Original Article

Outcome Following Nonoperative Treatment of Brachial Plexus Birth Injuries

Patricia DiTaranto, MD; Liliana Campagna, OT; Andrew E. Price, MD; John A. I. Grossman, MD, FACS

ABSTRACT

Ninety-one infants who sustained a brachial plexus birth injury were treated with only physical and occupational therapy. The children were evaluated at 3-month intervals and followed for a minimum of 2 years. Sixty-three children with an upper or upper-middle plexus injury recovered good to excellent shoulder and hand function. In all of these children, critical marker muscles recovered M4 by 6 months of age. Twelve infants sustained a global palsy, with critical marker muscles remaining at M0–M1 at 6 months, resulting in a useless extremity. Sixteen infants with upper and upper-middle plexus injuries failed to recover greater than M1–M2 deltoid and biceps by 6 months, resulting in a very poor final outcome. These data provide useful guidelines for selection of infants for surgical reconstruction to improve ultimate outcome. (*J Child Neurol* 2004;19:87–90).

The correct treatment for children sustaining a brachial plexus birth injury remains controversial. Many physicians agree that a patient who presents with a global injury that includes a flail and insensate limb can benefit from early operative intervention.[1,2] On the other hand, a variety of approaches have been advocated for selecting a treatment strategy for infants with upper (C5–C6) and upper-middle (C5–C6–C7) plexus injuries based on the degree of early motor recovery.[3–7] We report the natural history with regard to functional recovery in a series of infants, all treated nonoperatively with only physical and occupational therapy, and confirm that certain patients should be selected for surgical reconstruction to benefit their ultimate recovery.

METHODS

Ninety-one infants born at the same institution with a brachial plexus birth injury were evaluated and treated with only physical and occupational therapy under the supervision of the first author over a 7-year-period (1994–2000; Table 1). During this period, there were 38,589 live births. No neonate with a brachial palsy was excluded. The patient population consisted of 38 boys and 53 girls, with an average birthweight of 3850 g. Thirty-six patients sustained an associated ipsilateral clavicular fracture. Seventy lesions were on the right side. All of the patients underwent sequential complete motor examinations at 3- to 4-month intervals from birth through a minimum follow-up period of 2 to 5 years. Recovery of critical marker muscles (deltoid, biceps, triceps, and wrist extensors) was carefully documented at each follow-up using the British Medical Research Council Muscle Grading Scale (Table 2). Therapy consisted of active, active-assisted, and passive range of motion

Received May 19, 2003. Received revised July 24, 2003. Accepted for publication July 25, 2003.

From Department of Orthopedics, Hospital Materno Infantil, Mar del Plata (Dr DiTaranto and Ms Campagna), Argentina; and the Brachial Plexus Program (Drs Price and Grossman), Miami Children's Hospital, Miami, FL.

Supported by a grant from the Dr Ralph and Marian C. Falk Medical Research Trust.

Address correspondence to Dr John A. I. Grossman, 8940 N. Kendall Drive, Miami, FL 33176. Tel: 305-666-2004; fax: 305-271-7993; e-mail: info@handandnervespecialist.com.

Table 1 Incidence of Neonatal Brachial Plexus Injuries

Year	*Live Births*	*Brachial Plexus Injuries*
1994	5470	13
1995	5863	23
1996	5667	12
1997	5471	10
1998	5317	10
1999	5414	12
2000	5387	11
Total	38,589	91

Table 2. Medical Research Council Muscle Grading System

Observation	*Grade*
No contraction	M0
Trace contraction	M1
Active movement, gravity eliminated	M2
Active movement against gravity	M3
Active movement against gravity and resistance	M4
Normal strength	M5

exercises. Shoulder and hand function were evaluated after 2 years of age using the internationally accepted classifications of Gilbert and Raimondi (Tables 3 and 4).

RESULTS

Group 1: 12 Infants

These infants presented at birth with a global palsy, including a flail and insensate limb. At 6 months of age, no patient had greater than M1 deltoid or biceps, all patients lacked active wrist extension, and all patients had persistent extensive hand paralysis. Long-term follow-up showed extensive limitations throughout the extremity with minimal functional use (Figures 1 and 2).

