

Birth Brachioplexus Palsy

Early Intervention Is Crucial for Treatment

by **Michael Partington, M.D., Marshall Taniguchi, M.D., and Ann Van Heest, M.D.**

Approximately two in 1,000 newborns experience brachial plexus injuries at birth. The brachial plexus is a complex network of interconnecting nerves that innervate the arm from the shoulder to the hand. The C5 through C8 and T1 spinal nerve roots form the basis of the brachial plexus.

Injuries and lesions to the brachial plexus are common and occur for various reasons. Infantile brachial plexus cases, on which we'll focus in this article, are often related to shoulder dystocia during birth. Dystocia occurs when the baby's shoulders become impacted while passing through the birth canal, injuring the brachial plexus nerves. Tumors, irradiation and nerve entrapment also can cause brachial plexus injuries. One other predisposing factor that might be associated with a brachial plexus injury is high infant birth weight. Birth order and gender aren't factors in brachial plexus injuries.

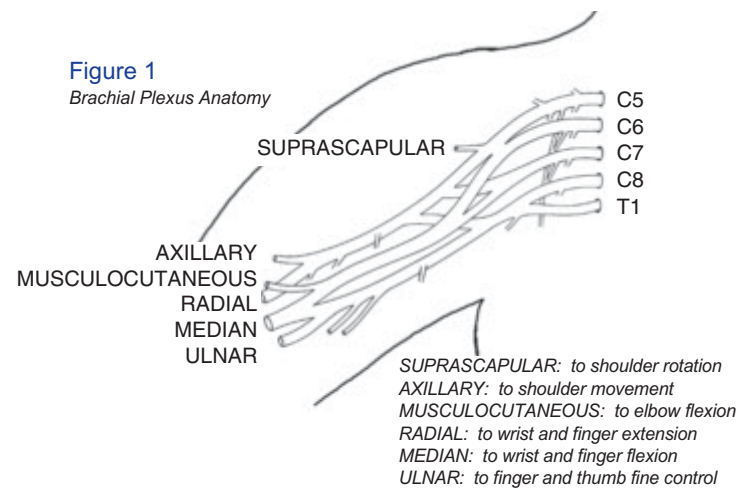
Many birth brachial plexus cases resolve without any treatment or with therapeutic exercise alone. In instances where the injury doesn't heal spontaneously, Gillette Children's Specialty Healthcare is using new diagnostic tools and treatment modalities to improve care of and increase function for children with brachial plexus injuries.

Effects of Brachial Plexus Injuries

Infants who have traumatic lesions might lose critical motor function in the shoulder, elbow, wrist and hand, along with some impairment in the fingers. Lesions in the upper trunk (C5 and C6) result in the loss of shoulder and elbow flexion, and injuries to the lower trunk (C8 and T1) impair hand function. Injuries to the complete brachial plexus impair the entire upper limb.

Full to partial paralysis of one or both arms can occur from brachial plexus injuries; therefore, early intervention is imperative if the child is to regain optimal function.

Pediatricians and primary-care physicians can often monitor infants who have brachial plexus injuries. Occupational or physical therapy should be prescribed for patients immediately after diagnosis. Therapists work with patients



who have brachial plexus injuries on range-of-motion exercises and exercises to prevent muscle contractures. They also work on movements that encourage use of the injured arm. It's important that patients continue therapy between doctor visits. Therapists can teach parents how to do exercises with their children at home.

Infants should be referred to a brachial plexopathy clinic for further treatment if, at 3 months of age, they can't normally:

- Squeeze someone else's fingers
- Bend their wrists
- Bend and straighten their elbows
- Raise their arms

Severe cases of brachial plexus palsy, when noted at birth, should be referred immediately to brachial plexus specialists.

Diagnosing Brachial Plexus Injuries

Active Movement Scale

When patients are referred to Gillette's brachial plexus clinic, occupational therapists use the Active Movement Scale (AMS) to assess motor skills. This assessment scores children's arm movements; these scores help physicians and therapists know which of the child's muscle groups are working and what type of therapy is needed.

continued on page 2

The AMS measures movement in children’s shoulders, elbows, forearms, wrists and fingers. Therapists measure 14 arm movements against gravity and with the effects of gravity eliminated. Therapists perform the AMS assessment at each patient visit — typically at three-month intervals, but sometimes monthly — to check progress.

If children recover partial function between examinations, physicians can continue monitoring. Children who fail to improve on subsequent visits — or who improve initially but then plateau at a nonfunctional level — might require electromyography (EMG) and nerve-conduction study (NCS) examinations. Infants might have their first EMG and NCS as early as 3 months of age.

