

## "AN APPRAISAL ON BRACHIAL PLEXUS BIRTH INJURY"

Dasari Sri Lakshmi

Ayurvedic Physician and Physiotherapist, SGS Hospital, A Unit of Swami Narahari Teertha Medical Mission Trust, Sri Ganapathy Sachchidananda Ashram, Mysore

## ABSTRACT

Brachial plexus is network of nerves formed by the anterior rami of the lower four cervical nerves and first thoracic nerve ( $C_5, C_6, C_7, C_8,$  and  $T_1$ ). This plexus extends from spinal cord, through the cervicoaxillary canal in the neck, over the first rib, extending down into the armpit supplying the arm. Brachial plexus birth injury (BPBI) is unfortunately a common injury in newborn. Incidence varies between 0.15-4 per 1000 live births in various countries. BPBI occurs when these nerves are stretched, compressed, or in most serious cases ripped apart from the spinal cord. BPBI may be associated with high birth weight, breech presentation, shoulder dystocia or prolonged labor. Erb's palsy is due to upper roots ( $C_5-C_6$ ) injury and rare klumpke's palsy due to lower roots injury ( $C_8-T_1$ ). Total brachial plexus palsy is caused due to all five nerves roots ( $C_5-T_1$ ) involvement. Horner's syndrome, ptosis, miosis and anhydrosis may also be associated with BPBI. It is the severity of injury that affects the extent of recovery. Early approach to multidisciplinary specialized centers with expertise evaluation and appropriate early intervention yields encouraging results in most cases. BPBI patients should undergo a rehabilitation program starting at the earliest possible which may extend up to an age of 2 years, till the nerve regenerates to avoid complication and maximize use of the affected arm in daily activities.

**KEYWORDS :** Brachial plexus palsy, erb's palsy, klumpke's palsy, shoulder dystocia, rehabilitation.

## INTRODUCTION:

Brachial plexus are group of nerves that conducts signals from the spinal cord and innervate the muscles and skin of the chest, shoulder and entire arm. BPBI causes arm weakness and loss of motion. 0.15-4 per 1,000 live babies suffer this condition.<sup>(1)</sup> Extent of recovery depends on type and site of damage. Parents play an active role in helping their child recover maximum function in the affected arm. Majority of mild BPBI cases are said to recover completely in 4-6 weeks after birth. Children who continue to have problems beyond six weeks should be under the guidance of pediatric orthopedist or brachial plexus specialist. Daily rehabilitation of BPBI cases during 3-12 months of recovering age is essential to maximize use of the affected arm. Nerve avulsion cases are indicated for surgery.

## AETIOLOGY:

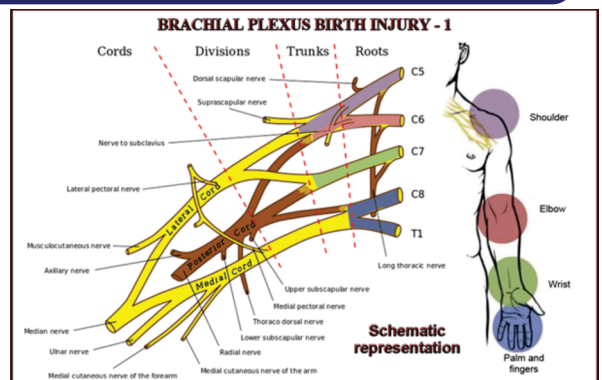
BPBI is often caused in newborns due to traction of neck to one side during a difficult delivery in which the brachial plexus nerves are stretched resulting in nerve injury. Causative factors can be divided into foetal and maternal.

1. Foetal factors are breech presentation and macrosomia.
2. Maternal factors include shoulder dystocia, small stature/cephalopelvic disproportion, diabetes during pregnancy, prolonged second stage of labour, primiparous or multiparous.

