BRACHIAL PLEXUS

Etiology

Generally caused by MVA in adults.
Generally males aged 15 to 25 years old.

Naracas: Rule of "seven seventies.
70% occur secondary to MVA;
70% involve motorcycles or bicycles.
70% have multiple injuries.
70% have supraclavicular lesions
70% have at least one root avulsed.
70% with a root avulsion also have avulsions of the lower roots (C7, C8, orT1).
70% will have persistent pain.

If head is rapidly forced away from shoulder the injury is generally at C5,C6.
If arm is rapidly abducted the lesion is generally at C8-T1.

Brachial Plexus Anatomy

Brachial plexus is formed from C5, C6, C7, C8, and T1 nerve roots.
There may be contributions from C4, and T2. A plexus with contributions from C4 is called "prefixed." (28% to 62%). "Postfixed" = contributions from T2 (16% to 73%).

Types of Lesions [Leffert]

I – Open
II – Closed: Supraclavicular Preganglionic or Postganglionic
Infraclavicular
Trunk injury: Upper – biceps and shoulder
Middle - wrist and finger extension
Lower - wrist and finger flexion
III Radiation
IV Obstetric: Erb, Klumpke, Combined

1. Avulsion of the T1 root (a pre-ganglionic injury) Horners syndrome
   Interrupts the T1 sympathetic ganglion causing Horner's syndrome
   Miosis (small pupil), enophthalmos (sinking of the orbit), partial ptosis (lid droop), and anhydrosis (dry eyes).
2. Avulsion of the upper roots: Serratus anterior and rhomboids are involved

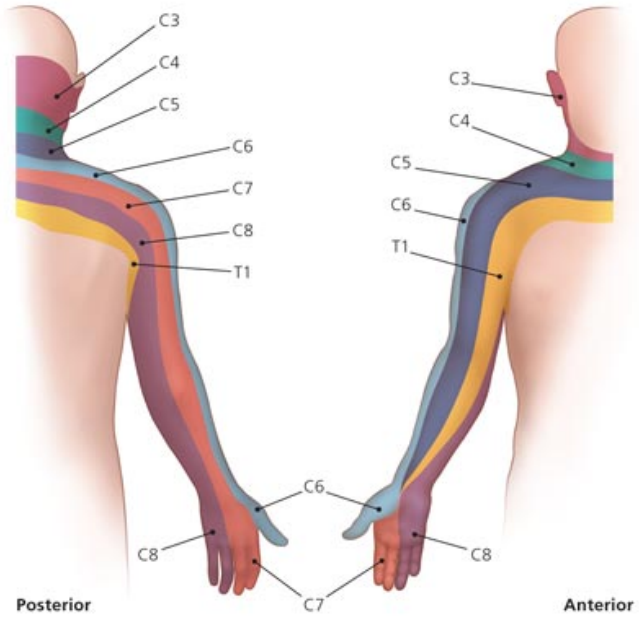
Motor Supply

Upper trunk = C5, C6 = rhomboids, deltoid, infraspinatus, brachioradialis.

Middle trunk = C7 = pronator teres, extensor carpi radialis

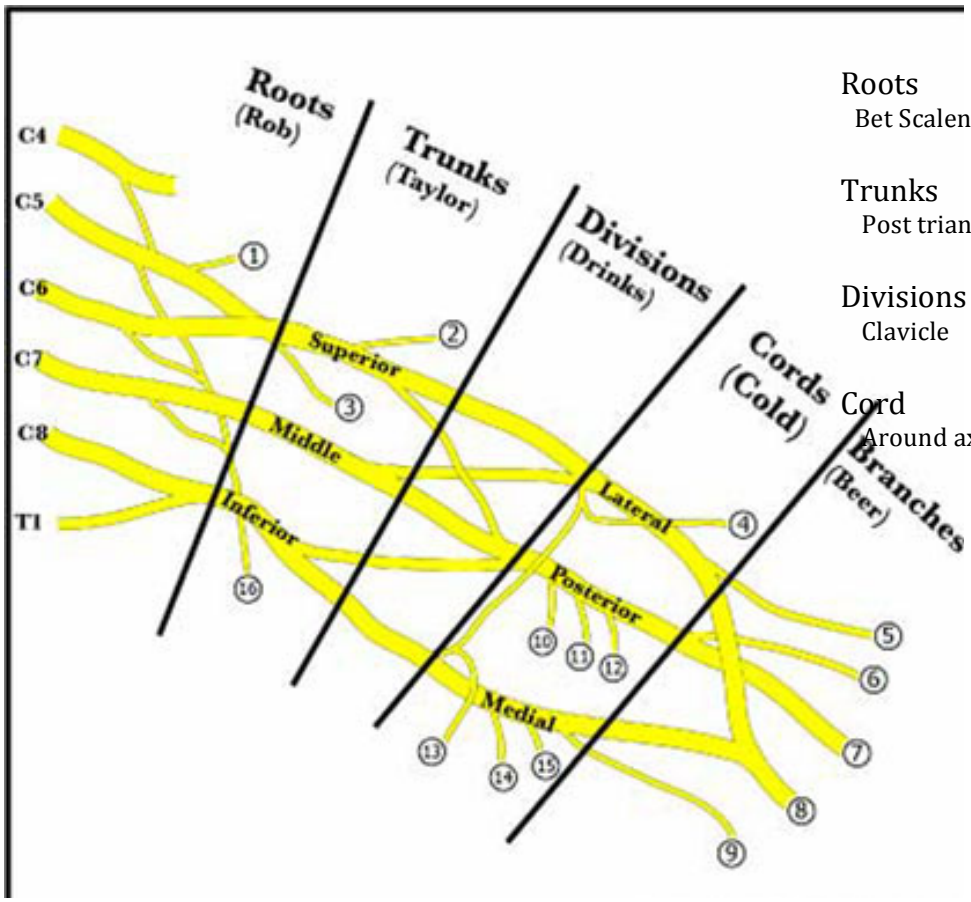
Lower trunk = C8 = extensor carpi ulnaris, flexor carpi ulnaris, flexor pollicis longus.

