BRACHIAL PLEXUS BIRTH INJURY
Bringing Electricity to the Sun City!

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Brachial Plexus Birth Injury (BPBI), previously known as “birth palsy”, obstetrical palsy, or Erb palsy can present in a perplexing number of presentations to the upper limb and shoulder. This mirrors the complex biology of peripheral nerve injury, pediatric neural plasticity and plexus architecture. In the past, injuries to the brachial plexus, a thoroughfare of nerves traversing the posterior triangle of the neck, diving beneath the clavicle and entering the shoulder and arm, proved a medical enigma. We now understand how to better treat newborns with plexus injuries through defined classification schemes, rehabilitation protocols and surgery – achieving better and better outcomes.

A Highway of Nerves
The brachial plexus arises from the C5, C6, C7, C8, and T1 nerve roots forming three major trunks (upper, middle and lower) prior to giving off anterior and posterior divisions, then exiting from beneath the clavicle as cords (media), lateral, posterior) to finally become the major named nerves of the arm (median, ulnar, radial). Figure 1. In practice the plexus often looks more like a Spaghetti bowl. But given the predictable anatomic constraints defined injury patterns do exist. The most common site of injury occurs at Erb’s point(f), the confluence of the C5 and C6 nerve roots creating the classic “Upper Trunk” palsy. An infant will demonstrate an internally rotated shoulder, lack of elbow flexion, loss of wrist extension and present with the “Walters Tip position.” This represents palsies to the suprascapular nerve (shoulder instability), musculocutaneous nerve (loss of bicep), and radial nerve (loss of wrist extensors).

How does it happen?
Distracting forces between the cervical spine and shoulder during labor and delivery produce tension on the fixed plexus. Damage to the nerves occurs due to stretch injury. Direct pressure from the pelvic outlet and pubic symphysis have been implicated. But we know that Shoulder Dystocia carries the highest risk, followed by Macrosomia and Forceps delivery(t). Fortunately, rates of macrosomia are declining in the United States and with current rates of Cesarean Section we have seen a steady decline in Brachial Plexus Birth Injury from 1997 to 2012 according to the AHRQ Kid’s Inpatient Database from 1.8 to 1.2 persons per 1000 live births.(2) Certainly, regional differences may exist and currently rates in the El Paso region are unknown.

DEFINING THE INJURY – A Dance of Clinical Biology
Once a newborn has been identified with a possible BPBI, the single most important step in evaluation of the newborn with an extremity palsy is early consultation with an Occupational Therapy Team familiar with the injury. Firstly it is important to assess the posture and spontaneous movement of the newborn and extremity, identify concomitant clavicle or humerus fractures, evaluate for a Homer’s Syndrome and hemi-paralysis of the diaphragm by both physical examination, ultrasound or Xray. The occupational therapy team will utilize the Active Movement Scale (AMS) to chart the patient through time and monitor the progress with monthly reassessments and daily therapy sessions. Fortunately, the majority (>80%) of infants born with Brachial Plexus Birth Injury will spontaneously recover, particularly those with Upper Trunk, Erb Palsy (s).1, 3 This is representative of a lesser type of stretch injury on the nerve called Neuropahty. However, we know there are certain groups of patients that will not recover. These patients with Herter syndrome represent pre-ganglionic avulsive nerve injuries, whereby the nerve roots have pulled out from the spinal cord, between the spinal cord and dorsal root ganglia. There are also patients who follow an intermediary clinical pathway toward partial recovery during infancy representative of Axonotmesis or Neuroma. These patient’s clinical recovery may ultimately stall and the patient can lack vital functions such as elbow flexion or shoulder abduction. Hence the importance of monthly reassessment with the OT team and use of a standardized scale to measure progress.

When to Intervene and Why...
Early surgical intervention includes primary Brachial Plexus exploration with debridement of damaged nerves, scar, and neuroma with reconstruction of nerve gaps using grafts and or transfers to recover distal function, Figure 2. Indications for early microsurgical exploration include pan-plexus palsy, failed bicep recovery by six-months of age, and a failed cookie test (ability to raise a cookie to the mouth by age nine-months) (3) Secondary reconstruction of the shoulder, elbow, wrist and hand may be necessary with incomplete nerve recovery and the presence of weakness and or associated conditions like glenohumeral dysplasia. As surgeons, we strike a delicate balance between the natural biology of plexus injury – watching for spontaneous recovery versus early intervention. We know that a child who has not recovered the majority of their function, particularly elbow flexion, by age 4-5 months represents a more severe injury that warrants surgical consideration – refer to Table 1.

Figure 2
Microsurgical reconstruction of an upper trunk, Erb Palsy, in a six month old who failed to recover Bicep function and Elbow Flexion & Supination. Demonstrating clinical landmarks and a small transverse cervical incision with evidence of C5-C6 Nerve Trunk captures (friday), replaced with Sural Nerve Grafts (right).

