Median Nerve to Musculocutaneous Nerve Transfer for Restoring Elbow Flexion in Obstetric Brachial Plexus palsy

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Abstract

Background: Birth injuries to the brachial plexus are highly rare; however, they necessitate treatment and follow-up from infancy until skeletal maturity. Many complications may arise as a result of primary nerve surgery.

Objectives: To study the long-term complications of nerve repair procedures in patients with obstetric brachial plexus palsy.

Patients and methods: This was retrospective research that was performed on 8 cases having obstetric brachial plexus palsy and underwent nerve surgery procedure. The ages ranged from 3 to 20 months. The assessment of the surgical procedure outcomes involves post-operative evaluation of both short and long-term complication.

Results: Our study showed that the most frequent long-term complications were decreased innervation (25%), followed by decreased strength and stamina and balanced discoordination (12.50%) while there were no complications encountered in 50% of cases. The short-term complications included wound infection, seroma and hematoma.

Conclusion: The nerve surgery procedure is an efficient primary approach in the management of cases with brachial plexus injury. However, a long-term follow-up is usually associated with late squeal such as reduced innervation and decrease in the overall strength and stamina.

Keywords: ERB's palsy; Nerve surgery; Obstetric Brachial Plexus Palsy (OBPP); Complications.

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Introduction

OBPP is not an uncommon condition, multiple studies around the world show the incidence ranges from 0.15 to 3: 1000 live births **(Thatte et al., 2017).**

Brachial plexus birth palsy (BPBP) happens because of challenges during delivery related to the fetal-maternal size mismatch. Major risk factors for BPBP include great birth weight, breech presentation, shoulder dystocia, assisted delivery, and previously having a child with obstetrical brachial palsy **(Al-Qattan and Al-Kharfy, *1996*)**

Obstetric brachial plexus injury significantly affects the quality of life for a child. The performance of daily activities, involvement in school and the community, and overall quality of life can be compromised by structural deficits that affect utilizing of the upper extremity **(El-Shamy and ALsharif, 2011)**

The extent of neural impact in brachial plexus birth palsy varies from temporary neurapraxia to avulsion-type root injuries. The function of the shoulder and elbow is influenced by damage to the upper plexus (C5-6), whereas the function of the wrist is influenced to varying degrees by more severe damages involving the upper and middle plexus (C5-7). Finger function is also impacted in total damages (C5-T1) **(Sheburn et al., 1997).**

Most cases of brachial plexus birth palsy resolve on their own during the first year of life, with 66-92% of patients experiencing spontaneous recovery. While the indication for brachial plexus surgery could be varied, it is widely acknowledged that severe total injury or upper-middle plexus injury without any signs of improvement in three-six months serves as an indication for early surgical intervention **(Smith et al., 2004).**

The main focus of reconstruction is on restoring shoulder movement, elbow flexion, and hand function. This typically involves surgical exploration of the brachial plexus to remove neuromas and graft any resulting defects with sural nerve cable. In some cases, neurolysis may be required. Additionally, Intra-plexus or extra-plexus motor nerve transfers are often carried out based on clinical motor investigation and the specific anatomy of the plexus damage **(Swan and Clarke, 2014).**

Although numerous studies demonstrate encouraging outcomes after addressing obstetric brachial plexus injury, patients with permanent BPBP frequently experience muscle weakness and imbalance in the affected upper limb **(Strömbeck et al., 2007).**

This may result in soft tissue contractures with subsequent deformities in the adjacent joints **(Nath et al., 2007)**

The work aimed to examine the short and long-term complications following nerve surgery procedures for treating OBPP injury**.**

Patients and methods

This was retrospective clinical research that was performed on 8 cases that underwent nerve surgery procedures to repair OBPP. This research was performed at plastic surgery department, Zagazig university hospital, Zagazig University). Ethical approval code: SVU-MED-PIS013-2-21-9-235.

The patients include children < 20 months of age (with mean age at the operation time was 12.875 months), with both sexes (4 boys and 4 girls).