Group 2: 63 Infants

These infants presented at birth with a typical Erb's palsy posture: shoulder paralysis with the arm held in adduction or internal rotation, absent biceps, weak triceps, and wrist extension. At 4 to 6 months, biceps and deltoid recovered M4–M5. At 3 to 6 months, triceps and the radial wrist extensors recovered M5. At final evaluation, no significant limitations in hand and wrist function were found. Mild limitations in shoulder range of motion were seen (Figures 3 and 4).

Group 3: 16 Infants

The initial presentation at birth was similar to that of group 2. However, minimal spontaneous recovery was noted at 6 months, deltoid and biceps remained M1–M2, and wrist extension remained M0–M1. At the final evaluation, all children had a persistent deformity and functional loss (Figures 5 and 6). In 5 children, recovery of active wrist extension with reasonable hand function occurred. In 11 children, the deficit involved the shoulder, forearm, wrist, and hand.

Table 3. Gilbert Shoulder Evaluation

Grade (Function)	*Clinical Finding*
0 (None)	Completely flail shoulder
1 (Poor)	Abduction = 45; no active external rotation
2 (Fair)	Abduction < 90; no external rotation
3 (Satisfactory)	Abduction = 90; weak external rotation
4 (Good)	Abduction < 120; incomplete external rotation
5 (Excellent)	Abduction > 120; active external rotation

Table 4. Gilbert/Raimondi Classification of Impairment of the Hand in Patients With Obstetric Palsy

Grade (Function)	*Criteria*
0 (None)	Complete paralysis or slight finger flexion of no use, useless thumb—no pinch; some or no sensation
1 (Poor)	Limited active flexion of fingers; no extension of wrist or fingers; possibility of thumb lateral pinch
2 (Fair)	Active extension of wrist with passive flexion of fingers (tenodesis)—passive lateral pinch of thumb (pronation)
3 (Satisfactory)	Active complete flexion of wrists and fingers—mobile thumb with partial abduction—opposition intrinsic balance—no active supination; good possibilities for palliative surgery
4 (Good)	Active complete flexion of wrist and fingers; active wrist extension—weak or absent finger extensor; good thumb opposition with active ulnar intrinsics; partial prosupination
5 (Excellent)	Same as grade 4 (above) with finger extension and almost complete prosupination

DISCUSSION

Over the past 20 years, early operative intervention has gained increasing acceptance as the treatment of choice for carefully selected infants with brachial plexus birth injuries.[1,2,5,6,8] Nevertheless, considerable resistance to surgical treatment still exists based in large part on literature in which the actual motor recovery is not clearly defined owing to the lack of consistent and reproducible criteria for documentation.[9,10]

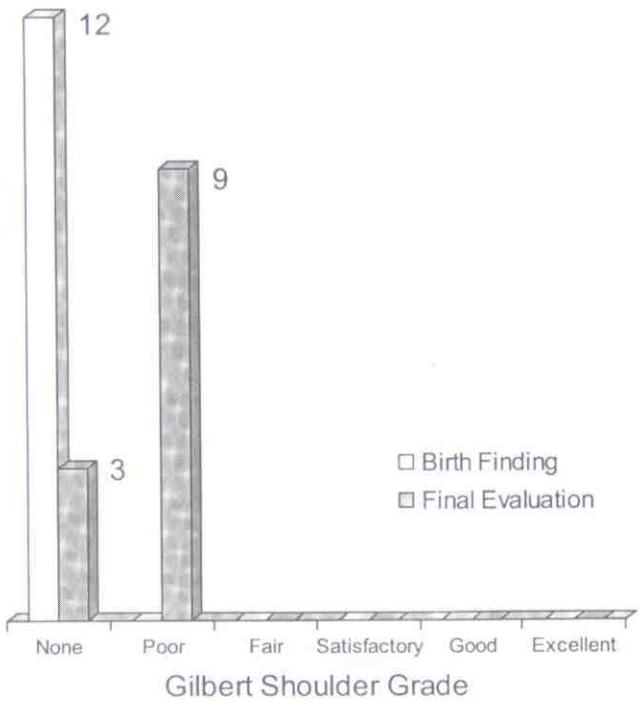

Figure 1. Group 1 (C5–T1): evolution of shoulder function global injury ($n = 12$).