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El Paso’s Team and Referral

At El Paso Children’s Hospital and Texas Tech University Health Sciences El Paso, we are building the region’s only dedicated Brachial Plexus Birth Injury Center with microsurgical capabilities and a multidisciplinary team of Plastic and Reconstructive Surgeons, Orthopedic Surgeons, Neurosurgeons and occupational therapists to serve the larger El Paso Region, Paso Del Norte, New Mexico and Colorado. We will join a consortium of children’s hospitals nationally that participate in microsurgical intervention for the Brachial Plexus in order to fulfill an academic mission to track our patient’s outcomes and provide the highest level of Quaternary medical care.

Certainly, the presence of an Extremity palsy at birth produces tremendous anxiety for the medical team and family. It is critical to maintain a no-fault attitude and know that having a home for these patients in El Paso will help serve not only our patients but the physicians in the region as well.

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<th>Recommended Time for Repair</th>
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<td>Pan Plexus Palsy (Flail Arm) +/- Horner Syndrome</td>
<td>Microsurgical Exploration</td>
<td>3 Months</td>
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<tr>
<td>Upper Trunk Erb Palsy with Failed Bicep Recovery</td>
<td>Microsurgical Exploration</td>
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<td>Failed Cookie Test (Elbow / Shoulder Function)</td>
<td>Microsurgical Exploration Nerve Transfer</td>
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<tr>
<td>Loss of Shoulder Passive Motion, Glenohumeral Dysfunction</td>
<td>Microsurgical Exploration, Nerve Transfer, Tendon Transfer Surgery</td>
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<tr>
<td>Incomplete Shoulder External Rotation or Abduction</td>
<td>L’Episcopo Tendon Transfer Surgery</td>
<td>3 years – 6 years</td>
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<td>Incomplete Elbow Flexion or Bicep</td>
<td>Nerve Transfer (Oberlin)</td>
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<td>Wrist Instability</td>
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<tr>
<td>Internal Rotation of the Arm</td>
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<td>Elbow Flexion Contracture</td>
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Table 1: Surgical Indications and Timing

MASK UP!

Helping Children with Special Needs during Covid-19

By: Lisa Ayoub-Rodriguez, MD and Ricardo Reyna, MD

Our world has drastically changed in the last few months, and we’re needing to do things that we never expected. Wearing face masks is probably at the top of that list! But like anything new, this may be easier said than done, especially true for our young ones and even more difficult for those with special needs. In this population of children, in which they often may be considered high-risk or have an impaired immune system, it is important to do the most possible preventative measures to keep them safe.

Wearing masks is an unusual experience and kids may resist cooperating at first. Be that as it may, we can offer some effective solutions to these obstacles! In regards to children with special healthcare needs planning and preparation need to be considered. It is not natural or comfortable for children initially, so practicing is critical to the success of getting all children used to masks especially in children with special needs.

1. Be a Role Model: Parents can set a good example by practicing wearing masks too. The more positive, calm and easy-going we are about it, the more likely kids will be to follow our lead.
2. Do practice sessions at home- Allow them to touch it, sniff it, and hold it in their hands for an increasing amount of time to build skill and comfort (5, 10, 30 seconds for example). Then have them hold it to their mouth for 1, 2, 5, 10 seconds, progressing up to a minute or more.
3. Explain in simple terms why kids should wear masks- Wearing a mask is an act of kindness. Just like we have taught you to sneeze into your elbow, we’re asking you to wear a mask to prevent germs from spreading.
4. Practice with others- Set up a video chat with friends or family members to practice wearing masks together.
5. Provide incentives when necessary- If your children typically need incentives when trying something new, you can provide one here as well.
6. Stay positive and make it fun- Give them lots and lots of compliments for practicing and keeping the mask on for longer periods of time. Practice putting masks on their toys, dolls, or stuffed animals. If they’re into superheroes, they may enjoy being called a “masked superhero” when they wear the facial covering.
Fetal echocardiography, performed by the pediatric cardiologist, is the ultrasound evaluation of fetal cardiovascular system. It was introduced in late 1980’s for focused diagnosis of complex congenital heart disease (CHD) prenatally (1). Since then it has become an integral part of diagnosis and management of complex heart defects. Early diagnosis of these complex lesions will enable the providers and family to provide better quality care for these neonates.

Indications for Fetal Echocardiography:
Fetal echocardiographic indications can be broadly classified into high risk, low risk and no risk indications. Another commonly used classification is fetal and maternal indications. Table 1 shows the indications for fetal echocardiography. From a scientific statement released by American Heart Association (AHA) in 2014 (2), Family history of congenital heart disease, chromosomal abnormalities, extracardiac malformations, increased nuchal translucency (3), invitro fertilization (3-fold increase in the incidence of CHD) are some of the well-known risk factors for CHD.