## NEUROPATHOLOGY:

The nerves from the spinal cord emerge out between the cervical vertebrae. Along the side of neck, near the shoulder, these nerves merge together. They branch out to form plexus of nerves, these nerves travel behind clavicle and spreads out into the arm. The nerves that go to the shoulder lie higher in the neck than those that travel to the hand and fingers. Sensory nerves to the hand and fingers lie lower in the neck and deep in the armpit. This nerve complex is composed of four cervical nerve roots ( $C_5-C_8$ ) and the first thoracic nerve root ( $T_1$ ). These roots combine to form three trunks.  $C_5-C_6$  form the upper trunk,  $C_7$  continues as the middle trunk and  $C_8-T_1$  form the lower trunk. Each trunk splits into ventral and dorsal rami.<sup>(2,3)</sup>

**Plate-1: Schematic representation of nerve cords involved and areas affected in BPBI**



## TYPES OF BPBI:

BPBI may be categorized into four types depending on site of nerve injury.

1. Erb's palsy results from a lesion at Erb's point where  $C_5$  and  $C_6$  unite to form the upper trunk of the brachial plexus. It presents with typical waiter's tip position of the hand (Plate-2).
2. Klumpke's palsy is caused due to injury of lower roots  $C_8-T_1$  roots. This almost never occurs in babies. It typically affects the muscles of palm and fingers.
3. Horner's syndrome occurs when the stellate ganglion is disrupted. It is usually associated with an avulsion with sympathetic chain of nerve being injured, usually in  $T_2-T_4$  region. The child may have ptosis (drooping eyelid), miosis (smaller pupil of the eye) and anhydrosis (diminished sweat production in part of the face). The child may have more severe injury of the brachial plexus.
4. Total plexus palsy is where all five nerves roots of the brachial plexus are involved ( $C_5-T_1$ ). Children may not have any movement at the shoulder, elbow and wrist.<sup>(3)</sup>

## SEVERITY OF BPBI:

The nerves of the brachial plexus may be stretched, compressed or torn in a difficult delivery. The result might be a loss of muscle function, or even paralysis of the upper limb. Severity of BPBI may be categorized into four types

1. *Neuropraxia* is stretch injury that shocks the nerve, but does not tear. It is the most common type. Normally, these injuries permits complete prompt recovery within first 3 months of the baby's life. Neuropraxia can happen in adults as well due to a stretch injury during play; it is

- called a burner or stinger.
2. *Neuroma* is a stretch injury that damages some of the nerve fibers that may result in scar tissue. The scar tissue may press on the remaining healthy nerve interfering with normal function. This condition is called a neuroma that may require surgical treatment with nerve reconstruction and/or secondary tendon transfers. Some but not total, gradual recovery usually occurs with rehabilitation.
  3. *Rupture* occurs when nerve is torn, but not where it attaches to the spine and will not heal on its own. Nerve rupture is also common BPBI that may require surgical repair by splicing a donor nerve graft from another nerve of the child.
  4. *Avulsion* is less common BPBI that occurs when the nerve roots are torn from the spinal cord. It is not possible to repair an avulsion from the spinal cord. In some cases, it may be possible to restore some function in the arm by nerve transfer. Nerve ruptures and avulsions are the most serious types of nerve injury.