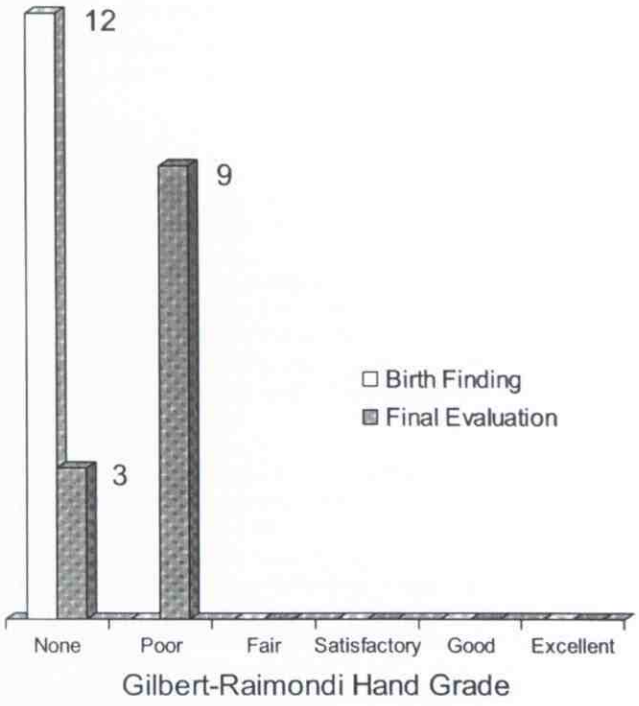

Figure 2. Group 1 (C5–T1): evolution of hand-wrist function global injury (n = 12).

Based on the natural history of spontaneous recovery by 2 years of age in the patients presented, three important conclusions can be drawn. First, children with global injury (group 1) are doomed for life with a useless limb unless some degree of extremity function can be restored. Published reports confirm that early nerve reconstruction can clearly provide a significant number of infants with useful hand motor function, protective sensibility, and elbow flexion and a stable shoulder.[1,2] The degree of recovery depends on available intra- and extraplexal donor nerves. Usually, this

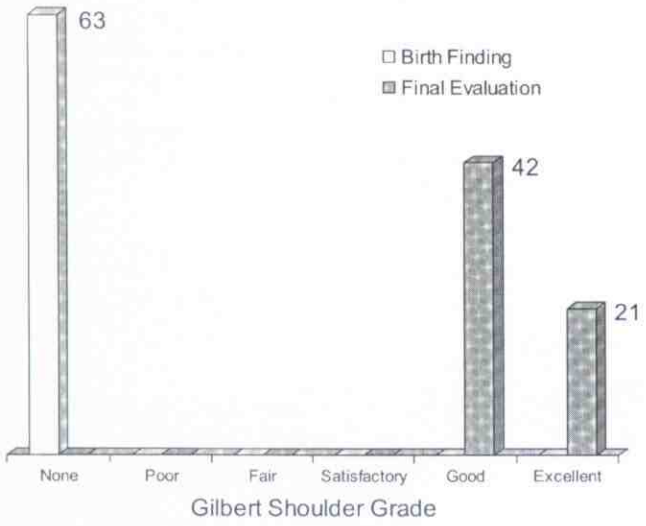

Figure 3. Group 2 (C5, C6, ± C7): evolution of shoulder function (n = 63).