Radicular



C6	Thumb
C7	Middle finger
C8	little finger
T4	Nipple level
T10	Umbilicus
T12	Symphysis
L4	Medial ankle
L5	Medial side of foot
S1	Lateral board of foot
S2	Sit

Brachial Plexus



Roots
Bet Scalene

Trunks
Post triangle

Divisions
Clavicle

Cord
Around axillary A

1. Dorsal scapular N 2. Suprascapular N 3. N to subclavious 7

Post cord Upper subscapular N [10]; Thoraco-dorsal N [11]; Lower subscapular N [12];
Axillary N [6]; Radial N [7] Mnemonic UTLAR

Medial cord: Medial pectoral N [13]; Medial N of the arm [14]; Medial N of forearm[15]
Medial branch of Median N [8]; Ulnar N [9]

Lateral cord: Lateral Pectoral N [4], Musculoskeletal N [5], Lateral branch of median N [8]

N to serratus anterior [16]

Types of nerve lesion

1. Root avulsion [avulsion] Preganglionic
2. Root rupture [rupture] Postganglionic

In relation to dorsal ganglion: C5,6,7 = Rupture is more common
C8, T1 = Avuslion is more common

Both are Traction injury to the plexus

Brachial Plexus Clinical Evaluation

1. Often involves poly trauma patients. EMST
2. Motor and assessment as per neurological sheet.
3. Preganglionic Vs Postganglionic lesion

a. Horner's syndrome, (miosis (small pupil), enophthalmos (sinking of the orbit), ptosis (avulsion at the C8-T1 level.

b. Long thoracic nerve: formed from the roots of C5-C7. Innervates the serratus anterior muscle.

c. Dorsal scapular nerve: Formed from C4-C5. Innervates the rhomboid muscles. Injury indicted by atrophy of the rhomboids and parascapular.

4. Trunk SSN	SS, Infraspinatus: Look for rotation
Post cord	Deltoid: Look for Abduction and flexion
	Belly press
	Lats : cough
	Triceps: elbow and wrist extension
Lateral	Biceps and Pectorals
Medial	Wrist : Flexion and extension
	ROM of wrist
	Finger: abduction and adduction

5. ROM: neck, shoulder, elbow and hand

Attitude, Scapular winging, Tinel's sign

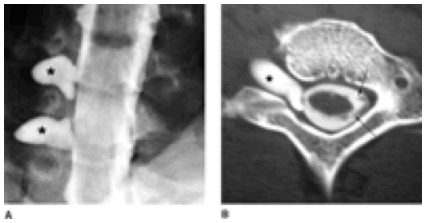
Preganglionic or Postganglionic

1. Horner's syndrome
2. Involvement: of Dorsal scapular N, Serratus Anterior palsy, Phrenic N palsy
3. Tinel's sign absent in preganglionic
4. Sensory involvement: SSEP is present in Preganglionic
5. Pseudomeningocele on CT or MRI
6. EMG: Paravertebral denervation
7. Normal axon reflex [Preganglionic]

Investigations

1. C-spine, shoulder (anteroposterior and axillary views), and chest views indicated. Clavicle or rib fractures (first or second rib) suggest brachial plexus injury.

2. CT with myelography: helping to define the level of nerve root injury. Root avulsions appear as pseudomeningoceles on CT myelogram done 3 to 4 wks



3. MRI: may show: large neuromas after trauma or associated inflammation or edema, mass lesions in patients with spontaneous nontraumatic neuropathy.