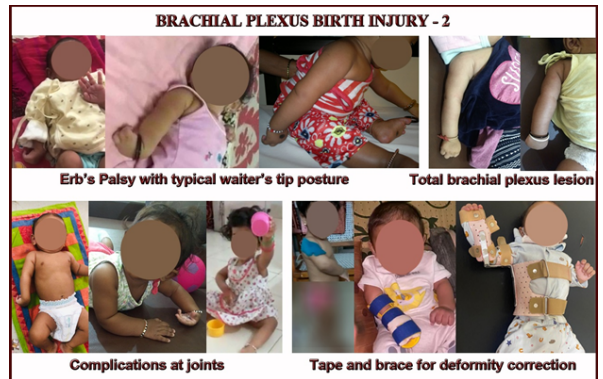
**CLINICAL MANIFESTATION:**

The clinical manifestation can be classified according to the anatomic structures compromised. BPBI is a closed supraclavicular lesion that affects sequentially the upper, middle and lower brachial plexus trunks. The right side is affected in two thirds of the cases due to the most common fetal presentation. Bilateral cases are usually asymmetric. Isolated lesion of the upper trunk presents with typical "waiter's tip" limb posture, where in arm is adducted and internally rotated, the elbow is extended, and the wrist is flexed (Plate-2). The Moro reflex is absent on affected side, but the grasp reflex is normal. Motor deficit includes shoulder abduction, external rotation and elbow flexion. Biceps tendon reflex is lost, but pain sensibility is usually preserved. Upper and middle trunk (C<sub>5</sub>-C<sub>7</sub>) lesions accounts for one third of the cases. In addition to the motor deficits seen in Erb's palsy, elbow and wrist extension are also compromised. Finger flexion is present, but usually weaker than the healthy side. All tendon reflexes are absent in the affected limb. Pain sensibility may be lost in the thumb or middle finger, and this is related to a poor prognosis. Total plexus lesions (C<sub>5</sub>-T<sub>1</sub>) with a complete flaccid arm, with abnormal sensibility and sympathetic ocular involvement known as "Claude-bernard-horner syndrome". Total plexus lesions with recovered upper plexus function later develop a "beggar's hand" posture presenting with flexed elbow, supinated arm and extended wrist.<sup>(3-5)</sup>(Plate-2)

**Table-1: Muscles involved and deficits due to BPBI**

S. No	Movements	Nerve roots	Muscle innervated	Resulting position due to nerve damage
1.	Diaphragmatic descent	C <sub>4</sub> , C <sub>5</sub>	Diaphragm	Elevated
2.	Shoulder abduction	C <sub>5</sub>	Deltoid	Adducted
3.	Shoulder external rotation	C <sub>5</sub>	Supra-spinatus and infra-spinatus	Internally rotated
4.	Elbow flexion	C <sub>5</sub> , C <sub>6</sub>	Biceps, brachioradialis	Extended
5.	Supination	C <sub>5</sub> , C <sub>6</sub>	Supinators	Pronated
6.	Wrist extension	C <sub>6</sub> , C <sub>7</sub>	Extensors of wrist	Flexed wrist
7.	Finger extension	C <sub>6</sub> , C <sub>7</sub>	Extensors of fingers	Flexed

**Plate-2: Clinical presentation and complications of BPBI patients**



**DIAGNOSIS TESTS:**

The diagnosis of BPBI is clinically obvious and diagnostic tests may not be done in first few months. Plain x-ray helps detect concurrent lesions, such as clavicular fracture, shoulder joint alignment or phrenic paralysis. Imaging studies like MRI helps to identify any damage to the bones and joints of the neck and shoulder. Electromyography (EMG) or a nerve conduction study (NCS) helps to evaluate severity of injury and nerve roots involved in BPBI, but nerve conduction studies for babies may not be as reliable as they are for adults.

**PROGNOSIS:**

Prognosis depends on the level of the injury (pre- or post-ganglion), severity of the post-ganglion tear and quality of initial management. Spontaneous recovery is obtained within 4-6 weeks in few children where as others suffer various degrees of sequelae, up to complete loss of function of the affected upper limb. Children who continue to have problems beyond six weeks should be evaluated by a pediatric orthopedist or brachial plexus specialist. Many children improve by 3-12 months of age with regular rehabilitation. Progress should be regularly monitored and evaluated by brachial plexus experts.

**SURGICAL INDICATION:**

Early surgery provides a larger window time for nerve regeneration and theoretically would have a better outcome. The most popular criterion is based on biceps function at three months of age, but some studies have criticized this approach due to a low specificity. Biceps function was originally related to biceps palpable contraction, others consider elbow flexion. Electric muscle activity detected by needle electromyography is not considered biceps function. On the other hand, since the rate of recovery is high, many children would be submitted to an unnecessary procedure. For patients with total plexus lesions, there is little controversy about the indication of early surgery. Some actually prefer to operate earlier than three months, while most wait due to anesthesia safety. Clinical evaluation should not only be biased with elbow flexion, but also consider shoulder abduction, elbow extension and wrist and finger extension. Surgery after twelve months of age is usually not very effective, although some late selective distal nerve transfers can still offer good results.

