED (POSTERIOR CORD)

ACUTE PHASE

- PAIN
- TENDERNESS
- BRUISING
- SWELLING
- EXCESSIVE CLAVICULAR MOBILITY
- HAEMATOMA
- AUDIBLE BRUIT (PSEUDOANEURYSM)
- ARTERIAL AND VASCULAR SIGNS
- VENOUS COMPROMISE CAUSES OEDEMA
- DIMINUTION OR LOSS OF PULSE

CHRONIC CALLUS FORMATION

DIFFERENTIAL DIAGNOSIS

C8, T1 RADICULOPATHIES

ULNAR NEUROPATHY WITH MEDIAL CORD INVOLVEMENT

C7 RADICULOPATHY

RADIAL NEUROPATHY WITH POSTERIOR CORD INVOLVEMENT

SUPRACLAVICULAR BRACHIAL PLEXUS INJURY

DIAGNOSIS

MOTOR AND SENSORY NERVE CONDUCTION STUDIES
ELECTROMYOGRAPHY (EMG)
ULNAR SOMATOSENSORY EVOKED POTENTIALS (SSEP)

REINNERVATION OF THE MEDIAL CORD
INVOLVEMENT ONLY OCCURS THROUGH COLLATERAL SPROUTING WITH INTACT NERVES AND THEREFORE INCOMPLETE LESIONS

USUALLY OCCURS WITHIN SEVERAL MONTHS

TRUE NEUROLOGICAL TOS

RARE

YOUNG TO MIDDLE AGE PRESENTATION

PREVALENCE OF ONE IN A MILLION PERSONS (GILLIATT 1984)

FIRST REPORTED THOMAS AND CUSHING IN 1903

LESION INVOLVES C8/T1 LOWER TRUNK

THENAR MUSCLES PARTICULARLY AFFECTED

MOTOR SIGNS GREATER THAN SENSORY SIGNS

LATE PRESENTATION WITH WASTING (THORBURN 1905)

MAY BE CONFUSED WITH CTS

<u>BUT IN CTS</u>

a) HISTORY OF EPISODIC HAND TINGLING
b) LATER SENSORY LOSS
c) SPONTANEOUS TINGLING AT REST
d) SYMPTOMS PRECIPITATED BY UPPER EXTREMITY ELEVATION (DRIVING) AND RELIEVED BY LOWERING
e) AFFECT OF DOMINANT LIMB PREDOMINANTLY
f) RESTRICTION OF MOTOR ABNORMALITIES TO MEDIAN INNERVATED HAND INTRINSICS, NOT ULNAR OR RADIAL INNERVATED MUSCLES

NON-SPECIFIC TOS

ADULT ONSET

MORE COMMON IN FEMALES

FREQUENTLY BILATERAL

PROPOSED MECHANISMS

1. INHERENT PREDISPOSITION
   - CONGENITAL CERVICAL RIBS
   - ABNORMAL FIRST RIB
   - SCALENE MUSCLE DEFORMITY
2. TRAUMA
3. ABNORMAL POSTURE AND HABITUS
   - LONG NECK, DROOPY SHOULDERS (WILBOURN 1999 MULDER 1973 CAPRISTRANT 1977)

NON-SPECIFIC TOS

TRAUMA

- SINGLE EPISODE – WHIPLASH/DECELERATION CERVICAL SPINE
- CUMULATIVE TRAUMA INJURY

RESULTS IN:

a) SCALENE MUSCLE TRAUMA WITH SECONDARY FIBROSIS AND SCARRING
b) MUSCULOTENDINOUS LIGAMENT SPASM
c) SCARRING PRODUCING TRACTION ON THE BRACHIAL PLEXUS
d) REPETITIVE MOTION INDUCED MUSCLE DYSRHYTHMIA

(ELLISON 1994
WILBOURN 1999)

