**Module 2 Assignment: Evidence for Treatments**

**Peripheral Nerve Injury – Obstetric Brachial Plexus Injury**

 Peripheral nerve injury is a general phrase that can describe damage to the neurons of the peripheral nervous system due to any etiology. Because the peripheral nervous system contains both sensory and motor fibers to transmit information between the brain and the body, either or both of these functions can become impaired based on the location and extent of the injury. One patient population in which peripheral nerve injury manifests itself in the upper extremity is infants with obstetric brachial plexus injury (OBPI). Recent data suggest that the incidence of OBPI is between 1.6 and 2.6 per 1000 births, which is more common than cystic fibrosis and similar to the incidence of autism.1 Therefore, this is certainly a condition with which pediatric physical therapists should be familiar in order to intervene early and minimize residual deficits over time.

Since peripheral neurons are relatively large in size compared to other cells, they require structural and metabolic support from numerous surrounding glia.2 For example, Schwann cells are a type of glia that form the myelin sheath of peripheral nerves in order to facilitate impulse conduction. Consequently, when a neuronal injury occurs, it can affect the whole system involving the neuron and its glial support cells, rather than just the neuron itself.2 Peripheral nerves can be damaged in a number of ways, including transection or crush injury, which then leads to distal axonal degeneration while the proximal end of the axon forms a seal.2 Fortunately, the human body is equipped to regenerate damaged neurons in many cases, and functional ability can be restored either partially or completely through axonal sprouting to merge the gapped area and Schwann cell proliferation to generate a new myelin sheath around the axon.2 Interestingly, intact peripheral nerves actively inhibit these regeneration processes, so axon sprouting only occurs in nerves that have already experienced injury and are undergoing the healing process.2

In infants with OBPI, neuronal damage is incurred during the birthing process as the child moves through the birth canal and is delivered from the mother’s body.1 One of the most common risk factors for this condition is shoulder dystocia,3 which is a complication of delivery where one or both of the infant’s shoulders become stuck inside the pelvis. This obstruction leads to nerve injury as increased stretch is placed on the brachial plexus as the delivery continues. Additional risk factors for OBPI noted in the literature include gestational diabetes, maternal obesity, breech delivery, and large birth weight of the child.4 When OBPI has occurred during delivery, the newborn will present with flaccid paralysis of the affected upper extremity.1 Interestingly, Coroneos et al indicate that this characteristic presentation of flaccidity immediately after birth appears the same irrespective of the severity of nerve injury.1 In approximately 4 out of 5 cases of OBPI, the C5 and C6 nerve roots are involved in the injury, which results in a condition called Erb palsy.4 Patients with involvement in this area of the brachial plexus demonstrate a posture of shoulder internal rotation and adduction, elbow extension, and forearm pronation.4 When the C7 nerve root is affected as well, wrist flexion is added to this presentation, resulting in a characteristic posture known as the “waiter’s tip.”4 Lower brachial plexus injury affecting the C8 and T1 nerve roots is referred to as Klumpke palsy; however, this condition is much less common than Erb palsy and results in a characteristic “claw hand” deformity due to impairment of the intrinsic hand musculature.4

Infants with OBPI represent an interesting patient population for multiple reasons. First of all, since the damage is incurred during the birthing process, there is no opportunity for baseline assessment to determine the extent of the injury in terms of how it has functionally impacted the child.1 In addition, it is important to focus not only on how the injury affects the child during infancy, but also on how it will limit functional ability as the child grows and develops, requiring increased use of the upper extremities for play and daily activities. Due to weakness and decreased use of muscles that are innervated by the affected nerves, the resulting muscular imbalance can lead to contracture and glenohumeral deformity over time.5 Since the deltoid and rotator cuff musculature are commonly involved due to their C5-C6 innervation, shoulder abduction and external rotation are typically most limited in these patients.5 Overall, restoration of upper extremity function, either through surgical or conservative treatment, is the primary goal of intervention for infants with OBPI.

While the majority of OBPI cases result in spontaneous recovery, surgical intervention is occasionally warranted in order to correct muscle imbalance through the use of tendon transfers, muscle releases, and bone procedures.5 One procedure that has demonstrated particular success in terms of improving upper extremity mobility and function is transferring the latissimus dorsi and teres major tendons to the rotator cuff.5 In order to maximize the functional gains from this surgical procedure, the target age range of patients is 3 to 4 years.5 As expected, an intensive post-op physical therapy program is indicated that progresses as follows over a period of 6 months: casting followed by splinting to protect the healing tendon transfer, pendulum and grip strength exercises, active-assist range of motion, scapular stabilization exercises, resisted shoulder strengthening, and advanced functional activities.5 This type of therapy program has been shown to promote significant increases in shoulder abduction, external rotation, and flexion range of motion compared to preoperative measures.5