4. Electrodiagnostic

a. EMG : Denervation changes (ie, fibrillation potentials) is seen within 2 weeks;
In 3weeks: Reduced recruitment of motor unit potentials:
Reinnervation: The presence of active motor units on volitional activity

EMG: Pre or Post ganglionic:

1. cervical paraspinals, rhomboids, serratus
2. Sensory nerve action potentials: SNAP is preserved preganglionic although sensation is absent.

.b. Intraoperative electrodiagnostic studies

Surgical decision : Neurolysis Vs bridging graft is routinely used.
Nerve action potentials (NAPs) and SSEPs, CMAPs. NAPs allow the surgeon tc months before conventional EMG techniques would demonstrate activity and to determine whether a lesion is neurapraxia (negative NAP) or axonotmesis (positive NAP).

Treatment

1. Physical therapy should be started immediately to prevent contractures

2. Sharp open injuries: Immediate exploration and primary repair of the injured

portion of the brachial plexus is indicated.

3. Low-velocity gunshot wounds: should be observed because most are neurapraxic brachial plexus injuries.

4. High-velocity gunshot wounds: controversial, consider surgical exploration depending on amount of soft tissue injury.

5. Stretch injuries: Exploration/reconstruction indicated if no/inadequate reinnervation has occurred 3 to 6 months after injury.

Early exploration/reconstruction (3-6 weeks) is indicated for root avulsions.

Results from delayed (6 to 12 months) or late (>12 months) surgery are poorer because the time for the nerve to regenerate to the target muscles is greater than the survival time of the motor end plate after denervation.

Primary surgical options

Immediate	Open injury
Early	Within first 3 weeks Is preferred in avulsion as recovery is unlikely No point in waiting for observation
Delayed	Partial injury or postganglionic Allow time to recover. At 3 months: Use NAP Then decide, Neurolysis or Nerve graft

Surgical Priorities

(1) elbow flexion,
(2) shoulder stability,
(3) protective hand sensation,
(4) stable wrist extension,
(5) dynamic finger flexion,
(6) intrinsic hand function.

Type of Surgery

a.Post ganglionic:

a. Direct repair: Seldom in traction injury

b. Sural N graft

c. Vascularized nerve graft : Ipsilateral vascularised ulnar N

d. Nonvascularised nerve graft or neurotization

b.Preganglionic:

Neurotization is better for C5 & 6 than C8 & T1.

Accessory N	to	SSN
Phrenic	to	Axillary N
Intercostal IV,V,VI	to	MCN

Results

1. Long observation. 12 months
2. Best results: Shoulder 50-80° abduction

Usually Grade III or IV in 98% in the shoulder

in 70% in the elbow

Neurotisation:

Spinal accessory: 70% Grade 3 and 20% Grade IV [SSN]

Intercostal neurotisation: 60%

Failure rate is high with any surgery after 6 months: due to motor plate degeneration.

Merrell evaluated the results of 1,088 nerve transfers in 27 studies to determine the outcome of nerve transfers of the shoulder and elbow. For restoration of elbow Flexion. Overall, 70% : MCN achieved M3 flexion.

Free Muscle transfer

When?

1. Patients who presented late (>12 months after injury)
2. As a salvage procedure in those who had failed earlier nerve reconstruction.

Which muscle?

The latissimus dorsi (thoracodorsal nerve),

The rectus femoris (femoral nerve),

The gracilis (anterior division of the obturator nerve).

Secondary Reconstruction

1. Tendon transfer
2. Free functioning muscle transfer
3. Arthrodesis may be useful for shoulder and wrist
4. Humeral rotational osteotomy,
5. Thumb axis arthrodesis,
6. Bone-block opponensplasty, or
7. Finger joint arthrodesis, can improve function.

To improve flexion at the elbow

Clarkes Transfer

A. Pectoral major to biceps

B. Lats transfer

C. Steindler Transfer – proximalisation of the flexor origin allow a degree of pronation on elbow flexion

D. Triceps to biceps transfer – not if there is good shoulder function of the patient is dependent on the arms to mobilise.

Prognosis

1. Favorable: Low energy trauma [Shoulder dislocation]: good
   Avulsion: High velocity injury: Poor
2. Age: Age >50 year
3. Type pain: early neuritic and Paraesthesia, prognosis is poor
4. Pre Vs Post: Postganglionic prognosis is better
5. Duration: Injury more than 6 months and no recovery. Poor prognosis
6. Upper roots better than lower [cf. Erbs]
7. Intraplexus donor neutrotization [Ulnar nerve] better than extraplexus
8. Some extraplexus neurotization gives better results: ICN to Mus Cut N and Acc

References

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