Brachial Plexus Injury Awareness

GUIDELINES FOR THERAPISTS:
Treating Children with Brachial Plexus Injuries

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The reported incidence of birth related brachial plexus injuries vary greatly from 2-5 out of 1000 births. Of these, 80%-90% eventually resolve spontaneously. Other causes of brachial plexus injuries include: automobile, motorcycle, boating accidents; sports injuries ("burners" or “stingers"); animal bites; gunshot or puncture wounds; as a result of specific medical treatments/procedures/ and surgeries or due to viral diseases.

The brachial plexus consists of cervical nerves five through eight and thoracic nerve one. Upper brachial plexus palsy (C5-C7), or Erb's palsy, is the most common. The arm is extended, the shoulder internally rotated and adducted, the forearm pronated, and the wrist and fingers are flexed. Paralysis of the deltoid, supraspinatus, infraspinatus, teres minor, biceps, brachialis, brachioradialis, supinator, wrist extensors, and finger extensor muscles places the arm in the "waiter's tip" position. Klumpke's palsy results from pure lower plexus injury (C7-T1) and is rare. The arm is flexed, and the shoulder is in a relatively normal position: the forearm is supinated, and the wrist and fingers are flaccid. Horner's syndrome is usually present. Paralysis of the triceps, wrist and finger extensor and flexor muscles give the arm a posture resembling that resulting from a cerebral vascular accident.

There are four nerve injuries that can occur. An **avulsion** in which the nerve is torn from the spine is the most severe injury. A **rupture** is when the nerves are torn at either one or several places in the plexus. A **neuroma** is **when a partially ruptured nerve** has tried to heal itself, but scar tissue has grown around the injury. The scar tissue puts pressure on the injured nerve and as a result the nerve cannot conduct signals to the muscles. A **praxis** injury is when the nerve has been stretched due to tension from the pull on the neck and shoulder. Stretch injuries will spontaneously recover up to 1-2 years of age with 90-100% return of function in the arm. Scapula winging is common in brachial plexus injuries due to weakened scapula muscles. It is important to maintain scapulo-humeral mobility through scapular stabilization to reduce winging.

Recovery of the arm once a brachial plexus injury has occurred is:

Scapula elevation/depression, protraction/retraction 0-3 months
Finger Flexion/Extension 0-3 months
Wrist Flexion/Extension 0-3 months
Shoulder Flexion/Abduction 45-90 degrees 0-4 months
Elbow flexion with arm pronated initially 0-4 months

Elbow Extension 0-5 months
Shoulder Flexion/Abduction 90-160 degrees 4-8 months
Shoulder External Rotation 8-12 months
Supination 10-15 months

This is a general observation of return in a stretch injury. More mild injuries can recover at a faster rate, however it is those injuries in which movement has never returned or those that seam to have plateaued which require immediate surgical intervention. If the baby's arm is totally flaccid for 2 months of life surgery is recommended as soon as possible.

If the child regains most of the function of the involved extremity careful attention must be noted, as the child grows, to the shoulder and scapular area due to muscle shortening from soft tissue adhesion and muscle imbalance which may require secondary surgical intervention.

- Remember each child's nervous system and injury are different so depending on what nerves are damaged is what muscle function you will see.

- If you do not see continuous progression of active movement in the involved extremity there is a strong possibility that nerves are ruptured or avulsed and an **immediate referral to a brachial plexus specialist (such as Texas Children's Hospital) for evaluation** of need of surgery. An EMG is an important preliminary test used to determine what nerves are involved. Preferred primary surgery age is 3-7 months for best prognosis. Secondary surgical procedures can be done on children 12 months and older.

Neurosurgical techniques for repairing damaged neural elements include external neurolysis (neuroplasty), internal neurolysis, nerve graft, neuroma dissection and removal and direct end to end nerve anastomosis. In case of avulsion an intercostal to musculocutaneous nerve graft can be done providing free muscle surgery when above neurosurgical techniques do not take. The "**C7 Transfer**" is being used to increase hand function.

Other new surgeries are being performed and their post surgical protocols may vary. **The secondary surgery called the "Mod Quad" (performed at Texas Children's Hospital) is a technique** which involves five procedures which improves shoulder function in even older children who did not receive any of the abovementioned primary surgeries.

(Please note that the following recommendations are generalized. Specific instructions should come directly from the surgeon who performed the surgery.) Two weeks after a nerve graft surgery, parents are instructed to resume gentle PROM exercise. If the child has had neurolysis surgery, parents are instructed to resume gentle PROM exercise immediately after surgery. The child may resume therapy 4 weeks after a nerve graft surgery with weight bearing activities being included in 6-8 weeks; and 2 weeks after neurolysis surgery with weight bearing activities 3-4 weeks after surgery beginning with prone on elbow and progressing accordingly. Do not put weights on involved extremity at this time. Regeneration of nerves may be noted at 9-12 months after surgery with only minimal return of motion to involved musculature before this time. Scar

massage is to be performed one month after surgery once steri-strips have fallen off. Scar massage can be performed before ROM exercises or any time throughout the day. If scar on the leg goes down to the ankle, PROM of the ankle in all motions can be performed to maintain flexibility.