The exclusion criteria included: cases coming with their age > 20 months, cases with MCR more than or equal 3, babies who were refused to be included in the study, cases with post-traumatic injury of the brachial plexus, and cases un-fit for surgical procedures

The brachial plexus injuries involved Erb’s palsy in 5 patients and extended Erb's palsy in 3 patients. The extent of these injuries was comparable to Narakas' group 3 or 4. Four of these cases underwent neurolysis procedures, while four underwent nerve graft procedures.

All patients admitted with inclusion criteria were subjected to: General examination regarding vital signs and general condition. Routine examinations (CBC, Coagulation profile, liver and kidney function tests). Pediatric consultation for preoperative evaluation and estimation of medication doses (Antibiotics, analgesics). Specific investigations: Chest fluoroscopy. Cervical CT or MRI for measurement of the lesion extent and EMG and NCS.

Surgical technique: The vast majority of infant plexuses explorations are performed via supraclavicular approach in the posterior triangle of the neck., Dissection is performed under loupe magnification in sub platissmal plane where the omohyoid muscle was identified and divided along its tendinous mid portion. The upper and middle trunks were then identified and dissected along the lateral border of the plexuses in proximal to distal direction. Intra operative use of nerve stimulator is useful, **(Fig.1 &2).**

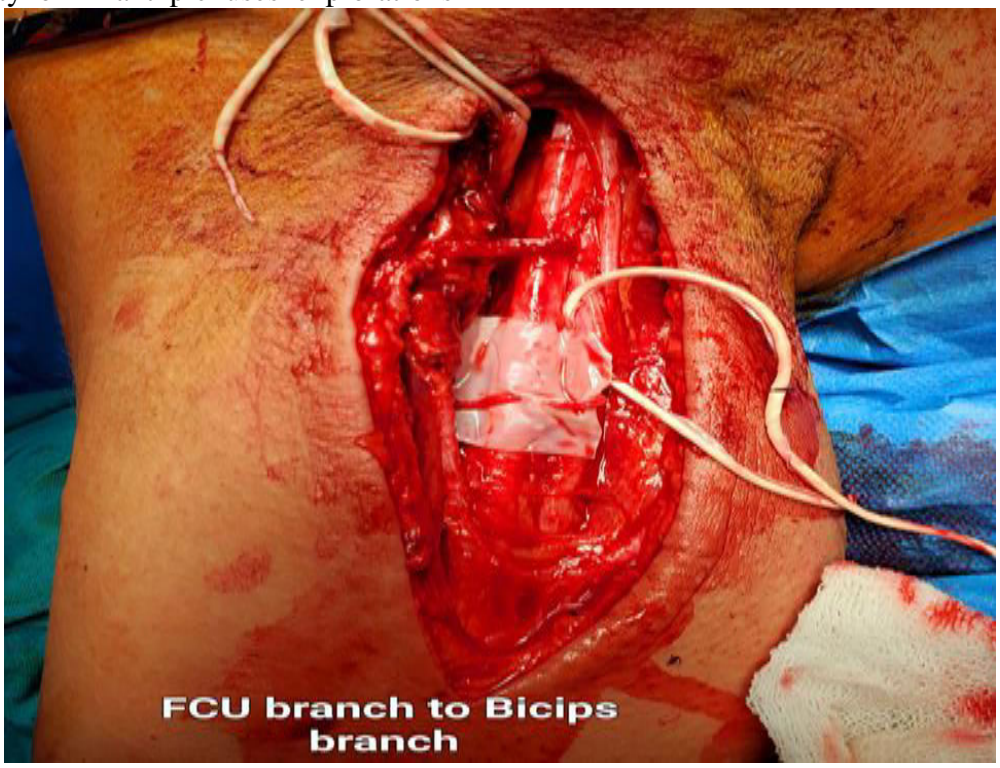

Fig .1. Intraoperative identification of flexor carbi ulnaris of ulnar nerve and musculocutaneus nerve

