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ORIGINAL ARTICLES

ROLE OF NERVE CONDUCTION STUDY AND ELECTROMYOGRAPHY IN ADULT TRAUMATIC BRACHIAL PLEXOPATHY

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ABSTRACT

Background: Traumatic brachial plexopathy mostly affects young adults and has a very high rate of morbidity.

Objective: The aim of this clinical survey was to highlight this problem and the diagnostic and prognostic value of electrodiagnostic procedures.

Patients and Methods: Fifty adult patients with the clinically brachial plexus injury who were referred to Armed Forces Institute of Rehabilitation Medicine (AFIRM) Rawalpindi for nerve conduction study (NCS) and electromyography (EMG) were included in this survey. They were followed up for two years. The recovery was assessed as per Medical Research Council (MRC) scale and electrophysiologically.

Results: Traumatic plexopathy mainly affects young adult males with mean age of 24 $\pm$ 7.26 years. The recovery was better with C5 & 6 lesions and those having neurapraxia and it was worse with avulsion injury. Nerve conduction studies and electromyography proved to be the key investigation in assessing brachial plexus injury, in regard to their localization, severity and extent.

Conclusion: The best investigation for assessment of brachial plexus injury is Electrodiagnostic procedures.

Keywords: Traumatic brachial plexopathy, nerve conduction study, electromyography

INTRODUCTION

Trauma to Brachial plexus is not uncommon in our country. Although exact figures at national level are not available, but incidence of brachial plexus injury is on the rise, primarily due to increase in road traffic accidents and upsurge of violence in our society in general. Inappropriate and poorly timed management can lead to disastrous consequences, not only for the individual but also for the community [1].

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The potential for permanent neurological deficit as well as the immediate threat to limb has challenged those dealing with traumatic brachial plexus injuries. In recent military conflicts it was 2.6% to 14% of all peripheral nerve injuries [2-4].

EMG is the single most useful test in clarifying the differential diagnosis of an obscure neuromuscular problem, second only to the clinical examination. It is not possible to clinically differentiate between neurapraxia, axonotmesis, incomplete neurotemesis and root avulsion or to determine the location (roots and or plexus), extent and severity of the injury [5,6]. The principle goals of

electrodiagnostic procedures in brachial plexopathy are to localize the lesion accurately and to assess its severity [7, 8]. In the survey carried out at Armed Forces Institute of Rehabilitation Medicine (AFIRM) we studied adults with traumatic brachial plexopathy.

The aim was to describe the problem of adult traumatic brachial plexopathy in regard to mode of presentation (frequency in various age, sex, sides, aetiology, pathology and type of lesion) and recovery. Moreover to highlight the role of electrophysiologic studies in diagnosis and prognosis of adult traumatic brachial plexopathy.

PATIENTS AND METHODS

A clinical survey was carried out at Armed Forces Institute of Rehabilitation Medicine (AFIRM) Rawalpindi, which is providing tertiary health care facilities in musculoskeletal and neurological injuries, diseases and disabilities. Fifty adult patients of both sexes referred to AFIRM from various Armed forces and civil hospitals (AJK, NWFP and part of Punjab) for Nerve conduction study & Electromyography (NCS/EMG) were included in the study. Duration of study was 2 years. Cases were assessed clinically and with NCS & EMG and data was collected through:

- Clinical Assessment Proforma attached as Annexure-A.
- Electrophysiologic evaluation Proforma attached as Annexure-B.

Nerve conduction study (NCS) was performed with model MS 6 Medleck UK using surface electrodes. Test was performed according to the protocol. EMG was done with Neuropack-2 ® Nihon Kohden Corporation (electromyograph) Japan, using concentric needle electrodes. Muscle selection and performing EMG was as per protocol.

After compiling the data of the survey, following variables were selected:-

a. Age

b. Sex

c. Side (Left & Right)

d. Aetiology (Road traffic accident, Gun shot wound, and others like falls, tight straps/weight over shoulders etc.)

e. Pathology

   Neurapraxia: Nerve Conduction Studies (NCS) – Normal Electromyography (EMG)–Impaired recruitment pattern

   Axonotemesis:NCS– decreased amplitude of Sensory Nerve action Potentials (SNAP) & Compound Muscle Action Potential (CMAP)

   EMG - discrete interference pattern & degeneration potentials i.e. fibrillations (fibs) and positive sharp waves (PSWs)

   Neurotemesis: NCS - Absent SNAP & CMAP

   EMG – No voluntary activity, involuntary activity i.e. fibs and PSWs

   Avulsion injury: NCS - Present SNAP & absent CMAP

   EMG - No voluntary activity, fibs and PSWs

f. Type of lesion (Erb's paralysis, Klumpke's paralysis, complete paralysis, Miscellaneous)

g. Recovery after 2 years graded as good, useful and poor as per MRC scale [1].

