IC09-L: Management of Pan-Brachial Plexus Injuries: A Global Perspective

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Session Handouts

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Complete Paralysis of the Brachial Plexus
Global Perspective

Priorities – Desirable x Achievable

- Pain Control
- Shoulder Control
- Elbow Flexion
- Elbow Extension

Graft Roots Eligibility

- C5: 85% (2006), 70% (2021)
- C6: 35% (2021), 40% (2006)

Clinical Exam

85% of the patients with complete paralysis of the Brachial Plexus pain is neurophatic rather than resulting from deafferentation. Complete avulsion of all roots is very rare (1 in 42 patients submitted to drezothomy). Immediately after root grafting pain subsides in 50% of the patients.
In 222 patients, 85% M3-M4 and full ROM

Sensory Recovery Following Root Grafting to the Musculocutaneous Nerve

Nerve Transfer
XI to SS

Extended Lesions of the Suprascapular Nerve

Suprascapular Nerve Dissection in the Suprascapular Fossa

Right Suprascapular Fossa

Shoulder Dislocation
Acromio-Clavicular Dislocation
Clavicle Fracture
Scapular Fracture
Extended Lesions of the Suprascapular Nerve

Suprascapular Nerve Dissection in the Suprascapular Fossa
Dr. Jayme A Bertelli

Accessory Nerve Dissection

110 patients
Average 60M 60°
80% > 30°

Long Thoracic Nerve Transfer to Triceps Long and Upper Medial Head Motor Branches

44 patients with C5 and C6 available
75% M3-M4

Elbow Extension Reconstruction

Two stages free gracilis transfer for finger flexion reconstruction
The Global Perspectives on Pan-plexus Brachial Plexus Injury
Dominic Power (UK)

Pan-plexus injuries result in total loss of upper limb function and, in most cases, lifelong neuropathic pain. Surgical strategies aimed at restoring some limited functions are complex, often multiple and staged over several years and require prolonged rehabilitation. Surgical advances have improved the reconstructive potential, however the functions that can be achieved remain poor and for many patients there is no useful recovery of bimanual activity due to muscle weakness, fatigue, loss of fine motor control and a lack of useful sensation.

The nature of nerve injuries is that prompt recognition and early surgery is necessary for a useful functional recovery. Patients with brachial plexus injuries in the UK often have polytrauma, associated injuries including spinal fractures and head injuries that may preclude early surgery or limit patient understanding of the complex interventions proposed and outcomes may be compromised by poor engagement with rehabilitation programmes.

Brachial plexus injuries are challenging to assess. Regional centres should be available to provided support to local trauma services. Rare, complex injuries requiring specialist input for reconstruction fulfil the requirements of the GIRFT (Getting it right first time) initiative in the UK, however there is a delay to implementation and in the absence of provision of specialist centres in the UK, local services have developed to serve the needs of the population.

Commissioning of NHS services is a challenge to developing new services. There is no recognition of the funding required to support complex reconstruction surgery services and as such development of new services creates local challenges as the services are not deemed to be cost-effective.

In the UK the numbers of cases of BPI are fewer than 500 with around 350 supraclavicular currently provided by more than 15 units. There is no data sharing mandated and not national injury reporting. This creates further variations in strategy that make collecting evidence-based outcomes for research impossible.

In my own unit I see all referrals on the wards or through urgent outpatient appointments in a designated brachial plexus and PNI clinic with the multi-professional team. The case is discussed within an MDT and the surgical strategy is formulated and adjusted based on the intra-operative findings. Typically, two consultants are involved in each operation and in the decision making.

Prior to surgery most patients have a special sequence MRI, some have neurophysiology but not all, especially if there is a clinical suspicion of a multi-root injury. Intra-operative SSEPs are not used.

In the presence of a C5 rupture this, if deemed good quality, may be directed with grafts to the anterior division of the upper trunk. The aim is restoration of elbow flexion and later shoulder arthrodesis. The XI nerve may be reserved for a FMT later to augment elbow flexion. In the 5-root avulsion, the XI may be directed to the musculocutaneous nerve with grafts and
intercostal nerves to triceps. Sensation may be recovered through supraclavicular and lateral intercostal nerve grafted to the lateral head of the median nerve.

Outcomes are generally poor. The arm will have limited function however, pain can be mitigated through some form of functional restoration.