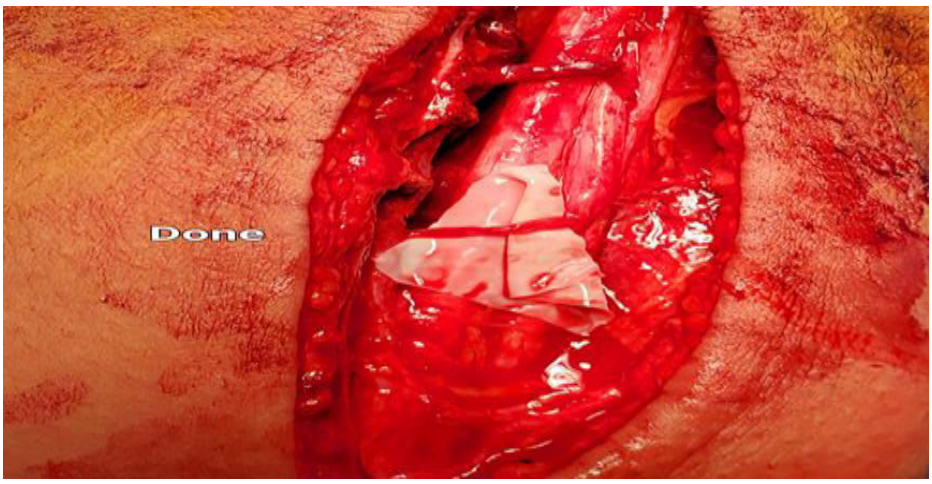

Fig .2. Oberlin type 1 technique

Neurolysis has been proposed as the standard technique to augment residual conduction within neuroma in continuity. The external neurolysis is usually performed in preference to an internal neurolysis. Nerve graft with sural nerve following neuroma resection was used when there was a gap between the proximal and distal stumps**, (Fig.3), (Eduardo and James, 2021).**

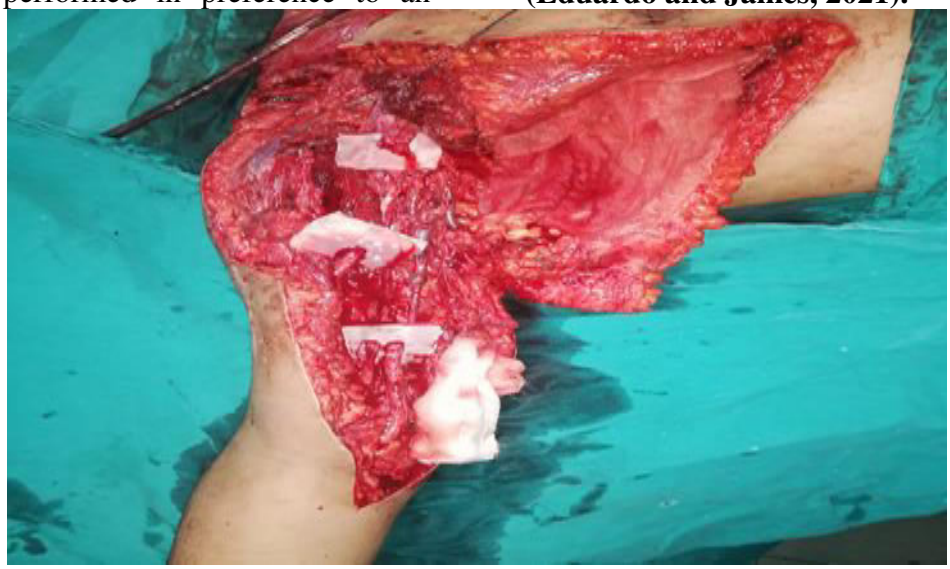

Fig.3. Intraoperative ulnar to musculocutaneus nerve transfer.