**TREATMENT:**

BPBI babies are to be re-examined frequently if the nerves are recovering. Nerves grow and recover very slowly; it may take up to 2 years for a complete recovery. Daily physiotherapy is very essential and can be started as early as about 3 weeks of age. Parent's involvement is essential for effective rehabilitation program. Daily passive range-of-motion exercises are to be done frequently and at regular intervals to avoid muscle contractures and maintain complete range of motion of the joints. Later with improved muscle power active assisted and active exercises should be encouraged. As the child shows intentional voluntary control, encouraging bimanual activities avoids 'developmental apraxia'. If there is

no improvement in first 6 months to 1 year with regular physiotherapy, surgery may be the option to improve the potential outcome. Wrist splinting can help to enhance hand function in cases of wrist drop, as long as it does not prevent limb use during daytime. Aberrant reinnervation can result in biceps-triceps co-contraction, which can be treated with botulinum toxin. Botox injections may be used (mainly for the shoulder) to help with joint motion, rebalance muscles, or prevent contractures and shoulder dislocations.<sup>[3,4]</sup>

Hand may be corrected and immobilized if shoulder joint is associated with subluxation or dislocation, or associated with bone fractures. Some advocate that immobilization may be useful for pain treatment during the first week, but it is difficult to evaluate pain in these patients. But adults with brachial plexus lesions suffer severe neuropathic pain, especially after root avulsions. Nerve surgery does not typically restore full, normal function, and is usually not helpful for older infants. Depending upon the nerve injury ruptured or avulsed nerves are repaired by splicing a donor nerve graft from another nerve or muscle of the child. Nerves recover very slowly, it may take several months, or even years, for nerves repaired at the neck to reach the muscles of the lower arm and hand. Post-operative physiotherapy helps in rehabilitating muscles and improves active range of motion. In cases of thickened soft tissues around the shoulder and elbow joints, surgical release of contractures is performed to improve joint mobility. To improve affected arm usage a functioning tendon is transferred from its normal attachment in the body and reattached in the shoulder area.<sup>[5,6]</sup>

#### LONG TERM COMPLICATIONS:

1. Internal rotation contractures and posterior humeral subluxation are the most common long term complication in BPBI. It is related to muscular imbalance between poor active external rotators and unresisted internal rotator muscles. It leads to a progressive shoulder deformity ranging from mild glenoid retroversion to a complete posterior subluxation with false glenoid and proximal humeral deformity.
2. Scapular winging, elbow flexion contracture, radial head luxation, fixed pronation or supination posture, and claw hand are other deformities.
3. Growth imbalance between the upper limbs is common in severe cases of BPBI. This occurs because nerves do have an effect on growth. Although the affected arm will continue to grow as the child grows, it grows at a slower pace, and the size difference will become more noticeable as the child gets older.
4. Prognosis of sensory deficits is usually good. However, some children can develop a self-mutilating biting behavior. This is more common after brachial plexus surgery and is probably related to uncomfortable paresthesia. This is only temporary and it is crucial to prevent the child from eating off their own fingers till it is relieved in few months.<sup>[3-6]</sup>

#### DISCUSSION:

BPBI is caused due to shoulder dystocia, traction to the neck due to pull of the obstetrician's hand or instruments like forceps/vacuum used during delivery. The neck on the side of the anterior shoulder is stretched and causes strain on the brachial plexus of that side, causing a varying degree of injury. There is a higher incidence of right-sided injuries due most common left occipito anterior (LOA) presentation of baby. However, posterior shoulder involvement and bilateral injury are less frequent. BPBI experts opine that few cases reviewed did not have shoulder dystocia and opine that it could be caused by intrauterine mal-adaptation and not birth trauma. Few others experts have described that BPBI has occurred following caesarean sections and also that shoulder dystocia does not always lead to BPBI. There is some