NON SPECIFIC THORACIC OUTLET SYNDROME

TYPICALLY SENSORY ABNORMALITIES OR SENSORY DIMINUTION INLOWER TRUNK DISTRIBUTION

MAY BE LIMB FATIGUE OR HEAVINESS

STUDIES HAVE REPORTED SENSORY COMPLAINTS IN 90% PATIENTS (SANDERS 1991)

UPPER PLEXUS TYPE: C5/C6

NECK OR SUPRACLAVICULAR PAIN RADIATING ALONG MEDIAL ASPECTS OF THE ARM, FOREARM AND HAND

LOWER PLEXUS TYPE: C8/T1

SHOULDER PAIN RADIATING TO THE IPSILATERAL NECK AND HEAD

ANTERIOR PLUS POSTERIOR UPPER THORAX

PROXIMAL ARM WITH WEAKNESS AND FATIGUE

(MACKINNON 1996

(WILBOURN 1999)

SENSORY SIGNS OFTEN MISSED EVEN BY THOSE WITH NEUROLOGY TRAINING

(LEDERMAN 1987)

(WILBOURN 1999)

OTHER SYMPTOMS AND SIGNS WITH NON-SPECIFIC TOS

1) EXACERBATION BY UPPER EXTREMITY USE, ESPECIALLY OVERHEAD OR UPPER EXTREMITY ABDUCTION
2) ORBITAL AND OCCIPITAL HEADACHE
3) SUPRACLAVICULAR TINEL SIGNS
4) FACIAL PAIN
5) FACIAL NUMBNESS
6) INTRINSIC HAND MUSCLE WEAKNESS
7) ANTERIOR CHEST WALL PAIN

(SANDERS 1991
MACKINNON 1996)

PROVOCATIVE TESTS

(a) ADSON – RADIAL PULSE PALPATED WITH PATIENT INSPIRATION. NECK HYPEREXTENDED HEAD TO SYMPTOM SIDE (ADSON 1951)

(b) COSTOCLAVICULAR TINEL SIGN

(c) ELEVATED ARM STRESS TEST (EAST) OR ROO'S TEST

ARMS SURRENDER POSITION, FOREARMS 90º, LATERAL ABDUCTION 90º, EXTERNALLY ROTATED, OPEN CLOSE HANDS EVERY 2 SECONDS

POSITIVE WITH SYMPTOM REPRODUCTION OR RADIAL PULSE REDUCED OR PATIENT HAS CLINICAL WEAKNESS

(WILBOURN 1999

ROOS 1966)

SOME STUDIES REPORT HIGH FALSE POSITIVE RATES WITH PARAESTHESIA AND PULSE ALTERATION

(PLEWA 1998)

MAY BE POSITIVE IN CTS

(d) WRIGHT MANOEUVRE

RADIAL PULSE PALPATED WHILE SYMPTOMATIC LIMB HELD OVERHEAD AND ABDUCTED TO 180º WITH ELBOW FLEXED WITH EXTERNAL ROTATION

POSITION MAINTAINED 60 SECONDS

POSITIVE – REPRODUCTION OF SYMPTOMS

(WRIGHT 1945)

(e) MILITARY MANOEUVRE – HALSTEAD TEST

RADIAL PULSE PALPATED WHILE THE PATIENT IS IN THE SHOULDER BRACED MILITARY POSITION WITH THE SHOULDERS HELD BACKWARDS AND IN A DOWNWARD DIRECTION (LEFFERT 1994)

