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Obstetric Brachial Plexus Palsy: An Overview of Examination and Intervention Principles

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Objectives

As a result of this course, participants will be able to:

1. Accurately discuss the pathophysiology underlying OBPP.
2. List three maternal or child-centered risk factors for OBPP.
3. Identify four appropriate tests and measures to be used in the physical therapist examination of a child with an OBPP.
Objectives

As a result of this course, participants will be able to:

4. List three effective interventions for a child with OBPP.
5. Describe at least three ways in which an OBPP may impact function as a child grows from infancy into adulthood.
The Brachial Plexus

- Includes both motor and sensory nerves
- Formed by the intercommunication of the 5 ventral rami or roots from C5–T1
- These 5 roots merge to create 3 separate trunks:
  - The superior trunk (upper C5-C6)
  - The middle trunk (C7)
  - The inferior trunk (lower C8-T1)

The Brachial Plexus

- Each trunk divides into 2 parts, forming 6 divisions
  - The anterior or posterior superior, middle, and inferior trunks
- These trunks then regroup into 3 cords that are classified according to their relationship to the axillary artery.
  - The posterior cord (C5-T1) is comprised of the posterior 3 trunk divisions
  - The lateral cord (C5-C7) is formed by the anterior divisions of the upper and middle trunks
  - The medial cord (C8-T1) is made up of the anterior division of the lower trunk
The Brachial Plexus

- The nerves in the brachial plexus provide the motor and sensory innervation for almost the entire UE
  - Exceptions: motor innervation of the trapezius and levator scapulae muscles and sensation in the axilla or armpit region

OBPP

- Most frequently occurs as the result of traction or stretching of the brachial plexus during a vaginal delivery
  - In the birth canal, when the baby is in the typical, head down or vertex delivery position, forceful rotation or pulling on the head may result in injury to the brachial plexus
  - Shoulder dystocia (difficult delivery of the shoulder) may also pull on the nerves of the brachial plexus
OBPP

The extent of injury in OBPP ranges from neuropraxia (a temporary nerve conduction block due to a stretch of the nerves) to a complete avulsion in which the nerve root or roots are forcefully torn away from the spinal cord.
OBPP

- The reported incidence varies from .15 to 2.54 per 1000 live births
- Risk factors include
  - Increased birth weight
  - Shoulder dystocia
  - Maternal diabetes
  - Prolonged or difficult labor
  - Breech delivery
  - Vacuum or forceps assisted delivery

Upper OBPP: C5-C6 (possibly C7)

- Most common
- Often referred to as Erb’s palsy
- The involved upper extremity is typically held in a “waiter’s tip position”
  - Shoulder adduction and internal rotation
  - Elbow extension
  - Forearm pronation
  - Wrist and fingers flexed
Upper OBPP

On occasion, C4 and consequently the phrenic nerve may also be involved in upper OBPPs and can result in ipsilateral paralysis of the diaphragm.

Lower OBPP: C7-T1

- Results in intact proximal musculature at the shoulder and elbow but paralysis of the wrist flexor and extensor muscles and the intrinsic muscles of the hand
  - Often known as Klumpke’s palsy or lower OBPP
- Children with lower OBPPs often hold the involved forearm in supination and demonstrate a poor grasp on the involved hand.
Total OBPP: C5-T1

- Results in total arm paralysis and loss of sensation
  - Often called Erb-Klumpke palsy
- The degree of initial involvement in total OBPP injuries often diminishes
  - Total loss becomes more focused in areas innervated by the upper cervical roots
- The pattern of loss in total OBPP injuries does not always fit into definitive categories
  - Relates to the intercommunication and mixing of the nerve roots in the brachial plexus
Horner’s Syndrome

- Results from the loss of the sympathetic nerve inputs provided through the T1 nerve root
  - Children with Horner’s syndrome may exhibit decreased sweating, abnormal pupillary contraction, and ptosis (droopy eyelid)
Prognosis

- Early studies reported rates of recovery as high as 92%
- Recent studies have suggested lower rates of full recovery ranging from 66 to 73%

Prognosis - Hoeksma et al 2004

- Sample of 56 children with OBPP
  - 19 of the 56 subjects (34%) achieved early full neurologic recovery within the first 3 weeks of life
  - An additional 18 of the subjects (32%) achieved full neurologic recovery between 1.5 and 16 months of age (mean age of assessment 6.5 months)
  - The remaining 19 subjects (34%) had not achieved full recovery at 3 years of age
Prognosis - Hoeksma et al 2004

- Best predictors of a full neurologic recovery
  - Recovery of shoulder external rotation and supination
- No association found between initial symptoms and total neurologic recovery
  - Prognosis for recovery could not be made based on an infant’s initial presentation of symptoms (such as Horner’s syndrome, total plexus involvement, phrenic nerve involvement, etc)

Activity Limitations

- Those who do not achieve early full recovery or do not ever achieve full recovery may develop activity limitations that increase as the child develops
  - Difficulty reaching, grasping, and manipulating objects
  - Bi-manual skills requiring the use of 2 hands and activities of daily living such as dressing, opening containers, buttoning, etc.
Secondary Impairments