electrophysiological evidence to show that brachial plexus injury could have occurred in the intrauterine period since denervation potentials are seen on day 1 after delivery which ought not to be possible in case it occurred at the moment of delivery. It has been shown that the posterior shoulder can get stuck on the sacral promontory and cause injury through a stretch on that side while the baby is in early stage of labour before any question about shoulder dystocia and traction. Bicornuate uterus has also given rise to BPBI with phrenic palsy. There are also expert opinions where in majority of the high-risk patients diabetic women delivered by operative vaginal delivery with high birth weight need not have BPBI and caesarean delivery would have been unnecessary. Although macrosomia is commonly associated with BPBI, yet elective caesarean delivery in women with more foetal weight is not beneficial, unless they were also diabetic. The nerve injury can affect the growth and development of the shoulder. Testing if any nerve signals are present in the muscle of the upper arm may be required in unrecovered cases to correct rupture or avulsion surgically.

Electrodiagnosis and image studies can be useful for prognostic and surgical planning providing data to characterize the root viability as lesion is pre-ganglionic or post-ganglionic related to dorsal root ganglion (DRG). In the pre-ganglionic injury the lesion is proximal to the DRG and is associated with root avulsion or intraforaminal root injury. The root cannot be used as donor to reconstruct the brachial plexus. The postganglionic injury is distal to the DRG and the repair can be performed by interposing nerve grafts from the viable root/roots to the distal plexus. Nerve conduction studies and electromyography are commonly performed at three months of age as part of preoperative investigation. Technical issues and overly optimistic results led several surgeons to abandon this procedure. Motor nerve conduction studies can estimate the percentage of motor axonal degeneration, which correlates with the functional outcome. Preservation of sensory potentials in a patient with severe paralysis is indicative of pre-ganglionic lesion, which carries a grim prognosis. Detection of nerve root avulsions is the main indication for image studies. Modern image studies can detect intraspinal nerve root continuity. The ideal method for evaluation is still a matter of controversy. Some prefer computed tomography myelogram due to a higher resolution. On the other hand MRI is less invasive, allows multiplanar reconstructions, and can evaluate extraspinal lesions. Some authors report similar resolution between these methods. MRI is currently the method of choice in pediatric patients. BPBI is a common situation and there is no perspective of adequate prevention.

#### CONCLUSION:

Early specialized centers with multidisciplinary approach should be provided to all BPBI patients who do not recover by 4-6 weeks. BPBI patients should undergo a rehabilitation program starting at the earliest possible extending up to an age of 2 years till the nerve regenerates. Avulsion and rupture of nerve are indicated for surgery for better results.

#### REFERENCES

1. Suneet P Chauhan, Sean B Blackwell, Cande V Ananth. Neonatal brachial plexus palsy: incidence, prevalence, and temporal trends. *j.semperi.* 2014 Jun; 38(4):210-8.
2. Ghai OP Essential Paediatrics. Ch. 5, 4th revised reprint. Delhi: Interprint Publishers; 1985 p. 55, 423.
3. Venkattaramani H, Bhardwaj P, Faruquee SR, Sabapathy SR. Functional outcome of nerve transfer for restoration of shoulder and elbow function in upper brachial plexus injury. *J Brachial Plex Peripher Nerve Inj* 2008; 3:15.
4. Srilakshmi D, Chaganti S. A holistic approach to the management of Erb's palsy. *J Ayurveda Integr Med* 2013; 4:237-40.
5. Carlos Otto Heise, Roberto Martins, Mário Siqueira. Neonatal brachial plexus palsy: a permanent challenge. *Arq. Neuro-Psiquiatr.* São Paulo Sept. 2015, vol.73 no.9.
6. J. Gert van Dijk, Willem Pondaag, Martijn J. A. Malessy. A review of electromyography in OBPL. Chapter-6, Muscle and nerve, 2001, 24: 1451-1461.