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ORIGINAL ARTICLES

Extraplexal Nerve Transfers to Shoulder and Elbow in High Grade Obstetric Brachial Plexus Palsy

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Abstract

Background: There is a paucity of reports on the use of extraplexal nerve transfers in the management of severe grades of obstetrical brachial plexus injury. The present study is aimed at evaluation of results of spinal accessory and intercostal nerve transfer in restoration of shoulder abduction and elbow flexion in obstetric palsy.

Material and methods: Twenty patients with severe grades of obstetric palsy, who had avulsion of 4 or more spinal roots, underwent nerve transfer between spinal accessory nerve to suprascapular nerve and the three intercostal nerves to musculocutaneous nerve. Any available nerve root was directed to the median nerve or inferior trunk with intervening sural nerve grafts.The age at surgery ranged from 3 to 23 months, with a mean of 10 months.

Results: The children were followed up for 24 to 98 months, with an average of 40 months. No complications, per or postoperative, were noticed on harvesting of three intercostals nerves. Active abduction was restored in 18 patients with abduction strength of M4 in 4, M3 in 10 and M2 in 4. Eight patients had useful recovery in external rotation. Seventeen children restored active elbow flexion with biceps strength of M4 in 5, M3 in 13 and M2 in 2. Functional results were better when surgery was performed before the age of 6 months.

Conclusion: Use of spinal accessory and intercostal nerves is a safe and an effective procedure in the rehabilitation of patients with severe grade of obstetric brachial plexus palsy.

Introduction

The incidence of obstetric brachial plexus palsy ranges globally from 0.5 to 2 per 1000 births[1] with the higher numbers in under developed countries. The severity of injury in obstetric palsy can fall within a wide spectrum and is the key determinant of prognosis and the need for intervention. Various risk factors include large birth weight infants with big head, vacuum or forceps deliveries, shoulder dystocia, and maternal diabetes[2]. Fortunately most of the babies recover almost completely. However a few of them recover partially and develop secondary deformities.

The rate of spontaneous recovery correlates directly with the severity of injury at the time of birth. Narakas et al[3] classified these injuries in four groups.

Group I: C5 and C6 involvement (Most of cases fall in this group and have good prognosis)

Group II: C5, C6 and C7 involvement (prognosis is inferior to C5, C6 injury alone)

Group III: A total paralysis with flail extremity

Group IV injury: As in Group III with Horner's syndrome. This group of cases have the worst prognosis.

In Group III and IV, intraplexal donors are not available. Use of extraplexal donors provide basic functions in these babies[4]. The present study is aimed at evaluation of results of spinal accessory and intercostal nerve transfer in restoration of shoulder abduction and elbow flexion in severe grades of obstetric palsy.

Material and Methods

Twenty patients with avulsion of 4 or more spinal roots were treated by spinal accessory and intercostal nerve transfer to shoulder and elbow respectively. The age at surgery ranged from 3 to 23 months, with a mean of 10 months. Any available root / roots were directed to the median nerve or inferior trunk with intervening sural nerve grafts. Preoperatve assessment included a detailed clinical examination (especially for Horner sign, hand condition) and plain x-ray films of the clavicle, humerus and chest. Magnetic resonance

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imaging (MRI) of the supra-and infraclavicular brachial plexus, with babies under mild sedation, was utilized as one of the main diagnostic tools. Presence of a pseodomeningocele indicated a root avulsion injury and was confirmed subsequently during exploration. Motor power was assessed according to Toronto Muscle Grading System[5] (Table 1).

Table 1: Toronto Muscle Grading System

Muscle Grade	Description
0	No contraction
1	Contraction- no motion
2	Motion < ½ range, gravity eliminated
3	Motion > ½ range, gravity eliminated
4	Full motion, gravity eliminated
5	Motion < ½ range, against gravity
6	Motion > ½ range, against gravity
7	Full motion, against gravity

No objective sensory assessment was done as loss of sensory function is a rarity in obstetric palsy even with severest grade.