- Soft tissue contractures and abnormal bone growth that may further impact functional use of the involved upper extremity
  - Contractures vary based on a child’s specific pattern of motor loss
    - Example: Upper brachial plexus (C5-C6) injury: often see contractures in shoulder adduction and internal rotation, forearm pronation, and either elbow extension or flexion (depending on triceps innervation)

- The development of bony deformities is also dependent on the pattern of motor loss
  - A majority of children with OBPP exhibit glenohumeral abnormalities
  - Abnormal shortening of the clavicle
  - Scapular abnormalities (hypoplasia, malpositioning)
Secondary Impairments

- Bone mineral density in children with OBPP is also decreased in the involved upper extremity as compared to the uninvolved upper extremity
Impact on UE Function

Reaching patterns may lack variety and a child may perform all reaching tasks with the shoulder internally rotated, the forearm pronated, and the wrist flexed.

Attempts to Increase Function

- In an attempt to maximize function, may see various compensatory movement patterns based upon the available muscle innervation.
  - Example: Limited active range of motion in overhead reaching may be compensated by an increased lordosis to position the hand higher overhead.
Sensation & Neglect

- Due to a loss of sensation, some infants with an OBPP will ignore or neglect their involved upper extremity and may even develop self-injurious behaviors such as biting or pinching their involved arm
  - Some children may not be able to feel cuts, burns, or other injuries on their involved arm
Sensation & Neglect

- If neglect is severe and the child habitually turns the head toward the unaffected arm and away from the affected arm, a positional torticollis may develop.
- As regeneration occurs and sensation is restored, some children may experience pain or hypersensitivity to touch before normal sensation is restored.

Motor Development

- Skills such as hands and knees mobility patterns may be too difficult for some children and therefore may be skipped.
  - May use alternative forms of mobility such as scooting in sitting or may just skip a floor mobility stage and go straight to walking.
- Tend to perform movement transitions to the uninvolved side.
Motor Development

- Protective reactions in sitting are often delayed or absent to the involved side.
  - These factors combined with sensory losses in the involved upper extremity may combine to the development of asymmetries in posture and movement.
Neurosurgical Repairs

- Options include nerve grafting, removal of scar tissue, and direct end-to-end anastomosis of nerve endings
  - Opinions vary related to the timing and benefits of neurosurgical interventions for children with an OBPP
  - It is generally agreed that children who have a total plexus injury plus Horner syndrome and who show no signs of recovery require neurosurgical repair in order to have any chance of an improved outcome
Neurosurgical Repairs

- Options include nerve grafting, removal of scar tissue, and direct end-to-end anastomosis of nerve endings
  - It is also generally agreed that infants who demonstrate early, full recovery within 3-4 weeks of life are best managed conservatively and do not require neurosurgical interventions

Neurosurgical Repairs

- Traditionally, a lack of biceps function has been felt to best inform the need for neurosurgical intervention
  - Previously used a prediction model that combined active movement scores of the elbow flexors and extensors, the wrist and thumb extensors, and the finger flexors and extensors
  - More recently, a lack of recovery in the shoulder external rotators and the forearm supinators has been found to best predict the need for neurosurgical intervention
Orthopedic Surgeries

- Soft tissue releases, tendon transfers, and osteotomies are also quite common in the management of children with an OBPP
  - The timing of these orthopedic surgeries has been debated

Long Term Impact

- Studies examining the long term impact of OBPP are limited
  - Activities such as writing, performance of bimanual tasks, and participation in sports and leisure activities have been found to difficult for children with OBPP
  - In a study of 7 to 8 year-olds with a history of OBPP, a majority of the children in the study preferred to use their non-involved hand and greater than 45% of the children complained of upper extremity pain
A survey of adults with OBPP further determined that a majority of the respondents (average of 39.5 years) were experiencing pain, impaired sensation, upper extremity arthritis, and functional limitations that impeded activities of daily living at the time of the survey. Such studies suggest that many children may experience the impact of an OBPP well into adulthood.
Physical Therapist Management

Initial Rest Period

- An initial “rest” period of 7 to 10 days after birth is typically recommended for neonates with an OBPP
  - Allows for a reduction in the initial edema and hemorrhage of the affected nerves
  - During this rest period, any movement, including assessment of range of motion, is prohibited
Examination of Motor Activity

- Care must be taken when moving the involved extremity to not to be overly aggressive in stretching muscle or in moving joints
  - Such activities may potentially cause further damage especially to unstable joints

- In young infants, often assess through symmetrical administration of developmental reflexes
  - Moro reflex, the palmar grasp, ATNR
  - Motions of the involved limb should be assessed in a gravity lessened position and in positions against gravity
Active Movement Scale

- Assesses 15 different motions of the involved upper extremity
  - 8-point ordinal scale ranges from a score of 0 (no contraction) to 7 (full motion against gravity)
  - Does not require the child to perform tasks on demand.
- May be used with children with an OBPP from birth to 4 years, 7 months of age

