

## PedsCases Podcast Scripts

This is a text version of a podcast from PedsCases.com on “**NEONATAL BRACHIAL PLEXUS INJURIES.**” These podcasts are designed to give medical students an overview of key topics in pediatrics. The audio versions are accessible on iTunes or at [www.pedcases.com/podcasts](http://www.pedcases.com/podcasts).

### **NEONATAL BRACHIAL PLEXUS INJURIES**

Developed by Jaskiran Sandha and Dr. Matthew Prowse for PedsCases.com.  
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#### **Introduction:**

Hi, my name is Jaskiran Sandha, I'm a fourth-year medical student at the University of Alberta who will be talking to you about neonatal brachial plexus injuries (NBPI). This podcast was created in conjunction with Dr. Matthew Prowse, a pediatric physical medicine and rehabilitation specialist at the University of Alberta.

We'll start with a case, and then outline an organized approach to neonatal brachial plexus injuries. Emily is a 2-week-old baby born following a difficult delivery involving shoulder dystocia. At birth, she was noted to have prominent right arm weakness, and you are following up in your general pediatrics clinic for a well-baby visit. What is your approach to her management?

#### **Learning Objectives**

1. Describe key features of NBPI.
2. Develop an approach to assessment and diagnosis of NBPI.
3. Discuss prognostic factors of NBPI.
4. Outline an approach to management and follow-up of patients with NBPI.

#### **What are NBPIs?**

Neonatal brachial plexus injuries include a group of conditions that involve injury to the brachial plexus, which arises from the spinal nerve roots C5 through T1. Approximately 1 in 1000 live births is associated with an NBPI, and 20-25% of these involve deficits persisting past one year<sup>1-3</sup>.

Injury to the brachial plexus is most commonly caused by stretching of the nerves, but can also be due to compression, inflammatory or infectious infiltration, or hypoxic injury<sup>4</sup>. Many risk factors have been proposed, such as shoulder dystocia, operative vaginal delivery, abnormal labour, and fetal macrosomia, but research has shown that none of these have high predictive ability for NBPI, and NBPI still occurs with C-section deliveries, though less commonly<sup>5</sup>.

The brachial plexus is responsible for the sensory and motor innervation of the upper extremities. They are typically unilateral and can be described according to the Narakas classification<sup>6,7</sup>. Erb's palsy, which involves injury to roots C5 and C6, is the most common, and

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comprises fifty percent of all NBPIs<sup>4</sup>. These injuries are manifested by adduction and internal rotation of the upper arm, extension of the forearm, and sparing of the hands and wrist. An additional 35% of babies present with extended Erb's palsy, in which injury also includes C7, and has the added "waiter's tip" posture from pronation of the forearm and flexion of the wrist and digits. Extended Erb's palsy can be further specified based on whether or not extension of the wrist recovers by 2 months of age<sup>8</sup>. The third category is injury to all roots C5 through T1 presenting with an upper extremity devoid of motor and sensory function known as a flail limb. The fourth type involves more extensive damage to the nerve roots that results in impaired sympathetic function, presenting as Horner syndrome. The least common distribution is Klumpke palsy, which includes injury isolated to C8 and T1, and presents with Horner syndrome and paralysis of the hand. Its existence is often disputed, and is not included in the Narakas classification.

### Assessment and Diagnosis

Diagnosis of NBPI is largely clinical, and requires a detailed prenatal and perinatal history with careful attention to exam findings as neonates have limited upper arm movements at baseline.

On history, remember to ask about any prenatal events or existing neuromuscular anomalies detected on prenatal testing. It is crucial to obtain details of the delivery itself, including fetal positioning, side of suspected injury and side of anterior shoulder, and signs of distress during delivery, as reflected by APGAR scores or the need for resuscitation or intervention during or following birth. Ask about any comorbid injuries or bruising, as NBPI may often be associated with extension of the paralysis to the face or diaphragm, damage to the spinal cord itself, subluxation of the cervical spine or shoulder joints, or fractures of the clavicle or humerus<sup>4</sup>.