Surgical Procedure

All babies were operated under general anesthesia, initially maintained with short acting muscle relaxants. Supraclavicular brachial plexus was explored with a reverse C-shaped incision along the posterior border of lower part of sternocleidomastoid muscle and continuing above and parallel to the clavicle. A nerve stimulator was used at 0.5, 1.0 and 2.0 mA to identify the suitability of donor nerves during the initial part of the procedure. Incision was extended in to the deltopectoral groove and medial aspect of proximal arm for exploration of distal plexus. An intact nerve root, as confirmed by electric stimulation, was connected distally to the median nerve or inferior trunk with sural nerve grafts. Spinal accessory nerve was dissected distally and divided in its retroclavicular location. It was coapted to a nearby suprascapular nerve with a 10/0 nylon suture under operating microscope or fibrin glue[6]. For the harvest of intercostals nerves a semicircular incision was extended from the axilla to the inframammary region. The deep central branches of the third, fourth and fifth intercostals nerves were used for transfer to the musculocutaneous nerve.

Postoperative follow up

Postoperatively arm was strapped to the chest for a period of 4 weeks. After that gradually increasing passive exercises were started in the limb. Modified Mallet scale, as described by Al- Qattan[7], was used for assessing shoulder external/internal rotation, and a modified Medical Research Council System for assessing other shoulder movements. Range of abduction was measured with a goniometer by measuring the angle formed between the arm axis and parallel to the spinal cord axis. External rotation was measured with the child standing and completely internally rotating the shoulder, with elbow flexed and forearm placed transversally over the abdomen. The range of motion for elbow flexion was also measured with a goniometer.

Results

A total of 20 babies were rehabilitated with nerve transfers to shoulder and elbow. Donor nerves used were spinal accessory nerve and 3rd, 4th, and 5th intercostals nerves. Shoulder abduction was restored in 18 patients whereas elbow flexion could be reinstated in 17. An initial evidence of restoration of active shoulder abduction appeared at 60 ± 4 weeks. The degree of restoration of shoulder abduction ranged from 30 to 140^0. At final follow up four patients had achieved M4, ten M3, and four M2 abduction strength. Eight patients had useful recovery in external rotation.

The initial evidence of active elbow flexion appeared at 68 ± 4 weeks. The degree of restoration of elbow flexion ranged from 70 to 110^0. Seventeen children restored active elbow flexion with biceps strength of M4 in 4, M3 in 11 and M2 in 2. Hand functions were not assessed separately.

Patient details are depicted in table 2 and Fig 1 to 13.

Discussion

Management of severe grade obstetric palsy should be done as early as possible by a multidisciplinary team of specialists consisting of a brachial plexus surgeon, a pediatrician, a physical therapist, a pediatric orthopedic surgeon, a neurophysiologist, and an occupational therapist. Babies with flail arms and positive Horner sign demand an early surgical intervention to achieve optimal results. With multiple root avulsions anatomical reconstruction is not feasible and intraplexal donor nerves are limited. In such circumstances extraplexal donor nerves can be

effectively used to restore the lost functions. The most suitable extraplexal donor nerves are spinal accessory (SAN) and intercostal nerves (ICN)[7]. Traditionally SAN is used for shoulder (suprascapular nerve) and three ICNs for elbow (musculocutaneous nerve). Any available root should be directed to hand (median nerve or lower trunk). The use of three intercostals nerves does not compromise respiratory functions. With ICN to MCN neurotization the elbow flexion initially was found to depend on the respiration, and the patient usually experienced involuntary elbow flexion while sneezing or coughing. Kawabata reported his experience with intercostal nerve transfer to musculocutaneous nerve, with 84% of patients achieving M4 power in elbow flexion. Most of these babies were operated earlier than 5 months of age.