The data were fed to SPSS-10.0 for Windows and Descriptive statistics were used to get the results.

Inclusion Criteria

Adult of both sexes with clinical evidence of traumatic brachial plexopathy were included.

Exclusion Criteria

Cases of more than 4 months duration, age group less than 12 years, brachial plexopathy due to neoplasm, radiation, neuralgic amyotrophy and patients with radiculopathies were excluded from survey.

RESULTS

Mean age was 24 ± 7.26 years, minimum and maximum age was 13 and 43 years respectively, 90% were less than 35 years and 86% were male. Road traffic accident was the most common cause i.e. 27 (54%) and out of these 25 (50%) were due to motorcycle accidents. Gun shot wounds accounted for 9 (18%) patients, 14 (28%) patients were due to other causes i.e. 4 (8%) due to carrying haversacks with straps over shoulders (soldier and military cadets), 6 (12%) were due to falls, 2 (4%) cases had compression of the cords in the axilla due to sleeping in abnormal postures and 2 (4%) were iatrogenic (Postoperative & post anaesthesia).

Axonotmesis and neurotmesis was the most frequent pathology i.e. 38% followed by neurapraxia 32%. Mixed lesions (patients having more than one pathology) were 16%.

After 2 years, 8 (16%) patients received surgical treatment and 42 (84%) were treated conservatively. All those who were operated upon had post ganglionic injury.

The detailed results were obtained from analysis through SPSS-10.0 for Windows in the form of tables and graphs, a few out of these are displayed. (see table 1-12 and fig. 1-4).

DISCUSSION

Brachial plexus injury is a disorder primarily affecting young adult males. This fact was proven in this survey i.e. the mean age was 24 years and 86% of the patients were male, results are similar to a study by Buzdar [9]. In a study by Birch the mean age was 28 years [2].

Table-1: Grading of recovery according to MRC scale [1].

Motor recovery		Sensory recovery	
M4	Good	S4 or S3+	Good
M3	Useful	S3	Useful
M2	Poor	S2	Poor
M1 & 0	Poor	S1 & 0	Poor

Table-2: Descriptive statistics.

	N	Min	Max	Mean	Std. Deviation
Age	50	13	43	24.18	7.26
Valid N (list wise)	50				

Table-3: Age – frequency table.

	Age	Frequency	Percent	Cumulative Percent
Valid	13	2	4.0	4.0
	14	2	4.0	8.0
	15	2	4.0	12.0
	16	2	4.0	16.0
	17	1	2.0	18.0
	18	2	4.0	22.0
	19	2	4.0	26.0
	20	1	2.0	28.0
	21	4	8.0	36.0
	22	5	10.0	46.0
	23	5	10.0	56.0
	24	2	4.0	60.0
	25	2	4.0	64.0
	26	2	4.0	68.0
	27	2	4.0	72.0
	28	2	4.0	76.0
	29	2	4.0	80.0
	31	3	6.0	86.0
	32	1	2.0	88.0
	35	1	2.0	90.0
	36	1	2.0	92.0
	37	1	2.0	94.0
	38	1	2.0	96.0
	41	1	2.0	98.0
	43	1	2.0	100.0
	Total	50	100.0	

Table-4: Gender.

		Frequency	Percent
Valid	Male	43	86.0
	Female	7	14.0
	Total	50	100.0

Table-5: Side of lesion.

		Frequency	Percent
Valid	Right	34	68.0
	Left	16	32.0
	Total	50	100.0

For penetrating injuries the most common cause was gun shot wounds and for closed traction injuries the commonest cause was road traffic accidents, especially motorcycle accident. This was again similar to the study by Buzdar & Birch [1,2].

Injury to upper roots (C5-6) i.e. Erb's paralysis was the commonest followed by complete injury (C5-T1). As far as extent of injury is concerned the lesion in continuity i.e. neurapraxia and axonotmesis were the commonest. This again is in consistency with the international studies [2,10-12].

Avulsion injuries although were only 14% but they can not be neglected due to significant disability and lack of any available standard treatment. Avulsion most commonly occurred in C8-T1 roots, as these roots are more vulnerable to longitudinal traction and out of the seven cases, 4 (8%) had associated Horner syndrome. On repeated examination those cases with injury in continuity to C5-7 had good prognosis as compared to C8-T1, because of less time-distance factor i.e. proximity to anterior horn cells. More over the patients with no degenerative potentials (positive sharp waves and fibrillation) and some voluntary activity on initial evaluation had better outcome on subsequent examinations [7,13-15]. Avulsion injuries had the worst prognosis and none of the patients was able to have any useful function [16].

