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CASE REPORT

Different Modalities of Management of Brachial Plexus Injuries

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Abstract

Introduction: ***Adult traumatic brachial plexus injuries constitute about 33 % of all peripheral nerve injuries and constitute 1% of poly-traumatized patients. They range from partial weakness to total weakness of all upper limbs.***

Aim: ***To evaluate the different modalities and recent surgical techniques for the treatment of traumatic adult brachial plexus injuries.***

Patients and materials: ***Twenty-eight patients presented with post-traumatic adult brachial plexus injuries from April 2018 to November 2023. As regards collected data about the age, sex, causes, and mechanism of brachial plexus injuries, the decision for surgical approaches and technique was made.***

Results: ***The majority of the patients were adult males with a mean age of 31 years; 72% encountered motor vehicle and road traffic Accidents (RTA), and 28 % were motorbike accidents. 60% showed supraclavicular upper brachial plexus injuries, mainly C5-6 root avulsion. Nerve transfer, Neurolysis, and nerve grafting were the main surgical procedures that were followed. Function upper limb recovery had been achieved in about 61% of the study cases.***

Conclusion: ***Brachial plexus surgery achieved significant results in regaining shoulder and elbow joint movement. Nerve transfer and Neurolysis achieved better improvement than nerve grafting.***

Keywords: Traumatic adult Brachial plexus injuries, Neurolysis, Nerve transfer, and Nerve Grafting

1. Introduction

About one-third of the peripheral nerve injuries presented as brachial plexus injuries and constitute 1% of poly-traumatized patients.[1,2,3] Adult males are more affected than females, with a mean age of 31-year-old with traction injury of 80% of patients with profound functional impairment of the upper limb. Patients presented with mild weakness or paresis of the shoulder and /or elbow to totally paralyze and loss of failing in the entire upper extremity.[4,5] In the last two decades, significant advancements in microsurgical procedures and refinement in the concept of peripheral nerve improvement and repair have resulted in highly advanced management techniques for patients presented with profound injuries to the brachial plexus.[6,7]

The aim of the study is to evaluate the different modalities for treatment of brachial plexus injury to restore shoulder and elbow joints movement.

2. Patients and methods

Twenty-eight patients presented with adult traumatic brachial plexus injuries were operated on by the team from April 2018 to November 2023. The prospective study reviewed a full clinical examination including the age, mechanism of trauma, mode of injury, ranges of shoulder and elbow joint movements, which were evaluated and recorded in all patients, and the incidence between trauma occurring and surgical treatment, type of surgical techniques, involving nerve transfer, grafted nerves, and neurolysis followed by functional outcome according to Medical research council (MRC) scale and the time of follow up. The main age was 31 years (26-34 years).

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There were C5-C6 level injuries in thirteen patients, and eight patients presented with C5-6-7 level injury and full brachial plexus injury in seven patients. All patients underwent nerve conduction velocity, and an EMG study was performed immediately after injury, followed by a follow-up after 3 months with the same study. Patients developing C5-6 root avulsion showing lost shoulder and elbow movement but reserved hand movement underwent the first operation for nerve transfer of spinal accessory nerve to the suprascapular nerve (neurotization) for restoration of just initiation of shoulder abduction up to fifteen degrees followed by the second operation neurotization of musculocutaneous nerve by fascicles of median and ulnar nerves. Followed by physiotherapy for 6 months. Patients with C5-T1 complete avulsion and flail limbs and underwent neurotization of SCN by SAN at the first operation, then negotiation of musculocutaneous nerve by four intercostal nerves. Other patients who develop some sort of nerve conduction improvement after three months of the injury are operated on for neurolysis only or associated with nerve grafting. Regular follow-up every six months was done for all patients, and the results were updated regularly. According to the Medical Research Council scale, The patients were evaluated pre and post-operatively (Table -1) & (Table -2).

Inclusion criteria: The patients underwent clinical examination, EMG, and NCV follow-up before surgery and after three months of trauma till recovery from associated orthopedic vascular injuries, adding to soft tissue healing in the poly-traumatized patients. Also, patients selected for surgical intervention showed no early or significant clinical or electrophysiological improvement.

Exclusion criteria: Patients presented after one year of the brachial plexus injury, and patients developed EMG improvement within three months after injury.

3. Results

Through this prospective study , Rood Traffic Accident account for 77% , gunshot 11% and dropping of heavy subject on the angle between the shoulder and the neck about 12% (table 3). Every year Egypt loses about 11,000 lives This is as a result to motor vehicle accident , 23 most of those(48%) killed are four-wheelers passengers while pedestrians also have a significant proportion (20%)of these fatalities.