Rehabilitation is lengthy with often multiple surgeries staged over 2-3 years. After elbow flexion returns, the shoulder is fused. If there is useful elbow flexion the FMT transfer can be directed to finger flexion.

Assessing outcomes should be standardised. The COMBInE study has provided a core outcome data set for assessment of brachial plexus injuries through patient therapist and surgeon consultation and a Delphi consensus. The BrAT is the preferred PROM for outcome assessment. MRC motor grade is still important for surgeon assessment of reconstruction success.

Pain management remains a challenge. A multi-professional and multi-modality approach is advised, however services in the UK are not cohesive and will require funding through specialist commissioning to further develop.

The future will include nerve-computer interfacing through TMR and RPNI to enable prosthetics and exoskeletons to augment limited function.

Collecting and sharing outcomes will enable the evidence-base to develop and prioritisation of clinically effective interventions. There is however variation in demographics and functional demands that will limit translation of all techniques to all territories.
Management of Pan-Brachial Plexus Injuries: The Chang Gung (Taiwan) Experience

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Demographics: Taiwan

• BMI (19-44 y/o): male 24.5 ± 0.3, female 23.0 ± 0.3
  (45-64 y/o): male 25.0 ± 0.2, female 24.0 ± 0.2

• National Health Insurance: affordable
• Travelling: driving, train, airplane
• Direct referral (no primary care physician)
• Rehabilitation convenient

Panplexus Strategy at Chang Gung Memorial Hospital

1. Exploration of Brachial Plexus
2. Donor nerves selection
   • Flexibility in your choice of donor
   • Location, location, location
3. Recipient nerves choice: Shoulder, Elbow, Hand
4. FFMT as backup (reserve donor nerve and recipient vessels)
Spinal Nerve: Rupture vs Avulsion

Non-usable Stump

Usable Stump


Level I Root Evaluation: Severity Grading

Chang Gung - Mayo Clinic

• 200 consecutive total paralysis patients
• 2 centers (US, Taiwan)
• Demographics, Mechanism, Nerve root

Manuscript in preparation

Total Brachial Plexus Palsy

• Priorities
  1. Elbow Flexion (MCN): VUNG (spinal nerves), ICN
  2. Shoulder movement (distal C5): Ph, Cervical, XII, ID
  2. Hand movement + Sensation (MN): VUNG (spinal nerves), FFMT
  3. Elbow and Wrist/Finger extension (PD of UT or RN): Ph, Cervical, ICN, ID

Proximal targets, like the anterior division of the upper trunk, should be avoided.

Vascularized Nerve Graft
- Extend abundant axons from root to distal targets
  - Survival of Glial Cells, Endoneurium
  - Structure
  - Immune system: macrophages, VEGF
- Direct Perfusion of Nerve Graft:
  - Immediate
  - Both ends of the graft vascularized

VUNG based on Superior Ulnar Collateral Artery

Ulnar Nerve and its vascular supply

Injured Side
- Healthy Side
**Shoulder Abduction and Flexion**

Donor: Phrenic nerve
Target: Suprascapular nerve (or Dorsal CS)

**Elbow Flexion with Forearm Supination**

**Finger Movement with Grip of Object**

**Daily Activities**
Shoulder (–) Elbow (–) Wrist and Finger flexion and extension (–)

25

Injured Side
Healthy Side

26

27

28

29

30

C7 dermatome mild numbness, No major motor deficit
Post Left CC7 (ant and post division) transfer
Chang Gung Michigan: Accelerometry

- 29 plexus patients: 12 (41%) had total root avulsion
  - 16 (55%) used CC7 as donor, 11 (38%) used Ipsilateral C5 as donor.
  - 96.5% ≥ MRC 3 elbow flexion, 82.7% ≥ MRC 2 finger flexion
  - 48.3% achieved ≥60 degrees shoulder abduction
  - 48.3% achieved ≥ MRC 2 elbow extension

- VT: 0.54 ± 0.14 (range 0.32 to 0.85); 55% had VT > 0.50
- VM: 0.30 ± 0.13 (range 0.16 to 0.71)

- No significant correlation found between VT and:
  1. MRC of elbow flexion, finger flexion or shoulder abduction
  2. the type of surgical strategies

- Patients with CC7 did not fare worse than Ipsilateral donors in VT