On examination, it is important to rule out other neurological or musculoskeletal conditions that often resemble NBPI by completing a thorough exam with a focus on neurological assessment<sup>4</sup>. This includes observation of movements, passive and active range of movement, sensation, and reflexes. Abnormal features pointing to NBPI include unilaterally diminished movements, decreased response to sensory stimulus, or impaired reflexes in the upper limb, such as the Moro reflex or asymmetric tonic neck reflex. Features of Horner syndrome such as ptosis or miosis should raise suspicion for extensive damage likely involving the entire plexus<sup>6</sup>. Diaphragmatic paralysis resulting in poor oxygenation, difficulty feeding, or asymmetric chest expansion point toward damage to the phrenic nerve, which arises from C3, C4, and C5. Pay attention to signs that indicate there may be an alternate explanation for deficits<sup>4</sup>. More diffuse patterns of deficits such as bilateral or hemiplegic involvement that extend beyond what is expected with NBPI point toward an alternate neurological pathology that may originate higher up in the central nervous system. Findings such as muscular atrophy, contractures, and loss of bone density develop several months after damage to the associated nerves. Therefore, presence of these signs in an older child may be attributed to NBPI, but increases the likelihood of an injury preceding birth when found in a newborn.

The role of investigations in diagnosis of NBPI is very limited<sup>4</sup>. Detection of comorbid injuries such as clavicle and humerus fractures may be made on plain film, and bone density scanning may be done to assess for bone demineralization, which may indicate that pathology has been present for several months. Evaluation with electromyography, nerve conduction studies, CT, MRI, or ultrasound varies by centre, and is used more for determining severity, prognosis at follow-up, or detection of comorbidities.

## Prognosis and Management

The majority of infants with NBPI show spontaneous functional recovery by 3 months, but approximately 20-25% have neurological deficits persisting past one year<sup>2-4,9</sup>. This can lead to secondary sequelae including contractures of the shoulder, flexion of the elbow, and supination of the forearm, as well as glenoid dysplasias, and susceptibility to dislocation of the shoulder<sup>10-13</sup>.

Deficits in tactile perception, which are more common in lower plexus injury, have been shown to persist up to 12 years of age, long after the initial injury, and may be permanent<sup>14</sup>. In addition to tactile perception, deficits in proprioception as well as musculoskeletal and neuropathic pain are also common in NBPI, and may take much more time to recover than motor deficits<sup>15</sup>.

Prognostic factors predicting persistence past one year include cephalic presentation, induced or augmented labour, birth weight greater than 9lbs, and the presence of Horner syndrome on presentation<sup>1</sup>.

As the presentations of NBPI involve a variety of deficits of differing severity, there is a range of treatment modalities including conservative management, physiotherapy, and surgical intervention under the supervision of a multidisciplinary team, which may include physical medicine and rehabilitation, plastic surgery, neurosurgery, or orthopedics, depending on the centre .

The purpose of physical therapy is to prevent contractures and maintain strength and function by using splinting and exercises that are often started within one week of birth<sup>4</sup>. For examples, elbow flexion contractures, which occur in nearly half of all brachial plexus injuries, can be managed with serial casting to reduce the severity of contractures, as well as nightly splinting to prevent progression<sup>11,16</sup>.

Indications for surgery are based on severity of the injury and extent of functional recovery. NBPI involving the entire plexus, severe damage or complete discontinuity of the nerves, or avulsion of the root itself are less likely to show optimal recovery without surgery<sup>4</sup>. Similarly, more severe functional outcomes, such as a flail limb or inadequate improvement in function by 3 to 9 months, may benefit from surgical intervention. Specific interventions include grafting of nerves, transfer of motor fascicles, and orthopedic reconstruction of the shoulder. It is important to maintain realistic expectations for surgical outcomes, as patients who undergo surgical intervention such as nerve transfer often improve in function but typically have persistent deficits post-operatively.

Management of NBPI requires close follow-up for the first several months to years of life to monitor progress of functional recovery and to intervene if necessary. As a child grows older, follow-up and support should also be geared toward facilitating participation in social and athletic activities as much as possible. In addition, ongoing psychosocial support is an important consideration for both the patient as well as the caregivers, as they are at higher risk of mental health concerns<sup>4,7</sup>.

So to summarize the approach to management:

1. NBPI can present with a range of motor and sensory deficits with possible musculoskeletal sequelae in persistent injuries.
2. 75% of patients with noted deficits in the post-natal period recover spontaneously.
3. Of those that remain, follow-up is needed at 1-2 months of age to determine if any deficits persist. At this point, children with persistent deficits should be referred to a subspecialty clinic if available. Decisions regarding surgery versus medical management will be made by this team.

Let's go back to our case.

Having assessed Emily at 2 weeks and having documented her deficits, we will follow up with the progress of her functional status when she returns for follow up at 1-2 months. At this point, if we notice her right arm weakness is persisting, we can refer her to the subspecialty plexus clinic for further evaluation and possible EMG studies to determine if she is a candidate for surgery, or if conservative management and monitoring for resolution is more appropriate.

Thank you for listening, this is the end of our podcast.

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