The assessment of the surgical procedure outcomes involves post-operative evaluation of both short-term and long-term complication. The short-term outcome involves the assessment of both early and late post-operative complications. Among these patients, 8 patients were evaluated at 1 year follow-up after the nerve repair procedure to investigate the long-term outcomes which include the assessment of innervation, strength and stamina, and balanced coordination**, (Fig.4).**

Fig .4. Post-operative shoulder abduction and elbow flexion with muscle incoordination.

Statistical analysis

Data management and Statistical Analysis: Using SPSS version 20, data entry, processing, and statistical analysis were completed (Statistical Package for the Social Sciences). The significance tests for Kruskal-Wallis, Wilcoxon, Chi-Square, logistic regression analysis, and Spearman's correlation were used. Each variable's data type (parametric and non-

parametric) was reported, and the appropriate analysis was run. Statistical significance was defined as a P-value of 0.05 or below (5%).

Results

This retrospective study involved 8 patients from the plastic surgery department at Zagazig University Hospital with obstetric brachial plexus palsy and underwent nerve surgery repair. Their ages ranged from 8 to 18 months with a mean age of 12.875 ± 3.35676 months. 50% of patients were males and 62.50% had Erb's palsy. The details of demographic and clinical features were demonstrated in (**Table1**).

Table 1. Patients' demographic and clinical features (N=8)

Parameters		**Frequency**	**Percentage (%)**
Gender	Male	4	50%
	Female	4	50%
Age	**Mean ± SD**	12.875 ± 3.35676	
	Median (range)	13 (8-18)	
Trauma type	Erb's palsy	5	62.50%
	Extended Erb's palsy	3	37.50%

In the follow-up of our cases, 50% had long-term complications, and 50% had short-term complications. The details of long-term and short-term complications were demonstrated in (**Tables 2 &3**) and (**Figs 5&6**) respectively. (**Table. 2**) shows the long-term complications of nerve transfer in our cases; The most frequent one was decreased innervation in 25% of cases, followed by decreased strength and stamina and balanced discoordination each occurring in 12.50% of cases.

Table 2. Long-term complications among the studied cases (N=8)

Long term complications	**Frequency**	**Percentage (%)**
Decrease innervation	2	25%
Decrease strength and stamina	1	12.50%
Balanced discoordination	1	12.50%
No complications	4	50%

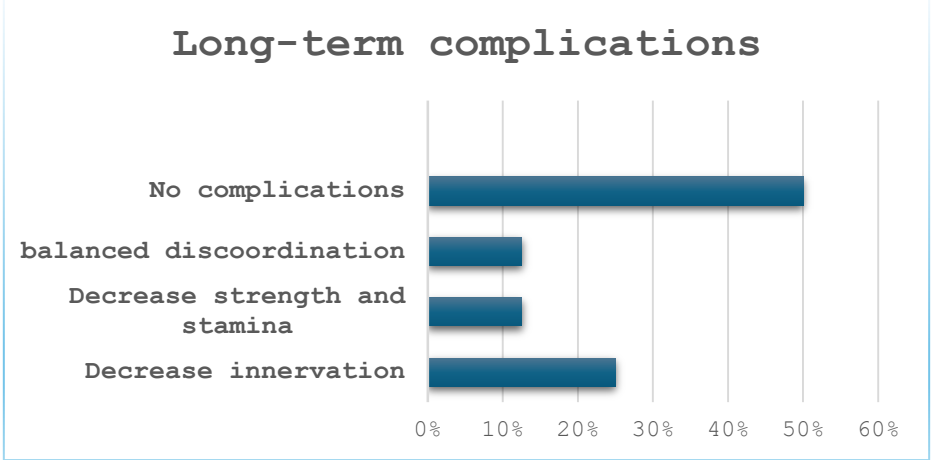

Fig 5. Long-term complications among the studied cases.

(**Table.3**) shows the short-term complications in our cases; the most frequent one was wound infection which occurred in 25% of patients, followed by seroma in 12.50% of patients, and hematoma in 12.50% of patients.