In many cases, OBPI is not severe enough to require surgery; however, physical therapy intervention is still a critical component of care in order to promote optimal function.6 A physical therapy program for conservative management should consist of passive range of motion, sensory education, and age-appropriate play activities to promote activation of weak musculature.6 In order to minimize the risk of contracture development, mobility exercises should be used to promote full motion of the upper extremity.6 An additional intervention of great importance is the development of a home exercise program, along with parent education regarding how to facilitate the completion of these exercises in an appropriate manner.6 As with all pediatric therapy, parent and caregiver involvement is a crucial component of care as young children are unable to perform their prescribed exercises independently. Another complication that can result from the shoulder resting in a posture of adduction and internal rotation is posterior subluxation or dislocation.6 In an attempt to prevent this further injury of the upper extremity, physical therapy programs should incorporate scapular stabilization exercises, and the scapula should be manually stabilized while the shoulder musculature is being passively stretched.6 Lastly, in terms of normal development, our bones depend on weight bearing for growth, strength, and density. Therefore, physical therapists and parents should also facilitate weight-bearing activities for children with OBPI in order to promote bone health within the involved upper extremity, as these children may neglect to utilize this arm on their own.6

In addition to therapeutic exercise to increase upper extremity strength, range of motion, and overall functional ability, neuromuscular electrical stimulation has also been studied for the treatment of OBPI. Evidence has demonstrated that this modality, used in conjunction with upper extremity weight-bearing and functional exercises, results in a greater improvement in bone mineral density and shoulder function compared to performing the exercises alone.7 For this particular randomized controlled trial, an alternating symmetrical biphasic current was utilized with electrodes placed on the anterior deltoid and the common extensor origin, and intensity was increased to each child’s level of tolerance.7 Neuromuscular electrical stimulation has also demonstrated the ability to aid in muscle contraction, promote increased range of motion, and decrease pain.6 Therefore, it seems that this modality may be a beneficial adjunct to the plan of care for children with OBPI.

In order to facilitate improvement in the current standard of care for OBPI, a few suggestions have been made as follows. Firstly, all newborns with OBPI should be referred to a multidisciplinary center prior to 1 month of age.1 When an infant receives initial examination at a multidisciplinary center within this period of time, quality indicators have been determined as ‘good,’ compared to ‘satisfactory’ between 1 and 3 months and ‘poor’ after 3 months of age.1 Secondly, objective outcome measures should be utilized with this patient population, such as the Brachial Plexus Outcome Measure (BPOM), the Active Movement Scale (AMS), and limb length measurements.1 Research has determined that each of these measures is reliable and appropriate for use with these individuals over time.1 Lastly, all newborns who display asymmetric upper extremity movement or who experienced shoulder dystocia during delivery should be physically examined for OBPI.1 This procedure allows for appropriate management and needed referrals to be initiated from the onset.

For me personally, my research on this topic caused me to wonder about the use of constraint induced movement therapy (CIMT) for OBPI. I was unable to find much evidence on the use of CIMT for this patient population outside of a couple case reports suggesting that there is potential for functional improvement with this intervention. However, I believe that this would be an excellent area for further research as it has demonstrated a high level of effectiveness for individuals with hemiplegia. In addition, the current literature on OBPI influences my treatment approach by conveying the importance of early intervention for this condition in order to optimize prognosis. Longer delay of treatment has the potential to produce many negative consequences, including increased muscle atrophy, joint contracture, decreased bone density, muscle imbalance, and shoulder dislocation. Additionally, children who experience persistent effects of OBPI are limited in their ability to explore and engage with their environment, which is a crucial component of normal development. Therefore, this information spurs me to intervene early in order to minimize the need for surgical intervention and maximize functional outcomes for these children over time.

**References**:

1. Coroneos C, Voineskos S, Christakis M, et al. Obstetrical brachial plexus injury (OBPI): Canada's national clinical practice guideline. *BMJ Open*. 2017;7(1):e014141. doi:10.1136/bmjopen-2016-014141.
2. Hall S. The response to injury in the peripheral nervous system. *The Journal of Bone and Joint Surgery*. 2005;87-B(10):1309-1319.
3. Coroneos C, Voineskos S, Coroneos M, et al. Obstetrical brachial plexus injury: burden in a publicly funded, universal healthcare system. *Journal of Neurosurgery: Pediatrics*. 2016;17(2):222-229. doi:10.3171/2015.6.peds14703.
4. Arzillo S, Gishen K, Askari M. Brachial Plexus Injury: Treatment Options and Outcomes. *Journal of Craniofacial Surgery*. 2014;25(4):1200-1206. doi:10.1097/scs.0000000000000841.
5. Safoury Y, Eldesoky M, Abutaleb E, et al. Post-operative Physical therapy program for latissimus dorsi and teres major tendons transfer to rotator cuff in children with obstetrical brachial plexus injury. *Eur J Phys Rehabil Med*.2016.
6. Ramos L, Zell J. Rehabilitation program for children with brachial plexus and peripheral nerve injury. *Seminars in Pediatric Neurology*. 2000;7(1):52-57. doi:10.1016/s1071-9091(00)80010-8.
7. Elnaggar R. Shoulder Function and Bone Mineralization in Children with Obstetric Brachial Plexus Injury After Neuromuscular Electrical Stimulation During Weight-Bearing Exercises. *American Journal of Physical Medicine & Rehabilitation*. 2016;95(4):239-247. doi:10.1097/phm.0000000000000449.