With the "Mod Quad" surgery the arm is immobilized in an Statue of Liberty (SOL) splint for 6 weeks 24 hours a day, then the splint is worn for a second 6 weeks at night only for children 2 years and older; and 4 weeks for children 2 years and younger. During the second 6 or 4 weeks scar massage, gentle PROM and no resistance active movement is allowed to the involved extremity. Full-body weight-bearing activities are not allowed until after the 12-week time frame is past. Then a strengthening program is recommended. Electrical stimulation and water therapy are highly effective means of strengthening muscle groups at this time.

Muscle transfers may be performed if a child is past desired age for optimum recovery from primary surgery. Muscle transfers are usually not performed before the child is 4 years old or later**. A new muscle transfer (done at Texas Children's Hospital) to increase supination is called the "Pronator/Teres Transfer."**

Some precautions or problems to be aware of are shoulder or elbow subluxations, frozen shoulder, and soft tissue/joint contractures.

Some children with severe sensory loss in the hand may experience regeneration later on which causes them to bite or pick at the skin. A neoprene glove can be used to protect the hand from skin damage.

When evaluating these children note any broken bones and the extent of passive and active range of motion, sensation, strength, and achievement of developmental milestones.

Treatment techniques should include the following:

- Provide patient's parents with home program PROM sheets
- Begin gentle PROM exercise in supine to increase joint flexibility and muscle tone
- 2-3 daily PROM x 10 reps in all motions
- Provide tactile stimulation to involved extremity using various textured materials, koosh balls, vibration and massage to increase sensory awareness of that extremity in overall body scheme
- Joint compression/weight bearing throughout involved extremity to increase proprioceptive input/muscle co-contraction
- Active use of involved extremity using a variety of developmentally appropriate activities to increase strength and coordination beginning in gravity eliminated then advance to against

gravity

- Always include bimanual/bilateral motor planning activities
- Pool therapy
- Theraband, tubing or Theraputty and light weights can be used for resistive exercises
- Electrical Stimulation can be used after an EMG has been performed providing the therapist is trained in pediatric protocols. Limitations to E-stim are many children cannot tolerate it and it may not have long term effects.
- Therapeutic Electrical Stimulation (TES) which is low level sensory stimulation applied to the muscle during sleep to prevent disuse muscle atrophy by encouraging muscle growth. Limitations include: Must be supported by therapist trained by Mayatek, difficult to get insurance to cover cost of unit, long term commitment from parents.
- If frozen shoulder or contractures are present, place hot pack on tightened musculature for 10-15 minutes followed by massage/myofascial release then resume passive stretching.

Positioning / Splinting:

- Place baby on back or sidelying with involved extremity pointing up. Do not pick up baby under armpit.
- Do not hold arm in elbow flexion on top of chest by restraining it for long periods of time (i.e. slings), although placing arm while feeding or resting in this position is acceptable to not let arm dangle in space. The only time slings are used is if the child is up and walking around with a totally flaccid extremity and there is concern of subluxation or injury. If a sling is used it should only be for short periods of time.
- For a flaccid hand/wrist, a resting hand splint should be provided to maintain hand in a proper functional position and for protection secondary to deficits in sensory nerves. A dorsal wrist cock up splint should be fabricated for the hand that has limited wrist extension but active finger movement to increase an active grasp.
- Dynamic splints are recommended for elbow contractures i.e. Ultraflex or Dynasplint.
- BENIKS also carries a line of neoprene splints for the hand and elbow.
- Smith Roylan carries the TAP splint to increase supination.

Air Splints:

- May be used on involved extremity to allow for stability in elbow extension to bear weight on involved arm to crawl
- May be used intermittently on uninvolved arm to immobilize it to allow involved arm to move actively without assistance
- Precautions: watch for circulatory changes, numbness or swelling
- Air splints can be ordered from Flaghouse or Sammons catalog for pediatric sizes

Instruct parents to always include bilateral upper extremity (BUE) in play, to use uninvolved arm as a guide to allow involved arm to experience everything that the other arm is doing, to always offer toys, food, or any other objects to involved arm first, to allow child to reach and grasp objects in a place where he/she can succeed to obtain these objects and then slowly increase the range to avoid frustration which leads to increase levels of motivation to use that arm.

Do not allow child to use compensatory movements especially in the trunk to obtain desired objects when reaching.

Children are extremely adaptable and will always try to use uninvolved extremity to perform the tasks. It will require constant verbal/tactile cuing to reprogram the child to use the involve arm spontaneously so BE CREATIVE!

Overuse Syndrome:

Overuse Syndrome is characterized by discomfort or pain in the muscles, tendons, and other soft tissues, with or without physical signs. Symptoms are fatigue, muscle discomfort, stiffness, soreness, aches/pain, burning sensation, weakness, numbness and tingling. There has been a proposed link between muscle damage, the intensity of exercise, the number of motor units available and destroyed, and the duration of exercise that can cause overuse syndrome. The goal of therapeutic exercise is to prevent problems associated with disuse and immobility while preventing exercise induced muscular weakness. Always start strengthening program at a very low level of intensity not to cause fatigue or pain. Determine what intensity level patient can tolerate and begin with half the reps and double rest periods if needed. Always explore energy conservation strategies and ergonomic technology as needed. Aquatic programs are excellent to minimize overwork, relieves pain and improves general body conditioning.