Male patients constitute the majority of our study ,and the mean age 26 years (21 to 30 years) old about 39% of patients ,(table 2) . Closed brachial plexus injuries account for 43 % in this study and 18 % presented with compound brachial plexus injuries ,(table 5). Patients associated with orthopedic and/or vascular injuries account for 10 patients , as fracture humerus, fracture clavicle, vertebral artery, subclavian artery, injuries and intracranial hemorrhage, respectively that need intensive care administration.

As regard inclusion criteria which including any age , traumatic , or gunshot wound and those underwent preoperative physiotherapy session and have not functioning motor improvement while time interval less than one year after traumatic injury, the surgical intervention as nerve transfer, nerve grafting, and neurolysis had detected according to the most properly protocols of new surgical techniques. 24

While exclusion criteria as cases presented with cervical anomalies , cord injuries and who had old brachial plexus surgical intervention. In this study the mean time interval between onset of trauma and surgical procedure was four months (At least three months and maximum one year) . Postoperative complications occurred in two patients, the first one showing ipsilateral panplexopathy immediate postoperatively that improved after one month spontaneously, and the second case had phrenic nerve injury post-operatively and administered in intensive care unite for 3 months before he arrested.

Table 1. 28 reported cases in our study including motor outcome as regarding Medical Research Council (MRC) . [8]

CASES NO	SEX & AGE	INTERVAL PERIOD	AVULSED NERVES	SURGICAL TECHNIQUES	FOLLOW UP	MOTOR FUNCTION OUTCOME
1	45Y – Male	8 months	C 5,6	Neurolysis	7 months	Shoulder abduction G5, Elbow flexion G4
2	30Y-M	5 Months	C 5,6	Neurolysis	8 months	No recovery
3	30Y-M	6 months	C 8, T 1	Nerve grafting (medial cord)	8 months	No recovery
4	27Y-Female	7 months	C 5,6 ,7	Nerve grafting (lateral cord)	9 months	Showing improvement without function recovery
5	42Y-M	8 months	C 5,6 ,7	Transfer of Radial nerve to axillary nerve – suprascapular nerve via spinal accessory nerve.	10months	Initiation of shoulder joint abduction fifteen degree.

6	19Y-M	6 months	C8 , T 1	Neurolysis	11months	Fingers flexion grade 2, elbow flexion G4 , Shoulder abduction G4
7	30Y-F	5 months	C5,6	Nerve transfer (Oberlin technique) , suprascapular nerve via spinal accessory nerve	12months	Initiation of shoulder joint abduction fifteen degree.
8	40y –M	7 months	C 5,6,7	Nerve transfer radial nerve to axillary nerve)	12months	No recovery
9	33Y-M	8 months	C5—T1	Nerve transfer (spinal accessory nerve t , intercostals nerves to musculocatanou	2 month	No recovery
10	20Y-M	6 months	C5,6,7	Nerve transfer (radial nerve to axillary nerve , spinal accessory nerve to suprascapular	13months	Shoulder abduction grade 5
11	32Y-M	6 months	C8-T1	Neurolysis	13months	fingers flexion grade 2, elbow flexion grade 3 & Shoulder abduction grade 4
12	25Y-M	5 months	C5-T1	Nerve grafting (posterior cord)	14months	Shoulder joint abduction grade 3 , elbow extension G3, elbow flexion grade 3
13	25Y-M	5 months	C5,6	Nerve grafting .	16months	Elbow flexion grade 4

Table 2. the 28 reported cases in our study including motor outcome as regarding Medical Research Council (MRC) . [8]

CASES NO	SEX & AGE	INTERVAL PERIOD	AVULSED NERVES	SURGICAL TECHNIQUES	FOLLOW UP	MOTOR FUNCTION OUTCOME
14	20Y-M	4 months	C7	(Neurolysis of suprascapular nerve & transfer of Radial nerve to Axillary nerve)	16months	Shoulder Abduction G5
15	20Y-M	7 months	C5,7	Nerve transfer (neurotization of suprascapular nerve by spinal accessory & intercostals nerves to musculocutanous nerve)	17months	shoulder abduction G4 & elbow flexion G4+
16	31Y-M	6 months	C8 T1	Neurolysis	18months	No recovery
17	18Y-M	7 months	C7	Nerve grafting (upper trank)	21months	shoulder abduction G4& elbow flexion G4,
18	22Y-M	5 months	C5-T1	Neurolysis	24months	Recovered elbow flexion &extension G3, shoulder abduction G4
19	9months-F	7 months	C5 T1	Grafting after neuroma resection	8 months	No recovery
20	9months –m	6 months	C5,6	Radial nerve to axillary nerve	7 months	Shoulder abduction G5
21	8 months-F	8 months	C8-T1	Neurolysis	8 months	No recovery
22	20 Year-M	9 months	C5-T1	Neurolysis	9months	Shoulder abduction G4
23	25 Y-M	6 months	C5 T1	Grafting after neuroma resection	12months	No recovery
24	21Y-M	6 months	C5,6	Transfer of Radial nerve to Axillary nerve	12months	Shoulder abduction G4
25	20Y-M	8 months	C5 –C7	Intercostals nerve to musculocatanous nerve	12months	Shoulder abduction G2, elbow flexion G2
26	30 Y-M	7 months	C8-T1	Neurolysis	18months	Shoulder abduction ,elbow flexion &fingers flexion G2
27	7 months-F	5 months	C5,7	Grating after resection of neuroma	24months	No recovery
28	22Y-M	6 months	C5 T1	Neurolysis	30months	Shoulder abduction , elbow flexion &fingers flexions G4