Table 2: Functional outcomes of extraplexal nerve transfers in obstetric palsy (N=20)

Case Number	Age at surgery (in months)	Follow up (in months)	Abduction (degree)	Elbow flexion (degree)
1*	4	98	140	110
2	7	26	50	70
3	9	24	40	Nil
4	5	28	50	80
5	21	34	Nil	90
6	6	27	60	80
7	9	46	90	100
8*	11	29	40	90
9	14	28	30	70
10*	6	44	130	110
11	5	39	120	100
12	23	28	Nil	Nil
13	9	52	170	100
14	13	28	60	80
15	10	28	50	Nil
16*	4	50	130	110
17	19	42	80	90
18*	7	68	140	110
19	9	29	80	70
20*	6	44	120	100

* These babies had one intact root which was used for hand reanimation

Fig.1 Severe grade obstetric palsy

Fig. 2 MR myelography showing pesudo-meningoceles at multiple root levels

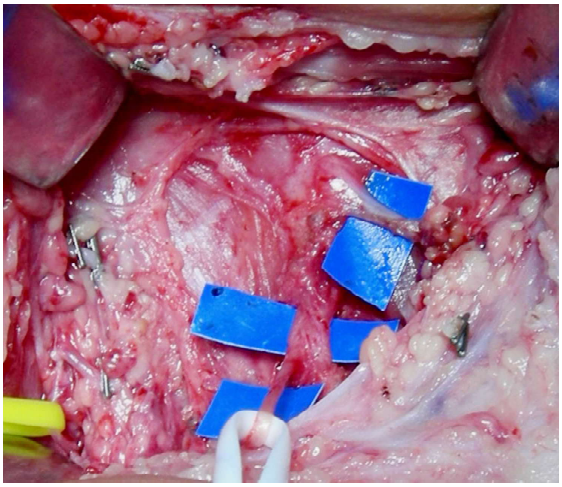

Fig. 3 No plexal elements on supraclavicular exploration

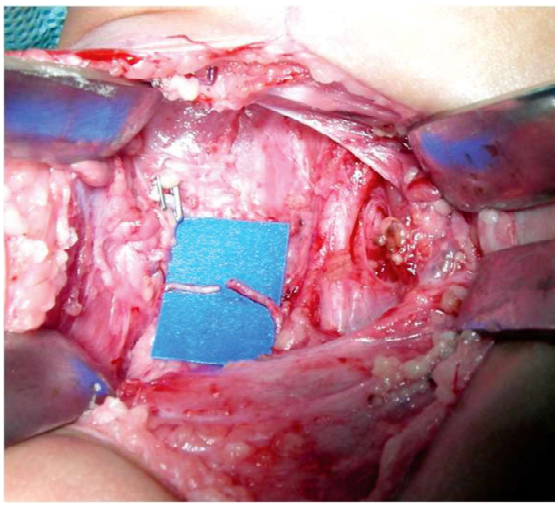

Fig. 4 Spinal accessory nerve to suprascapular nerve transfer

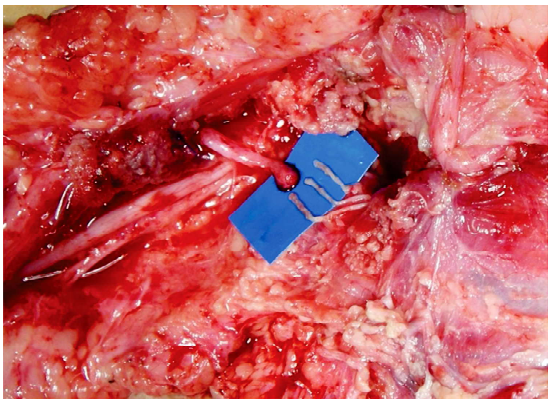

Fig. 5 Intercostal nerve transfer to musculocutaneous nerve

Fig. 6 Postoperative improvement in shoulder and elbow functions