Table 3. Short-term complications among the studied cases (N =8)

Short term complications	Frequency	Percentage (%)
Wound infection	2	25%
Seroma	1	12.50%
Hematoma	1	12.50%
No complications	4	50%

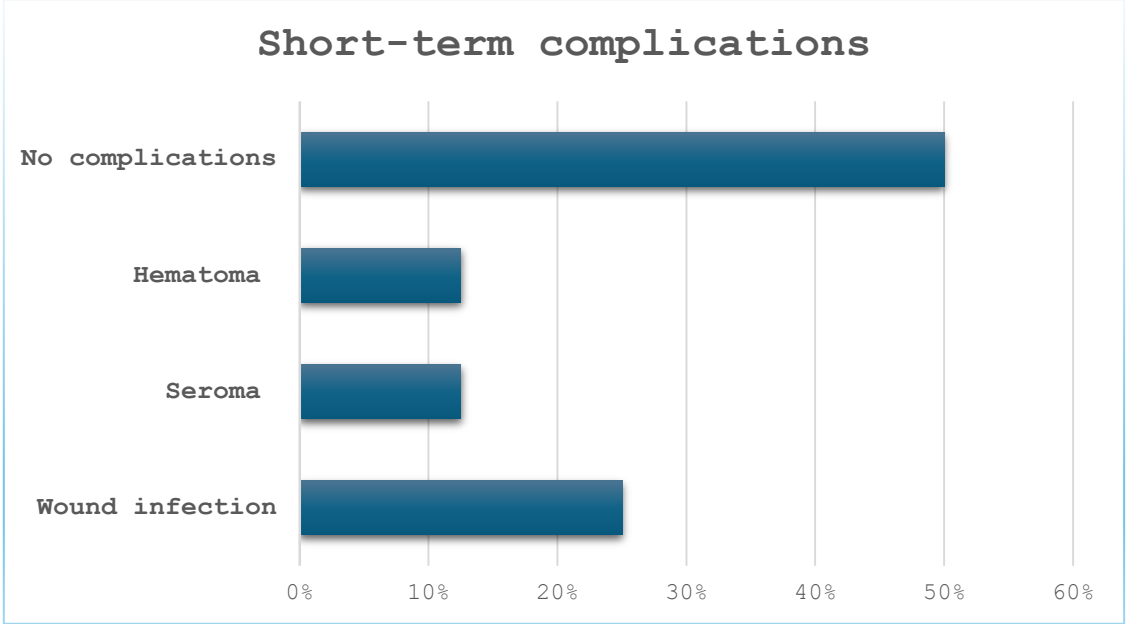

Fig 6. Short-term complications among the studied cases

Discussion

OBPP is characterized by a flaccid paresis of an upper extremity that is the result of traumatic stretching of the brachial plexus at birth **(Vakhshori et al., 2020; Akcakaya et al., 2021)**, Obstetrical brachial plexus palsy is caused by injury to the cervical roots C5-C8 and thoracic root T1, as evidenced by the passive range of motion being higher than the active range **(Van der Looven et al., 2020)**. Although most damages are transient **(Eldridge et al., 2020; Hardie et al., 2024; Barbosa et al., 2021),** In 70-92% of cases, the patient experiences a complete return of function; however, some cases result in a prolonged and persistent disability **(Leblebicioğlu, 2022)**. This is a significant source of pregnancy-related medical litigation **(Narendran et al., 2022)**.

