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Clinical assessment of the infant and child following perinatal brachial plexus injury

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ABSTRACT

Study design: Literature review.
Introduction: After perinatal brachial plexus injury (PBPI), clinicians play an important role in injury classification as well as the assessment of recovery and secondary conditions. Early assessment guides the initial plan of care and influences follow-up and long-term outcome.
Purpose: To review methods used to assess, classify and monitor the extent and influence of PBPI with an emphasis on guidelines for clinicians.
Methods: We use *The International Classification of Functioning, Disability, and Health (ICF)* model to provide a guide to assessment after PBPI for rehabilitation clinicians.
Discussion: With information gained from targeted assessments, clinicians can design interventions to increase the opportunities infants and children have for optimal recovery and to attain skills that allow participation in areas of interest.

Introduction

The purpose of this paper is to review methods to assess and classify perinatal brachial plexus injury (PBPI) in infants and children with an emphasis on guidelines for clinicians. PBPI which occurs primarily during the birth process can be transitory or have long-term consequences.[1] The incidence of PBPI reportedly ranges from 0.38 to 4.6 per 1000 live births depending on mean birthweight and obstetrical care in the region.[1–4] The most frequent cause of PBPI is a unilateral traction injury due to catching of the anterior or posterior shoulder behind the symphysis pubis or sacrum of the mother.[5–8] This is referred to as shoulder dystocia. Other risk factors for PBPI include maternal gestational diabetes, prolonged labor, labor induction, mechanical assistance (vacuum, forceps) or infant size > 90th percentile (4500–5000 g).[9,10] Despite the known risk factors, the positive predictive values for identifying PBPI prior to birth are less than 15%.[11] Risk factors continue to be investigated with the goal of prevention.[12,13]

The recovery rate from PBPI is now estimated to be closer to 65%[14–17] versus previous reports of 90%.[18] The difference in rate is influenced by the definition of complete recovery, the scale or method used to measure recovery and the age of the child. Incomplete recovery is more apparent in older children as daily upper limb tasks increase and become more complex.

Clinicians have an important role in injury classification as well as the assessment of recovery and secondary conditions. Early assessment guides the initial plan of care and influences follow-up and long-term outcome.

Models of rehabilitation

Clinicians use theoretical models to guide the choice of assessment and intervention and to conceptualize outcomes. The traditional medical model concentrates on curing disease with physical impairment as the main focus. The International Classification of Functioning, Disability, and Health (ICF) developed by the World Health Organization (WHO, see Fig. 1).[19] is a more contemporary model used by rehabilitation clinicians. This model relies on the dynamic interaction of multiple subsystems in which environmental factors play a key role. Each level of the ICF framework is relevant at all ages yet, the treatment priorities after PBPI typically shift from a strong emphasis on body, structure and function in infancy toward greater emphasis on activity and participation as the child gets older (see Table 1).

The ICF can assist the clinician with decisions on measurement including what, when and which measurement tool to choose.

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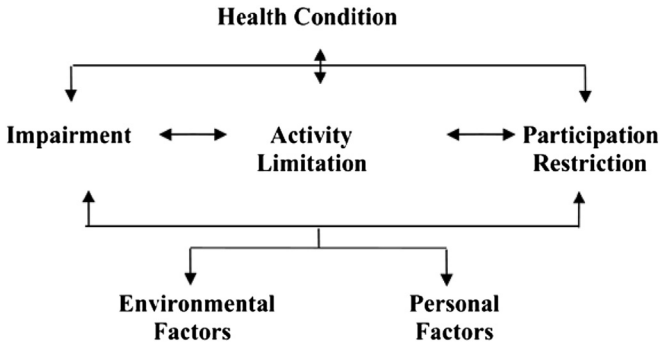

Fig. 1. International Classification of Functioning, Disability, and Health.

Tables 2 and 3 provide a sample list of outcome measures (with abbreviations) classified within the ICF. Table 2a lists assessment tools that are validated for this population (Table 2a). Table 2b includes standardized assessments that are potentially useful but currently are not validated for use after PBPI. These tables are guidelines in the choice of assessment for infants and children with PBPI.

