THORACIC OUTLET SYNDROME

DR DAVID E CULLUM
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 SCALENUM 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
ARTHRIAL 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
   BRUIISING
   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

BUT IN CTS

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 SHOULDER (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 IN LOWER 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 90°, LATERAL ABDUCTION 90°, 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 180°
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 SHOULDERS 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

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 SCALENOMY (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