EMG and NCS

NCS measures how well the nerves conduct electricity along both sensory nerves and motor nerves. When performing a NCS, the physician stimulates the patient’s nerves and records the severity of the brachial plexus injury. During the EMG, tiny needles are inserted into the muscle to assess the electrical activity generated by the muscle. Electrical signals are then converted to auditory signals as well as visual waveforms displayed on the computer monitor. The presence, size and shape of the wave produced on the oscilloscope provide information about the ability of the muscle to respond to stimulation.

The EMG helps to assess the precise location of the brachial plexus injury. It can help determine whether or not the natural recovery has been completed. Together, the EMG and NCS can help determine which children might be appropriate for surgical intervention. Gillette is one of the few U.S. health-care facilities to use EMG technology for diagnosing and treating brachial plexus injuries.

When conducting EMG exams, patients are given a sedative to reduce anxiety about the procedure. In a great majority of children, the sedative will cause temporary amnesia for the procedure. To further decrease the discomfort of the exam, physicians use topical Lidocaine cream where the needle is inserted.

Intraoperative EMG

Depending on the EMG and NCS results, physicians might determine that surgery is needed to improve the function of the brachial plexus. Surgery is begun by exposing the infant’s brachial plexus anatomy. Following exposure, intraoperative EMG studies test the damaged nerve segments. Intraoperative EMGs measure nerve-conduction strength. The basic techniques include free-running EMGs, stimulus-triggered EMGs, and intraoperative nerve conduction studies. Testing is critical to determining the most appropriate repair for the child.

Surgical Options

Depending on the intraoperative EMG results, physicians might recommend one or a combination of three surgical options:

- Nerve graft (using the sural nerve or NeuraGen nerve guide implant)
- Nerve repair
- Neurolysis

Nerve Graph and Nerve Repair

Gillette surgeons are using a new treatment — NeuraGen nerve guide implantation — to repair peripheral nerve injuries. These nerve guides — also known as NeuraGen tubes — are absorbable collagen tubes that help repair tears in patients’ peripheral nerves.

Peripheral nerves have the ability — under the right conditions — to regenerate. If the two ends of the severed nerve are brought together and repaired by a surgeon, the individual axons might regrow from the site of the repair to their proper targets. The axons are the fibers that carry information from the periphery to the spinal cord, thereby to the brain, and then ultimately back to the muscle to generate movement.

Traditionally, physicians repaired the nerve using only sutures to join the severed ends (nerve repair). Now, they use the tubes to reunite the nerve ends and provide a protective environment to direct the regrowth of the individual axons. The tube is flexible to accommodate the movement of joints and associated tendons. Tube implants are appropriate for nerve gaps of less than 2 centimeters.

For larger nerve gaps, physicians use grafting. They use the sural nerve from the leg and sew it in as a connection to fill the gap. But the nerves don’t work immediately after sewing them together or sewing in a graft. They have to regrow new fiber, from the body of the nerve cell all the way out to the muscle that it drives. This regrowth can take six to 12 months.

Neurolysis

Neurolysis is the most common type of peripheral nerve surgery for children with a brachial plexus diagnosis. Physicians perform this operation on patients whose intraoperative EMG results indicate malfunctioning nerves that are causing motor, sensory and trophic disorders. During the neurolysis procedure, the scar tissue that’s compressing the injured segment of the nerve is released. That allows improved conduction of the existing neural elements and a wider conduit for improved regeneration.

As with NeuraGen-tube implant and nerve-grafting surgeries, after neurolysis the nerves have to regrow new fiber from the body of the nerve cell to the muscle that it drives.

Shoulder Reconstruction Surgery

For some babies, nerve surgery isn’t recommended, either because they already have partial nerve function or because a complete avulsion of the nerve root has occurred.

In addition, in some babies normal shoulder movement isn’t restored after nerve surgery. In both of these instances, at an older age, a tendon-transfer surgery can be done. This will rebalance the muscles and improve shoulder function.

Authors' PROFILES

The most common tendon transfer is surgery on the shoulder. When the muscles that should rotate the arm outward can't do so, it's often helpful to transfer a tendon to the shoulder to rebalance shoulder movement and improve shoulder joint development. Without such surgery, a child's growth might hamper shoulder movement and development.

Other Treatments

Constraint Therapy

Constraint therapy is used to strengthen the affected arm once nerve regeneration is complete. During constraint therapy, therapists restrain the patient's uninjured arm by casting it, forcing use of the injured arm. Physicians use this therapy for patients who are suspected to have developmental apraxia — the ability to use the injured limb (there are nerve fibers going to some muscle groups) without knowledge of how to do so.