This clinical survey clearly demonstrated a role of NCS & EMG in diagnosis, prognosis and management of brachial plexus injuries and timely referral for surgical exploration [1,5,17].

The other investigations available are radiologic procedure like conventional myelography, postmyelographic CT (CTM) and magnetic resonance myelography. Advantage of myelography is its ability to delineate the entire injury. But the disadvantage with the first two is radiation exposure and possibility of reaction to contrast media [18]. Myelography is reported

Table-6: Aetiology.

		Frequency	Percent
Valid	RTA	27	54.0
	GSW	9	18.0
	Other	14	28.0
	Total	50	100.0

Table-7: Pathology.

		Frequency	Percent
Valid	Neurapraxia	16	32.0
	Axonotmesis & Neurotmesis	19	38.0
	Avulsion	7	14.0
	Mixed	8	16.0
	Total	50	100.0

Table-8: Type of lesion.

		Frequency	Percent
Valid	Erb's paralysis	18	36.0
	Klumpke's paralysis	13	26.0
	Complete paralysis	14	28.0
	Misc	5	10.0
	Total	50	100.0

Table-9: Pathologies in various types of lesions.

		Pathology			
		Neurapraxia	Axonotmesis & Neurotmesis	Avulsion	Mixed
Type of lesion	Erb's paralysis	5 [10%]	8 [16%]		5 [10%]
	Klumpke's paralysis	4 [8%]	3 [6%]	5 [10%]	1 [2%]
	Complete paralysis	6 [12%]	5 [10%]	1 [2%]	2 [4%]
	Misc	1 [2%]	3 [6%]	1 [2%]	

Table-10: Recovery after 2 years.

	Frequency	Percent
Good	16	32.0
Useful	25	50.0
Poor	9	18.0
Total	50	100.0

Table-11: Recovery in various pathologies.

		Recovery after 2 years		
		Good	Useful	Poor
Pathology	Neurapraxia	13 [26%]	3 [6%]	
	Axonotmesis & Neurotemesis	1[2%]	16 [32%]	2 [4%]
	Avulsion			7 [14%]
	Mixed	2 [4%]	6 [12%]	

to be unreliable at the level of the C5 and C6 nerve roots [19]. CTM is superior to conventional myelography in visualizing the nerve rootlets because of axial imaging, but it is difficult to detect the entire extent of the injuries. Vielvoye and Hoffmann concluded that detection of partial or complete cervical root damage was not fully reliable in either myelography or CTM [20].

The appropriate use of NCS & EMG involves understanding of the neurophysiologic basis, drawbacks, and limitations [6,7,21]. The role of neurophysiological studies as discussed by Birch in his lecture entitled brachial plexus injuries [23] generated a very healthy discussion and it was responded to by Fast and Thomas who elaborated on the role of NCS & EMG [24]. According to them sensory studies should be done shortly after injury and a normal SNAP from an anesthetic finger indicate that the lesion is preganglionic. If the response is missing the injury has involved dorsal root ganglion, the nerve distal to it or both. So there is no need to wait for 3 weeks to perform these non invasive studies. However, EMG depends on wallarian degeneration and changes appear somewhat later i.e. after second week in paraspinal and third week in rest of the limb. Birch on this, highlighted the problems, which a surgeon can face relying solely on neurophysiological study: -

- Extensive damage to DRG in a preganglionic injury can lead to confusion due to loss of conduction.
- Loss of conduction from associated vascular lesion without interruption of nerve.
- Inability to differentiate between axonotmesis and incomplete neurotmesis.

In this survey only one case in which root avulsion was missed and that was due to very

Table-12: Recovery in different type of lesions.

		Recovery after2 years		
		Good	**Useful**	**Poor**
Type of lesion	Erb's paralysis	8 [16%]	9 [18%]	1 [2%]
	Klumpke's paralysis	4 [8%]	3 [6%]	6 [12%]
	Complete paralysis	3 [6%]	10 [20%]	1 [2%]
	Misc	1[2%]	3 [6%]	1 [2%]

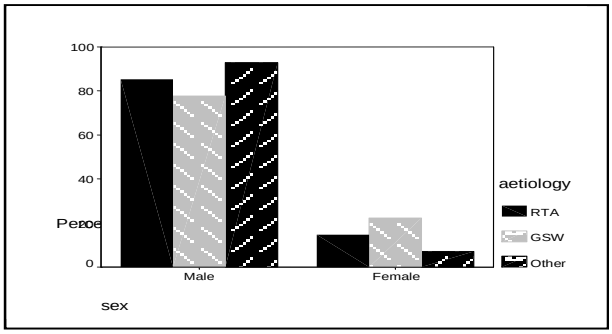

Fig. 1: Sex wise distribution of aetiology.