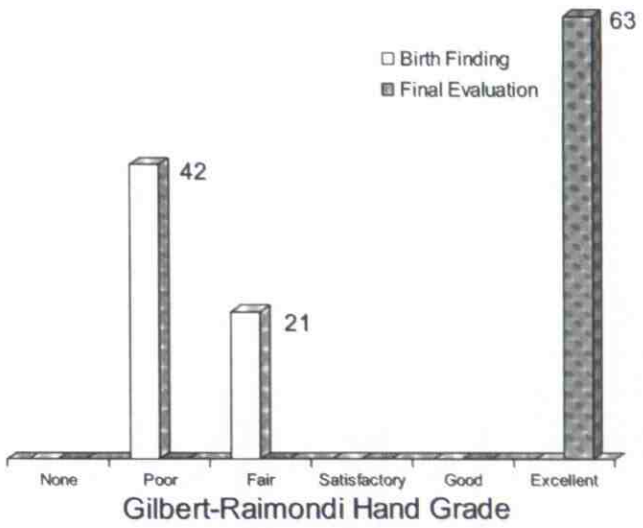

Figure 4. Group 2 (C5, C6, ± C7): evolution of hand-wrist function (n =63).

results in the potential for later muscle tendon transfers and other reconstructive procedures. Second, children with a neuropraxic injury will demonstrate a rapidly progressive motor recovery during the first 3 to 4 months of life, and by 6 months of life, the results of a careful examination in the sitting position will demonstrate potential for almost full recovery. Although some of these children with a seemingly complete neurologic recovery will develop a shoulder contracture or subluxation during growth, careful ongoing monitoring will allow prompt intervention to minimize the

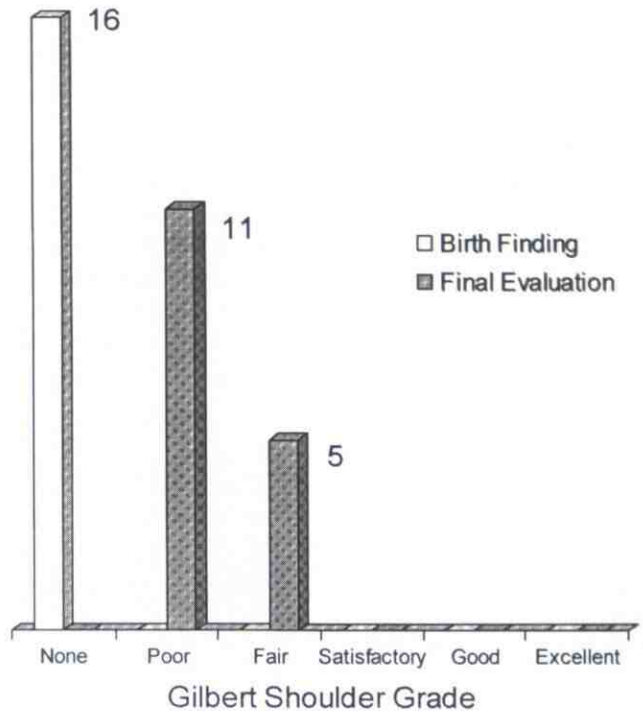

Figure 5. Group 3 (C5, C6, ± C7): evolution of shoulder function (n = 16).

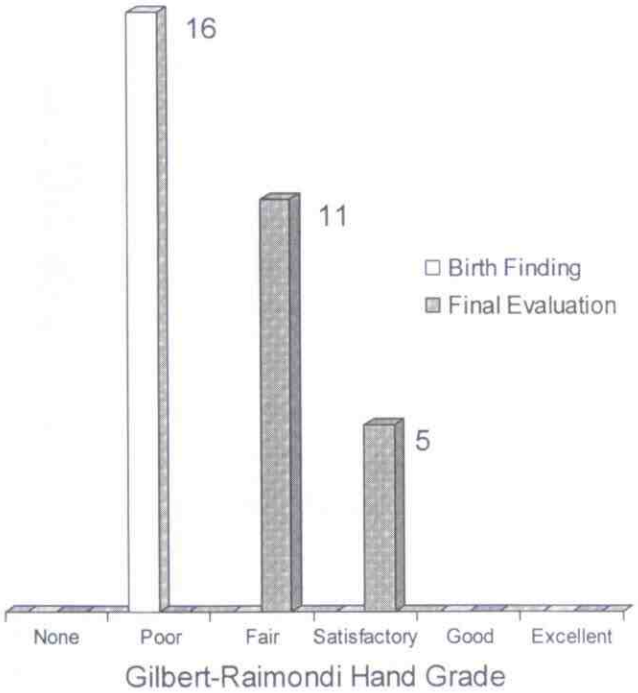

Figure 6. Group 3 (C5, C6, ± C7): evolution of hand-wrist function (n = 16).