The primary objective of reconstruction is to restore shoulder mobility, elbow bending, and hand functionality. This usually entails surgically exploring the brachial plexus to eliminate neuromas and graft any resulting nerve defects. There are numerous studies demonstrate encouraging outcomes after addressing obstetric brachial plexus injury However, patients with permanent BPBP frequently experience muscle weakness and imbalance in the affected upper limb **(Strömbeck et al., 2007).**

Motor disorders and loss of functional movements always compromises patient quality of life. Several authors have investigated the pathophysiology of delayed complications that occur after Brachial plexus birth palsy. It is widely acknowledged that muscle imbalance in Brachial plexus birth palsy may result in soft tissue contractures, ultimately causing joint defects, particularly impacting shoulder joint function **(Nath et al., 2007).**

This current study showed that the decreased innervation was the most

frequent long-term complications which represent 25% of our cases. Impaired innervation not only affect the movement and sensation, nevertheless also affect normal growth and functioning of the impacted muscles and bones. The decreased strength, stamina and balanced discoordination occurred in 12.50% each with no complications in 50% of cases. There is a direct correlation between the quality of nerve supply and the strength and stamina of any given body region. Stamina and strength decrease as the supply decreases.

This study showed that the short-term complications in our cases; the most frequent one was wound infection which occurred in 25% of patients, followed by seroma and hematoma in 12.50% of patients for each, followed by hematoma in 15% of patients and with no complications in 50% of cases. In accordance with our results, **O'Berry et al. (2017)** demonstrated that up to 35% of children experiencing life-long functional impairment. **John et al. (2018)** found that an internal rotation contracture is the most frequently encountered issue. These children have significant challenges with feeding and dressing due to the absence of external rotation, which significantly restricts their functionality. Therefore, **Price et al. (2013)** hypothesized that in the majority of cases, secondary musculoskeletal surgeries are necessary for the shoulder after BPBI, typically at the age of 2 to 3 years.

Moreover, an elbow extension deficit was present in nearly all cases (90%) with permanent Brachial plexus birth palsy. The deficiency of elbow extension in cases with residual C7-T1 neuropathy was related to muscle imbalance, which was resolved by the recovery of C5-6 function **(Strömbeck et al., 2007)**. **Ruchelsman et al. (2011)** also demonstrated that Patients diagnosed with BPBI often have restricted wrist extension. So, a tendon transfer procedure is one of the most commonly employed techniques to restore wrist extension. **Haerle and Gilbert (2004)** reported a series of 73 cases that underwent surgery among 1978 and 1994 for avulsions and complete paralysis with correlated root ruptures. 123 secondary procedures were performed throughout the average 6.4-year follow-up period, including 46 shoulders, 26 hand, 25 wrists, 13 elbow, and 13 forearm procedures.

Chuang et al. (2005) conducted a retrospective analysis of 78 OBPP cases that had nerve transfer surgery. In their investigation, 86% of cases achieved abduction higher than 90° and external rotation higher than 60°. Additionally, 59% of cases had satisfactory elbow flexion (as evidenced by a positive hand-to-mouth test), while 63% achieved satisfactory hand outcomes. **Strömbeck et al. (2000 and 2007)** examined a diverse patient cohort, with two-thirds receiving non-surgical treatment and one-third undergoing operative intervention, over a 13-year follow-up period. They conducted comparisons of outcomes between the two groups at an average of five years and again at 13 years post-treatment. The authors observed that the shoulder's active external rotation was commonly restricted; however, there was a slight increase in external rotation over the course of the extended follow-up period, partially linked to additional procedures. However, nearly all patients (90%) experienced elbow extension deficit, which had worsened significantly during the later stages of follow-up.

Sheburn et al. (1997) conducted a study involving twenty cases that underwent plexus operation at an average age of 10.5 months. After the operation, 93% of the patients showed improved strength. The authors noted that better results were observed in cases where the procedure was performed on patients younger than 6 months and when nerve grafting has been employed. **Birch et al. (2005)** reported the results of a study that

involved 100 children. The study found that 33% of C5 repairs, 55% of C6 repairs, 24% of C7 repairs, and 57% of operations on C8 and T1 resulted in favorable outcomes. Surgery was performed at a median age of 4 months.

Conclusion

The nerve surgery procedure is an efficient initial approach in the management of cases with brachial plexus damage, and it can provide cases with a satisfactory enhancement in their shoulder and elbow function. Nevertheless, a long-term follow-up is usually associated with late squeal in the form on reduced innervation and decrease in the overall strength and stamina.

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