Fig. 7 4 months old baby with severe palsy

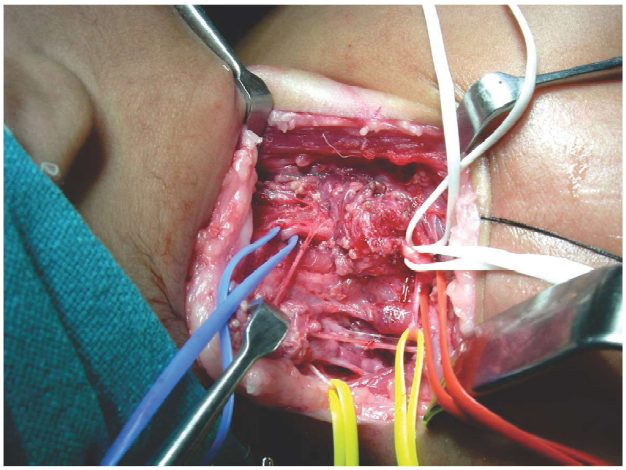

Fig. 8 C6 root intact, others avulsed

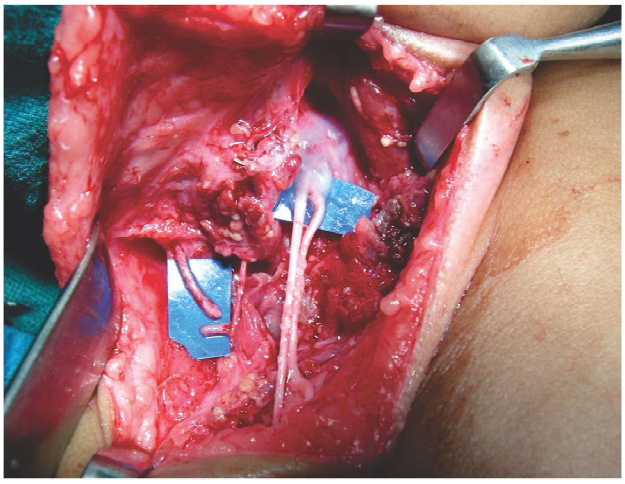

Fig. 9 SAN to SSN transfer, C5 root connected with nerve grafts to median nerve

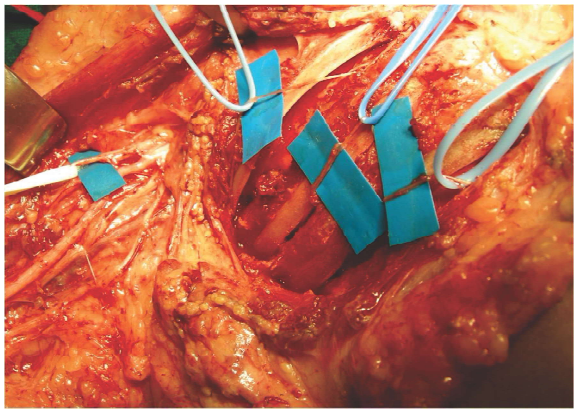

Fig. 10 Musculocutaneous nerve (MCN) in white tape, 3rd, 4th, 5th intercostal nerves dissected from the ribs

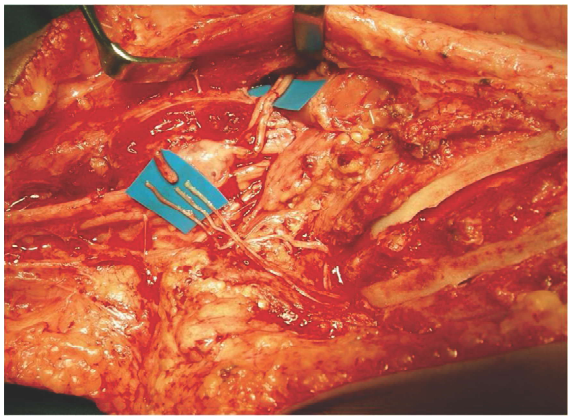

Fig. 11 Infraclavicular coaptation of nerve grafts to median nerve and intercostals nerves to MCN

Fig. 12 Post operative recovery in shoulder abduction

Fig. 13 Post operative recovery in elbow flexion

Conclusions

Obstetrical brachial plexus palsy is a devastating complication of delivery, the incidence of which has remained stable over several decades. With severe grade injury extraplexal nerve transfers using spinal accessory and three intercostals nerves is a worthwhile procedure towards suitable rehabilitation of these babies.

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