Table 3. Cases reported mechanism of Brachial Plexus Injury.

MECHANISM OF INJURY	CASES NUMBER	PERCENT
DROPPING HEAVY OBJECT	7	12%
GUNSHOT INJURY	11	11%
MOTOR VEHICLE INJURY	32	77%

Table 4. The mean age distribution of reported cases.

MEAN AGE	CASES NUMBER (50)	PERCENTAGE %
20-30 YEARS	27 cases	53%
10-20 YEARS	8 cases	17%
40-50 YEARS	11 cases	22%
1-10 YEARS	4 cases	8%

Table 5 . Brachial plexus leveling of the reported cases.

LEVELING OF BPI	NUMBER (50 CASES)	PERCENTAGE %
UPPER TRUNK C5-7	25	48%
LOWER TRUNK C8-T1	13	28%
C5-T1 PANPLEXUPATHY	12	24%

Table 6. Surgical procedures in our study .

SURGICAL TECHNIQUE	NUMBER OF CASES (50)	PERCENTAGE %
NEUROTIZATION (NERVE TRANSFER)	23	45%
NEUROLYSIS	18	35%
NERVE GRAFTING	10	20%

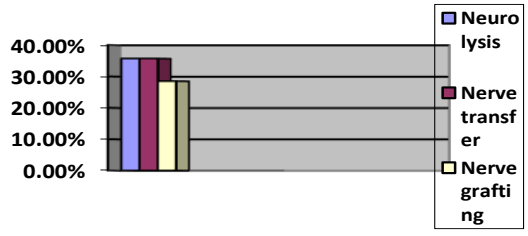

Chart 1. The surgical procedures(nerve grafting ,nerve transfer & neurolysis) percentage .

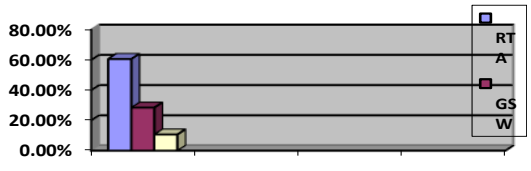

Chart 2. Causes of brachial plexus injuries percentage.

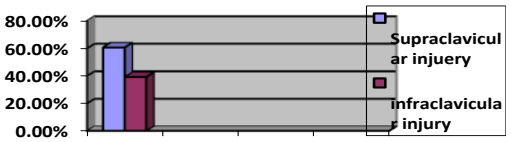

Chart 3. Leveling percentage of brachial plexus injury.

Table 7. Shoulder abduction response as regard MRC scale. (follow up after 18 months from surgical intervention)

SHOULDER JOINT ABDUCTION	PREOPERATIVE	POST-OPERATIVE
RANGE	0-5	0-5
MEAN -+ SD	0.78-+1.70	2.88-+1.85
T. TEST	11.87	
P. VALUE	0.002*	

Figure 1. Intra-operative positioning and transfer distal branch of spinal accessory nerve to suprascapular nerve.

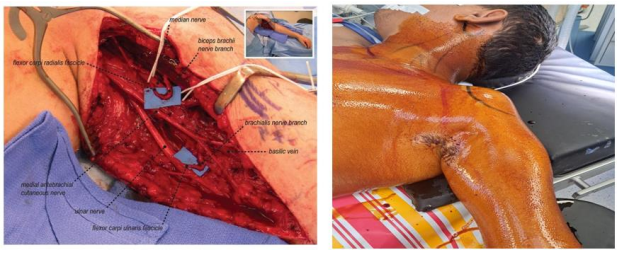

Figure 2. Intraoperative picture showing positioning and neurolysis of amalgamated cords of left brachial plexus .

Figure 3. Intraoperative positioning and neurotization of Musculocutaneous nerve with 2nd ,3rd &4th intercostals nerves .