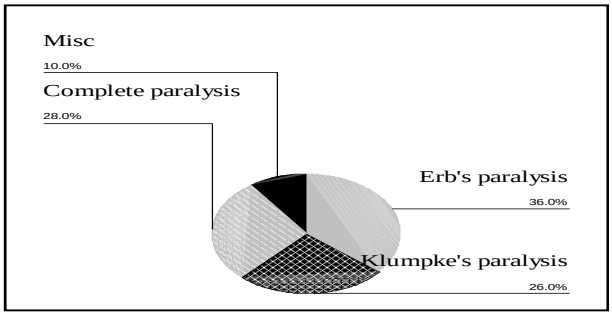

Fig. 2: Different type of lesions.

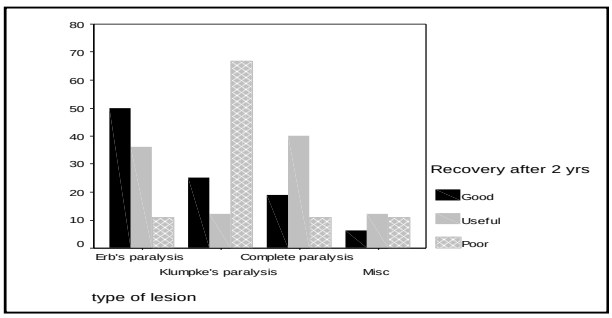

Fig. 3: Recovery in different type of lesions.

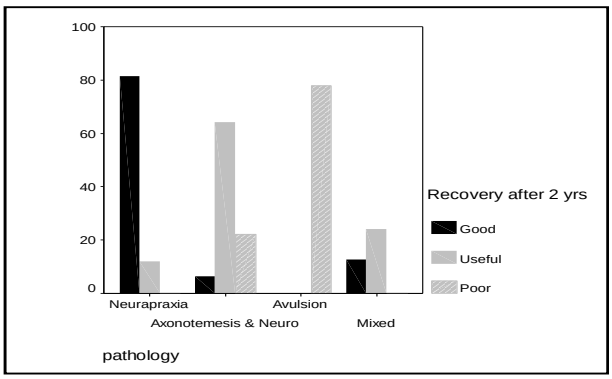

Fig. 4: Recovery in different pathology.

Annexure-A

Assessment proforma

Name: _____ Age: _____ Sex: _____
Entry Number: _____ Visit Number: _____
Presenting Complaint
1.
2.
3.
Associated Injuries

Treatment so far received
Conservative: _____ Surgical: _____
Past history
Physical Examination
General Physical examination

Local Examination
Position of upper limbs
Wasting
ROM
Muscle power 0,1,2,3,4,5 (Medical Research Council Classification)

Reflexes Normal Diminished Absent

Bicep
Supinator
Tricep
Sensations
Provisional Diagnosis
Investigations

Annexure-B

Electrophysiologic evaluation

Nerve conduction studies

			Amplitude (motor=mV; sensory=μV)			Latency (m/sec)			Conduction velocity (m/sec)			F-wave latency (m/sec)		
Nerve	Stimulation site	Recording site	RT	LT	N L	RT	LT	N L	RT	LT	N L	RT	LT	NL

Electromyography

		Spontaneous activity		Voluntary motor unit action potentials			
Muscle	Insertional activity	Fibrillations	Fasciculations	Recruitment	Duration	Amplitude	Poyph-asia

extensive damage in which root avulsion along with destruction of DRG was also present which was confirmed on exploration.

Relying purely on NCS & EMG it is difficult to differentiate between axonotmesis and incomplete neurotmesis, but combining clinical evaluation, radiographic investigation and repeated electrophysiological studies, the clinician can provide the patient with information regarding his/her treatment and prognosis.

The results of the survey cannot be generalized and it is a bit difficult to compare the results objectively because:-

- most of the patients belonged to a specific group of population

- advanced radiological studies are not available
- Few surgeons perform reconstruction / exploration of brachial plexus.

Even with these shortcomings certain important trends and patterns are worth discussing. This survey will provide a baseline data on the important topic of the diagnosis, prognosis, and subsequent outcome of adult traumatic brachial plexopathy.

CONCLUSION

Brachial plexus is a vulnerable structure that can be damaged at many points along its course. Assessment should include a detailed history, comprehensive physical examination, and radiologicand electrophysiological procedures. Electrophysiological study (NCS & EMG) is the most important available investigation to assess the functional status of the plexus objectively.

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