deformity and functional loss.[11,12] Third, infants with poor recovery of biceps, deltoid, and wrist extensors at 3 to 6 months of age will undoubtedly have sustained a neurotemetic or a dense axonotemetic lesion and, like the infants in group 1, will be faced with a severe impairment limited not only to the shoulder but also potentially to the hand and wrist. The data regarding group 3 infants compared with those of group 2 confirm that although many C5, C6, ± C7 lesions will make a reasonable recovery, in some infants, the functional outcome will be extremely poor.[13]

Available data on children who have undergone early surgery by experienced surgeons suggest a very worthwhile benefit from early microneurosurgical reconstruction.[1,2,5,7,8,14] Unfortunately, early microneurosurgical reconstruction was not available to any of these children. Although the observations presented are in large part consistent with the observations of Nehme et al,[15] we did not find any cases in which the indication to intervene surgically would have changed after 6 months of age. This information on the natural history of the injury without surgical intervention provides a basis to both compare with future surgical outcome data and to help refine further the selection methods for various treatment options.

References

1. Gilbert A: Results of repair to the obstetrical plexus, in Gilbert A (ed): *Brachial Plexus Surgery.* London, Martin Dunitz, 2001, 205–217.
2. Birch R: Birth injuries of the brachial plexus, in Birch R, Bonney G, Wynn Parry CB (eds): *Surgical Disorders of the Peripheral Nerves.* New York, Churchill Livingstone, 1998; 209–234.
3. Muhlig RS, Blaauw G, Slooff ACJ, et al: Conservative treatment of obstetrical brachial plexus palsy (OBPP) and rehabilitation, in Gilbert A (ed): *Brachial Plexus Surgery.* London, Martin Dunitz, 2001, 173–189.
4. Michelow BJ, Clarke HM, Curtis CG, et al: The natural history of obstetrical brachial plexus palsy. *Plast Reconstr Surg* 1994; 92:675–680.
5. McNeely PD, Drake JM: A systematic review of brachial plexus surgery for birth-related brachial plexus injury. *Pediatr Neurosurg* 2003;38:57–62.
6. Clarke HM, Curtis CG: An approach to obstetrical brachial plexus injuries. *Hand Clin* 1995;11:563–581.
7. Waters PM: Comparison of the natural history, the outcome of microsurgical repair, and the outcome of operative reconstruction in brachial plexus birth palsy. *J Bone Joint Surg Am* 1999;81: 649–659.
8. Grossman JAI: Early operative intervention for birth injuries to the brachial plexus. *Semin Pediatr Neurol* 2000;7:36–43.
9. Strombeck C, Krumlinde-Sundholm L, Forssberg H: Functional outcome at 5 years in children with obstetrical brachial plexus palsy with and without microsurgical reconstruction. *Dev Med Child Neurol* 2000;42:148–157.
10. Eng GD, Binder H, Getson P, O'Donnell R: Obstetrical brachial plexus palsy (OBPP) outcome with conservative management. *Muscle Nerve* 1996;19:884–891.
11. Bisinella GL, Birch R: Obstetric brachial plexus lesions: A study of 74 children registered with the British Paediatric Surveillance Unit (march 1998-march 1999). *J Hand Surg [Br]* 2003;28:40–45.
12. Hoeksma AF, Ter Steeg AM, Dijkstra P, et al: Shoulder contracture and osseous deformity in obstetrical brachial plexus injuries. *J Bone Joint Surg Am* 2003;85:316–322.
13. Kay S: Brachial palsies from obstetric procedures. *Lancet* 1999;354:614–615.
14. Anand P, Birch R: Restoration of sensory function and lack of long-term chronic pain syndromes after brachial plexus injury in human neonates. *Brain* 2002;125(Pt 1):113–122.
15. Nehme A, Kany J, Sales-de-Gauzy J, et al: Obstetrical brachial plexus palsy. Prediction of outcome in upper root injuries. *J Hand Surg [Br]* 2002;27B:9–12.