4. Discussion

Adult traumatic brachial plexus injuries constitute about 33 % of all peripheral nerve injuries and constitute 1% of poly-traumatized patients. They range from partial weakness to total weakness of all upper limbs. Stretch and Avulsion injuries constitute the main bulk of the

pattern of brachial plexus injuries; our study found that 72-75% of the cases were supraclavicular, and 85 % had at least one of the nerve roots avulsed. As regards Brophy et al.,4 had achieved that 70-75% of patients presented with supraclavicular, and 88% showed that one of the roots avulsed. C7, C8, and T1 constitute 57% of the avulsed nerve roots. The most commonly injured limb was the dominant one.[9] There were 509 stretch injuries of the brachial plexus, of which 356 (72%) were supraclavicular, and 139 (28%) were infraclavicular, according to Sulaiman et al., study.[10]

Patient malpositioning during operation presented with brachial plexus injuries described in the literature for nearly about one century. [9,11] Schwartz et al.,[12] had found 15 cases that underwent scoliosis surgery in a prone position complicated with brachial plexus injury that was recorded during the operation by somatosensory evoked potential(SSEP). Nerve transfer constitutes the mean new surgical procedure as suprascapular nerve, intercostal nerves, median and ulnar nerve fascicles (Oberlin technique). Medial pectoral nerve, phrenic nerve, cervical plexus, as (intraplexus neurotization)12.As regarding Bertelli et al. 1-2study that categorizes cases with brachial plexus injury into eight groups regarding injured roots and motor function deficits: C5-6, C5-6-7, C5-6-7-8(T1-hand), C5-6-7-8-T1(T-2 hand), C8T1 and totally paralyzed limb (flail limb) 335patients all adult had operated presented with supraclavicular BPI over a 7-year period. Nerve grafts and nerve transfer were used to restore motor function. Cases with upper or lower partial brachial plexus injuries developed significant motor functional improvement. While totally paralyzed patients with a nerve root are still available for nerve grafting, 92 %of cases developed restoration of elbow flexion, while the rate deteriorated to 45% if no nerve roots were grafted and only performance of nerve transfer was done. Pain complaints were also well eliminated within a short period after the operation of root exploration as well as nerve grafting .[13,14]

Transfer of spinal accessory nerve to suprascapular verve to restore initiation of shoulder joint abduction up to 15 degrees. Patients were operated on in a prone position by general anesthesia without muscle relaxation (Figure 1). Firstly, the spinal accessory nerve as donor nerve located at 40% distance from midline dorsally to the acromion. The suprascapular nerve is the recipient nerve located at the middle of the tangential line between the acromion and the superior border of the scapula. The skin incision was done one centimeter parallel to the upper border of the scapula. Then dissect the deeply splitting supraspinatus muscle toward the suprascapular notch, palpating the sharp, superior border of the scapula. Take care not to injure the suprascapular vessels. [15]

Secondly, the spinal accessory nerve is embedded in adipose tissue under the trapezius muscle. Thirdly, the suprascapular nerve is divided as proximal as possible to the spinal cord, and finally, the spinal accessory nerve is incised at its distally identified point to allow nerve transfer without tension.[16]

On the other side, the infraclavicular procedure considers the mean approach for detecting cords and the brachial plexus terminal branches after the incision of the minor pectoralis muscle. The musculocutaneous nerve is identified as a continuation of the lateral cord, while the ulnar nerve is a continuation of the medial cord, the medial continuation of both medial and lateral cord forming an M shape as a landmark or median nerve identification .[4,17]

Neurolysis via the supraclavicular and infraclavicular approach also constitutes the second main procedure while the patient is operated on in a supine position under total intravenous anesthesia (TIVA) without muscle relaxant, Figure 2. The affected upper limb was abducted. The line of incision extended through the posterior border of the sternocleidomastoid and then extended laterally one-centimeter supraclavicular line then via the deltopectoral groove passing through the axillary groove; the structures can be exposed via the supraclavicular approach, including the phrenic nerve; trunks and roots of brachial plexus. Skeletonization of both anterior and middle scalene muscles, then cutting omohyoid muscle, then the phrenic nerve should be cautiously traced till the C5 and C6 roots, then the upper trunk can be identified. [18]

The primary repair indicated for open wound cases involves trimming the nonviable edge of the repaired nerve. If both distal and proximal stump can be freely and clearly identified without any nerve traction. On the other hand, the nerve grafting technique can be used in cases presented with loss of nerve continuity, either with traction or sharpness. [16-17]

The most significant function in the brachial plexus injury is shoulder abduction and elbow flexion.[19] So, reinnervation of the supracapular nerve with spinal accessory nerve and neurotization of the musculocutaneous nerve with intercostal nerves (extarplexus) or with fascicles of median and ulnar nerves (intraplexus) have the most significant priority.[4,18,20]

4. Conclusion

The outcome of the brachial plexus operation can be achieved with optimal time, approach, and surgical technique. The results prove that nerve

transfer and neurolysis give more significant results than nerve grafting.

Disclosure

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Authorship

All authors have a substantial contribution to the article

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There are no conflicts of interest.

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