Patients with developmental apraxia never learned to move their injured arms. Without therapy, they function as if the injured arm isn't there and tend to complete most tasks using the "good" arm. Developmental apraxia is also common in stroke patients and children who have cerebral palsy — conditions in which one side of the body works better than the other side.

In various brachial plexus cases, clinicians found that, by limiting use of patients' uninjured arms, patients developed new movement that they hadn't known was possible.

Typically, constraint therapy lasts three to four weeks, although physicians and therapists continue to investigate the appropriate duration of the restraint. They're also evaluating the best method of restraint — casting or an arm sling — and whether partial restraint is adequate. At Gillette, we're using constraint therapy on children ages 18 months to 5 years.

At completion of the constraint therapy, physicians prescribe occupational and/or physical therapy so patients can continue working toward optimal use of the injured arm. Although there's no formal study protocol on constraint therapy, our clinicians are encouraged by patients' results.

Botulinum Toxin

Infants who have brachial plexus injuries might develop muscle imbalances. The intact muscles, which have innervation, are much stronger than the other muscles. Sometimes when one muscle is so strong, children can't develop movement in the opposing muscle. Botulinum toxin can weaken the strong muscle so that other muscles can develop.

Team Approach

An interdisciplinary team of physicians, including a neurosurgeon, orthopaedic surgeon, and pediatric rehabilitation medicine physician, staffs the brachial plexus clinic at Gillette. Occupational and physical therapists also work cooperatively with the physicians to design treatment plans for patients.



Michael Partington, M.D., is a pediatric neurosurgeon at Gillette Children's Specialty Healthcare in St. Paul, Minn.

Partington graduated from the University of Minnesota Medical School and served a residency in neurosurgery at Mayo Graduate School in Rochester, Minn. He held a research fellowship and a clinical fellowship in pediatric neurosurgery at Children's Memorial Hospital in Chicago and has practiced at Denver Children's Hospital, Denver, Colo. Partington has practiced at Gillette since 1998 and is the Center for Spina Bifida medical director.

In his practice, he has concentrated on patients with brachial plexus injuries and lesions, congenital hydrocephalus, congenital quadriplegia (cerebral palsy), and spina bifida. His professional associations include the Congress of Neurological Surgeons, the American Association of Neurological Surgeons, and the American Society of Neurosurgeons.

Marshall Taniguchi, M.D., is a pediatric rehabilitation medicine physician at Gillette, where he is medical director of the Center for Pediatric Rehabilitation. In his practice, he sees patients with brain injuries, cerebral palsy, spina bifida, brachial plexus injuries and other conditions.



Taniguchi received his medical degree from the University of Michigan in Ann Arbor. He completed a residency in physical medicine and rehabilitation at the University of Wisconsin in Madison and completed a fellowship in pediatric rehabilitation at Denver Children's Hospital, Denver, Colo.

Taniguchi is a member of the American Academy of Physical Medicine and Rehabilitation, the American Academy of Cerebral Palsy and Developmental Medicine, and the American Association of Electrodiagnostic Medicine. He is board-certified by the American Academy of Physical Medicine and Rehabilitation and by the American Board of Electrodiagnostic Medicine.



Ann Van Heest, M.D., is a pediatric orthopaedic surgeon at Gillette. She specializes in treating pediatric upper extremity conditions, including congenital and acquired disorders. She has a special interest in upper extremity problems related to neuromuscular disorders, such as arthrogyposis, cerebral palsy and spinal-cord injuries.

Van Heest received her medical degree from the University of Minnesota, where she later completed her orthopaedic surgery residency. At Harvard University, she completed a fellowship in hand and upper extremity disorders. She joined Gillette in 1993. Van Heest is board-certified by the American Board of Orthopaedic Surgery, with a certificate of added qualifications in hand surgery. She is a member of the American Academy of Orthopaedic Surgeons and the American Society for Surgery of the Hand.

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Gillette Welcomes John Garcia, M.D.

Gillette welcomes John Garcia, certified sleep specialist, to our medical staff. Using a combination of behavioral management and medications, Garcia will work with Gillette patients who have disabilities and associated sleep disorders. These disorders include obstructive sleep apnea, sleepwalking, circadian rhythm disorders, and restless legs syndrome.

Garcia is a graduate of the University of Iowa School of Medicine. He completed his pediatric residency and a fellowship in behavioral/developmental pediatrics at Riley Hospital for Children in Indianapolis, Ind. He completed a sleep training program at the Minnesota Regional Sleep Disorders Center in Minneapolis.

Garcia is available for patient appointments at our main campus in St. Paul and our Burnsville Clinic. To make referrals to Garcia at Gillette, call 651-229-3944 or 800-719-4040 (toll-free).

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