The Mallet Classification of Function

- Used with older children to measure and track motor recovery after a surgical intervention
- The involved extremity is tested in 5 different movements: shoulder abduction, shoulder external rotation, placing the hand behind head, placing the hand to the back, and bringing the hand to the mouth
  - Grades for each movement range from I (no active motion) to V (normal movement equal to the contralateral limb if unaffected)
The Sensory Grading System for Children with Brachial Plexus Injury

- Used to provide general information about sensation in the involved upper extremity of a child with OBPP
- In this grading system, scores range from S0 (no reaction to painful or other stimuli) to S3 (apparently normal sensation)

The Wrinkle Test

- A simple screen that can be used to assess the presence or absence of sensation at the palmar surface of the finger tips
  - Based on the premise that de-nervated skin does not wrinkle when soaked in water
The Wrinkle Test

- Requires soaking the child’s involved hand in warm water for 15-30 minutes and then checking for wrinkling
  - Wrapping the finger tips in a wet towel or other cloth for several minutes has been shown to be an effective alternative to prolonged soaking

Bialocerkowski et al 2013

- Systematic review to evaluate the psychometric properties of outcome measures used to quantify upper extremity function in children with OBPP.
- **Tools with the most robust psychometric properties**
  - The Assisting Hand Assessment
  - The self-care domain of the Pediatric Evaluation of Disability Index
  - The Pediatric Outcomes Data Collection Instrument (PODCI)
The Assisting Hand Assessment

- Designed to evaluate a child’s use of his/her involved hand for bi-manual tasks during a 10-15 minute semi-structured play session
  - Consists of 22 items
  - Scored from video recordings
- Intended for use with children ages 18 months to 12 years who have either an OBPP or hemiplegic cerebral palsy.

The Pediatric Outcomes Data Collection Instrument (PODCI)

- A standardized outcome assessment for use with children under 19 years of age who have musculoskeletal conditions
  - Provides a semi-quantitative, patient and parent report of function and quality of life in the following domains: transfers, upper extremity function, ability to participate in sports, comfort or pain, and happiness
- Developed primarily as an outcome measure for children undergoing orthopedic surgery
PT Intervention

- After the initial “rest” period of 7 to 10 days after birth, physical therapy interventions can typically commence safely
  - Avoid aggressive movements that force joints motion or over-stretch the involved upper extremity

PT Intervention

- Precautions and contraindications often vary
  - PTs should verify if any precautions or contradictions regarding specific movements or upper extremity weight-bearing exist prior to initiating intervention.
  - This pertains to all children with an OBPP whether or not they are post-surgical
PT Intervention - HEP

- Should emphasize precautions related to joint dislocation and subluxation as well as appropriate range of motion techniques for all upper extremity joints at risk for contracture

- **Murphy et al 2013 investigated the impact of a DVD on HEP compliance**
  - Found that use of the DVD increased HEP compliance from 74% to 96% over a 3 month period

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**PT Interventions**

- Interventions targeting activation of weak musculature during age appropriate functional activities should be encouraged
  - Place the infant in postures where weak muscles are in a gravity-lessened position and using manual contacts to gently guide and direct movements may assist in strengthening.
PT Interventions

- Interventions targeting activation of weak musculature during age appropriate functional activities should be encouraged
  - Place the infant in postures where weak muscles are in a gravity-lessened position and using manual contacts to gently guide and direct movements may assist in strengthening.
  - Example: Position the infant in sidelying on the uninvolved side and strategically placing toys in an area where the infant could easily reach the toys with the involved upper extremity

PT Interventions

- Modified constraint induced movement therapy
  - Abdel-Kafy et al 2013
    - 3-5 year-olds
    - Used sling
  - Kenyon unpublished data
    - Infant
    - Used sock
PT Interventions

Given the known decreases in bone mineral density of the involved upper extremity of children with OBPP, findings by Ibrahim et al 2011 suggest that incorporating weight bearing exercises into the intervention programs of older children may be helpful in improving bone mineral density.

Other interventions may include serial casting and splinting.

- Ho et al 2010 found that serial casting and splinting of elbow contractures in children with OBPP was effective.
  - Maintenance of the intervention effect was found to be dependent on patient age and compliance with follow up preventive measures.
PT Interventions

- Bo-tox may be used in conjunction with serial casting
  - Basciani & Intiso 2006: Use of botulinum toxin type-A followed by serial casting resulted in significant improvement of active elbow extension at 12 months post-injection
  - DeMatteo et al 2006: Botulinum toxin type-A injections alone may provide an opportunity to facilitate motor learning

PT Interventions

- Use of electrical stimulation to improve function and outcomes in children with OBPP is controversial
  - Early reports advocated for the use of electrical stimulation, few studies have explored the use of electrical stimulation in OBPP
    - Yang et al trial
PT Interventions

- Okafor et al:
  - Sample of 16 subjects with upper plexus injuries
  - Randomly assigned infants to an electrical stimulation group or a conventional physiotherapy group
  - At the end of a 6 week intervention period, statistically significant differences in shoulder abduction, elbow flexion, wrist extension and arm circumference

What’s the Problem Here?
Canada’s National Clinical Practice Guideline for OBPI


http://bmjopen.bmj.com/content/bmjopen/7/1/e014141.full.pdf

Review the Objectives: Any Questions?
Select References

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