INVESTIGATION

1) DOPPLER ULTRASOUND OF UPPER EXTREMITIES
   - EXPERIENCED RADIOLOGIST (STANTON 1988 SOBEY 1993)
2) CERVICAL X-RAY
3) MRI HIGH RESOLUTION NEUROGRAPHY (EXCLUDE SYRINX OR RADICULOPATHY) (MAGILL 2015)
4) CT ARTERIOGRAM
5) SHOULDER/BRACHIAL PLEXUS MRI
6) NERVE CONDUCTION STUDIES
   - REDUCED MEDIAN MOTOR AND ULNAR SENSORY
   - AMPLITUDE ON THE SYMPTOMATIC SIDE WITH POSSIBLE
   - DELAY OF F-WAVES
7) EMG TO RULE OUT RADICULOPATHY
8) ANTERIOR SCALENE MUSCLE BLOCK (SANDERS 1991)
9) VIBRATION THRESHOLD MEASUREMENTS (NOVAK 1993 BORG 1988)
10) TEMPERATURE THRESHOLD MEASUREMENTS

NOTE

OF THE 3 LESIONS THAT AFFECT BRACHIAL PLEXUS

1) DEMYELINATING CONDUCTION VELOCITY SLOWING
   - INFREQUENTLY SYMPTOMATIC
2) DEMYELINATING CONDUCTION BLOCK
   - NOT USUALLY PRESENT IN TOS
3) AXONAL LOSS. READILY IDENTIFIED WITH ROUTINE NERVE CONDUCTION TESTS
4) F-WAVES AND SSEP OF VARIABLE VALUE (KOMANTSKY 1996 WILBOURN 1996 FERRANTE 2004 FRENCH POLLACK GILBOUR MED J AUST 1991, 154-295)

RECOMMENDED ALL PATIENTS UNDERGO ELECTRODIAGNOSTIC TESTING PRIOR TO SURGICAL INTERVENTION

TREATMENT

1) UPPER LIMB THERAPY
   - LOUISVILLE PROTOCOL
   - POSTURE CORRECTION STRETCHING (NOVAK 1993)
2) DIETICIAN FOR OBESE PATIENTS
3) BREAST REDUCTION IF APPROPRIATE (LEFFERT 1992)
4) NEUROPATHIC MEDICATION
5) MUSCLE RELAXANT MEDICATION
6) RARE TO REQUIRE SURGERY
7) ANTICOAGULATION IN PRESENCE OF THROMBUS (MACKINNON 1996) (STANTON 1988) (CILERIT 1989)

SURGERY

REQUIRED FOR TRUE NEUROGENIC AND SIGNIFICANT VASCULAR TOS

1ST SCALENOTOMY (DIVISION OF ANTERIOR SCALENE MUSCLE) (ADSON, COFFEY 1927)

SCALENECTOMY (TOTAL MUSCLE REMOVAL) (ADSON 1947)

1ST RIB RESECTION (CLAGETT 1962)

TRANSAXILLARY APPROACH (ROOS 1996)

INFRACLAVICULAR APPROACH (LEFFERT 1994)

TRANSCLAVICULAR APPROACH (LUOMA 1991)

POSSIBLE TARGET STRUCTURES FOR SURGERY

1) INDIVIDUAL MUSCLES
   - ANTERIOR SCALENE
     MIDDLE SCALENE
     OMOHYOID

2) OSSEOUS STRUCTURES OR LIGAMENTS

3) FIBROMUSCULAR BANDS

4) DORSAL SYMPATHECTOMY

(MACKINNON 1996)

SURGERY IS CONTROVERSIAL

HIGH RECURRENCE AND COMPLICATION RATES

SURGICAL COMPLICATIONS

SEVERE DISABLING PAIN

NERVE TRANSECTIONS

- LONG THORACIC
  PHRENIC
  INTERCOSTAL BRACHIAL
  SUPRACLAVICULAR

BLOOD VESSEL RUPTURE AND DEATH

COMPLEX REGIONAL PAIN SYNDROME

(CHENG 1994)

(WILBOURN 1988)

(MELLIERE 1991)

SUMMARY

THORACIC OUTLET SYNDROME
HAS 5 DIFFERENT FEATURES
WITH DISCREET CLINICAL FEATURES
CLINICAL DIAGNOSTIC TESTS AND
SURGICAL AND NON-SURGICAL TREATMENT