Timing and Components of Fetal Echocardiogram:
18-22 weeks of gestation is the optimal time to perform a comprehensive fetal echocardiogram (4). As the gestational age advances, it becomes difficult to perform the study due to decreased amniotic fluid to fetal body mass ratio. Even though, fetal echocardiogram can be performed “16 weeks of gestation, study will be more often limited requiring repeat study.

Comprehensive fetal echocardiography evaluation includes 2D, color Doppler and spectral Doppler evaluation of various structures of the heart. 2D evaluation include the aortic valve anatomy in various views which include four chamber view, outflow tract view (left ventricular and right ventricular outflow tract view), short axis view and arch views (dextal and aortic arches). Spectral Doppler assessment is useful in diagnosis of obstructive lesions. In addition to anatomy, another very important aspect of fetal echocardiography is the assessment of fetal heart rhythm. M-mode and spectral doppler of atrial and ventricular flow patterns helps us to identify heart blocks and other arrhythmias.

Trends in Prenatal Diagnosis of Complex Congenital Heart Disease:
In spite of all the advancements we have witnessed in the field of pediatric cardiology, the national average for prenatal diagnosis of CHD is significantly lower, with a detection rate of “26%” in 2006 (5). There was also significant variation in prenatal detection rates across the states, with lowest being “12%”. Given a significantly lower diagnosis rate, American Institute of Ultrasound in Medicine and International Society of Ultrasound in Obstetrics and Gynecology, have included routine assessment of outflow tracts and ductal and aortic arches during fetal evaluation during second trimester.

Many of recently published studies have shown a steady increase in prenatal detection of complex CHD across the United States over the past decade (5). This has been attributed to multitude of factors which include but not limited to: 1. Advancements in the ultrasound technology, 2. Expanding the screening protocols to include outflow and arch views on level 2nd trimester obstetric ultrasound, 3. Increase in the indications for fetal echocardiography and 4. Experience gained in fetal heart imaging over time. A recently published study demonstrated significant increase in fetal diagnosis of cono-truncal anomalies since the introduction of outflow and arch views on second trimester obstetric screening study (Fig 1)(6).

Impact of Prenatal Diagnosis:
CHD is one of the major causes of morbidity and mortality among neonates and infants. Time from birth to initiation of life saving therapy plays a major role in outcomes of these sick neonates. Therefore, in theory, prenatal diagnosis should help with both infant morbidity and mortality by helping us to better coordinate the immediate postnatal care. In addition, it will also help both the providers and family to coordinate the multidisciplinary care of these patients. Recently published study demonstrated that patients with prenatal diagnosis are less likely to require mechanical ventilation, require intravenous antibiotics (7). These findings are more pronounced in ductal dependent lesions, like hypoplastic left heart syndrome. Another study by Espeen et al demonstrated prenatal diagnosis of left sided obstructive lesions results in reduced incidence of metabolic acidosis, organ dysfunction and hemodynamic instability (8).

However, the data on benefits of prenatal diagnosis of complex heart defects on infant mortality is still controversial. Although Bennett et al demonstrated survival benefit with prenatal diagnosis, many of the
recent studies failed to demonstrate such a benefit (9). Kumar et al showed demonstrated no mortality benefit with prenatal diagnosis, especially in patients with hypoplastic left heart syndrome and D-transposition of great arteries (10). The authors in these studies hypothesized that postoperative mortality is primarily influenced by the severity of cardiac malformation.

Conclusions:
Fetal echocardiography plays a pivotal role in prenatal diagnosis of heart defects. We have witnessed a progressive increase in the rates of prenatal diagnosis of CHD, which is thought to be multifactorial. Even though data on mortality benefit with prenatal diagnosis is conflicting, there is a clear morbidity benefit with early diagnosis of complex heart defects.

Note: Fetal echocardiographic evaluations are being performed at Pediatric Cardiology division, El Paso Children’s Hospital, El Paso. We request that the referrals be faxed over to (915) 242-8404. The patient will be scheduled for the study within 1 week after receiving the referral and the report will be faxed to the referring physician’s office no later than 24 hours from the time of performing the study. For patients with complex congenital heart lesions requiring specialized and coordinated care, the referring physician will be consulted to formulate the individualized plan of care for the heart defect in question for optimal neonatal and maternal outcomes.

In case of any emergency or the need to expedite the process (not only fetal studies but also for regular pediatric cardiology related concerns), I can be reached directly on my cell phone at (917) 328-7831.

2021 PEDIATRIC GRAND ROUNDS
The First & Third Wednesday of Every Month
Virtual WebEx Grand Rounds: 8:00 AM - 9:00 AM

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Accreditation: The Texas Tech University Health Sciences Center El Paso Paul L. Foster School of Medicine is accredited by the Accreditation Council for Continuing Medical Education (ACCME) to provide continuing medical education for physicians.

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