Assessment: infant

Early infancy is the time to focus on impairment (Table 1). During this period, the team determines the extent of the injury and monitors recovery. Early monitoring informs the decision regarding the need for reconstructive nerve surgery. Select medical tests such as electrodiagnostic measures, MRI, and ultrasound are often used to verify clinical findings.

History

Key information to gather from medical records and parents/caregivers includes a history of maternal gestational diabetes, incidence of sibling PBPI, length of maternal labor and mechanical assistance at delivery. Additional information to document includes the incidence of birth hypoxia, infant APGAR scores, infant birthweight, clavicular fracture and the appearance, posture and movement in the affected limb post-birth. If the history is obtained weeks to months after birth specifics regarding the progression and quality of affected limb movement can be obtained. Details of the actual birth and birthing experience are also important to explore with parents. For many it has been a traumatic experience which they may have not resolved emotionally[85] and can ultimately affect their ability to respond to the needs of their infant.

Observation

An initial observation of the infant's state,[66] parent–infant interaction,[86] infant posture[60] and general sensorimotor behavior[23] should be conducted as all of these will greatly affect the formal assessment and intervention. An infant who is highly irritable or a parent who is fearful of the affected limb may influence testing priorities and techniques. Resting posture and spontaneous movements observed in the neonatal period after PBPI provide a general indication of the extent of the injury, muscular involvement and the presence of pain. Global motor asymmetries, not just in the upper limb, affect the development of postural control and long-term function and should be observed and monitored as they may be indicative of central neurological issues.[60,87,88]

After partial or full denervation, the affected upper limb often lies immobile in postures that provide evidence of the lesion. For example, the common "waiter's tip" position of shoulder internal rotation/adduction, elbow extension, supination and wrist flexion suggests injury to the C5–C6 (C7) spinal nerves or roots with partial or full denervation in the associated muscle groups.[2] Some infants maintain the head turned away from the affected side, which may be indicative of injury to neck musculature (i.e., scalenes or sternocleidomastoid), the presence of regional nerve pain or sensory neglect. Sustained asymmetrical head posturing places an infant with PBPI at-risk for torticollis,[89,90] and/or secondary plagiocephaly.[89,90]

Specific signs and symptoms are indicative of extensive nerve involvement. The presence of ptosis (drooping eyelid), miosis (pupil constriction) and/or anhidrosis (dry eye) are signs of unilateral Horner's syndrome or injury to the sympathetic trunk; which is linked to injury in the lower roots of the brachial plexus.[91] Difficulty with oxygenation, feeding and asymmetric chest expansion are symptoms of partial denervation to the diaphragm and warrant further screening for phrenic nerve injury (nerves C3, C4, and C5).[92] Concerns raised during observations require further assessment.

Objective testing

Assumptions made during an observation can be confirmed or refuted through the use of objective measurements. Table 2a provides a list of objective measures within the ICF framework

Table 1
ICF classification from infancy to adolescence

	Infant	Toddler	Preschool	School age	Adolescent
Assessment focus	Impairment & environment	Impairment & activity	Impairment & activity & participation	Activity & participation	Participation & activity
Intervention focus	• Integration of limb • ROM/strength	• ROM/strength • Integration • Child development	• ROM/strength • Hand function	• Participation in age related school & leisure activities • QOL*	• Participation • QOL
Primary objective	• Surgery prediction • Sensorimotor recovery and function	• Hand function • Hand preference • Self esteem	• Preschool–prediction of school problems • Hand preference	• ROM/ strength:interventions • BTX-A* • Splinting • Secondary surgery	• ROM/strength: Interventions • BTX-A • Splinting • Secondary surgery
Other important considerations	• Family	• Other interventions • BTX-A • Splinting	• Other interventions • BTX-A • Splinting • Secondary surgery	• Self-efficacy • Self-esteem	• Self-efficacy • Self-esteem
Personal factors	• Child development	• Family	• Family	• Future planning	• Future planning

* BTX-A = Botulinum toxin type A; QOL = quality of life.