

## Original Article

# An epidemiological study of traumatic brachial plexus injury patients treated at an Indian centre

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## ABSTRACT

**Background:** Epidemiological studies on traumatic brachial plexus injuries are few and these studies help us to improve the treatment, rehabilitation of these patients and to allocate the resources required in their management. Epidemiological factors can vary in different countries. We wanted to know the situation in an Indian centre. **Materials and Methods:** Data regarding age, sex, affected side, mode of injury, distribution of paralysis, associated injuries, pain at the time of presentation and the index procedure they underwent were collected from 304 patients. Additional data like the vehicle associated during the accident, speed of the vehicle during the accident, employment status and integration into the family were collected in 144 patients out of the 304 patients. **Results:** Road traffic accidents accounted for 94% of patients and of the road traffic accidents 90% involved two wheelers. Brachial plexus injury formed a part of multitrauma in 54% of this study group and 46% had isolated brachial plexus injury. Associated injuries like fractures, vascular injuries and head injuries are much less probably due to the lower velocity of the vehicles compared to the western world. The average time interval from the date of injury to exploration of the brachial plexus was 127 days and 124 (40.78%) patients presented to us within this duration. Fifty-seven per cent had joined back to work by an average of 8.6 months. It took an average of 6.8 months for the global brachial plexus-injured patients to write in their non-dominant hand.

## KEY WORDS

Epidemiological study; Indian centre; nerve injury; traumatic brachial plexus injury

## INTRODUCTION

Epidemiological studies help healthcare providers to know the magnitude of the problem, adopt preventive measures to reduce the burden of the disease and help plan resources for the treatment and

rehabilitation of patients. Epidemiological studies of traumatic brachial plexus injuries are few and most of them focus on treatment and prognosis.<sup>[1]</sup> Midha from Canada studied the incidence of brachial plexus injuries in their centre and found that 1.2% of the multitrauma admissions had brachial plexus injury. Of all the motorcycle accidents, 4.2% had brachial plexus injury and of all the snowmobile accidents, 4.8% suffered from brachial plexus injury.<sup>[2]</sup> Goldie and Coates reported that 450-500 closed supraclavicular injuries occur every year in the United Kingdom.<sup>[3]</sup> Motorcycle riders are the most vulnerable group and this particularly applies to developing countries where the number of people using two wheelers are more.<sup>[4]</sup> We have not been able to find

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any study of the incidence and pattern of involvement of the injury in the Indian context. This will provide an idea of the demand, the treatment centres would face in managing these patients. Considering this we wanted to study the epidemiological pattern of the brachial plexus injuries in our centre which reflects the Indian scenario.

The 'rule of 7 seventies' from the study of Narakas has been frequently quoted by many authors and used to compare the findings and outcome at various centres.<sup>[5]</sup> Narakas stated that 70% of the traumatic brachial plexus injuries occurred secondary to motor vehicle accidents and of these motor vehicle accidents, 70% involve motorcycles or bicycles, 70% of these motorcycle riders will have multiple injuries, 70% of these individuals with multiple injuries had supraclavicular lesions and 70% of these supraclavicular lesions had atleast one of the roots avulsed. Of the avulsed roots, 70% involved C7, C8 and T1. Of the 70% of the avulsed roots, 70% had chronic pain. We wanted to know about the pattern of these figures in an Indian setting. In addition, we wanted to have an idea of the social impact by finding their return to gainful employment status.

## MATERIALS AND METHODS

Records of 304 consecutive operated patients for traumatic brachial plexus injuries from our centre from January 2002 to September 2011 were retrospectively analyzed. Age, sex, mode of injury, pattern of injury, associated injuries, pain at the time of presentation and the various index procedures they underwent were analyzed [Table 1]. 273 of the 304 patients underwent brachial plexus exploration and rest of the patients directly underwent secondary procedures due to their late presentation. Intra-operative findings of these 273 patients like the level of lesion (supraclavicular, retroclavicular or infraclavicular) were retrieved from the operative notes. The absence of the proximal usable nerve stump was considered as an avulsion injury of the nerve roots. The time interval between injury and the brachial plexus exploration was assessed.

We tried to reach 304 patients over telephone and 144 out of the 304 patients could be contacted, as the others had changed their location or discarded previous contact numbers. All retrospective data for 304 patients were available from the case records. In addition to

these data, in 144 out of 304 patients who could be contacted over telephone, we gathered details about the vehicle associated at the time of the accident and the approximate speed at the time of the accident. The social aspects of life of the injured patients like duration after which they joined back to work, duration after which they started to write with the unaffected hand, etc. were collected [Table 2].

## RESULTS

Road traffic accidents accounted for 94% of the brachial plexus injuries and of these 90% were associated with two wheeler accidents. Table 3 shows the mode of injury and the distribution, Table 4 shows the distribution of the vehicles involved in road traffic accidents leading to brachial plexus injury and Table 5 shows the distribution of the brachial plexus injury due to non-road traffic accidents. Table 6 shows the age-wise distribution of the patients. The average age of the patient in the study was 24 years and the age group 21-30 years accounted for

**Table 1: Following data of 304 patients were collected**

Age
Sex
Affected side
Dominant side
Mode of injury
Distribution of paralysis
Associated injuries (fractures, vascular injury, head injury)
Pain at the time of presentation
Index procedures they underwent

**Table 2: Following additional data were available from 144 patients**

Vehicle associated during the accident
Speed of the vehicle during the accident
Employment status
Integration into the family

**Table 3: The mode of injury and the distribution**

Mode of Injury	Number (n=304)	Percentage
Road traffic accident	287	94.40
Others	17	5.59

**Table 4: The distribution of vehicles associated with brachial plexus injury due to road traffic accidents**

Road traffic accidents	Number (n=287)	Percentage
Two wheeler accidents	259	90.24
Car accidents	18	6.27
Pedestrians	7	2.43
Driving truck	3	1.04

45.7% of the patients. There were 297 male patients and 7 female patients.

Right side was involved in 69.97% of the patients [Table 7]. Closed brachial plexus injury accounted for 302 patients in our study group and 2 of them had open brachial plexus injury. Table 8 shows the distribution of the type of brachial plexus injury. One had phrenic nerve palsy which was associated with global brachial plexus palsy. We did not find any isolated C7 palsy (fourth type of brachial plexus injury).<sup>[6]</sup> Table 9 shows the associated fractures with brachial plexus injury.

Fifty-four per cent (164) of patients had some associated injuries while 46% (140) had isolated brachial plexus injury. Thirty-two per cent (100) had fracture of more than one bone, 4.9% of them had vertebral fracture and 10% had clavicle fracture. Fourteen (4.6%) of them had vascular injury and of which 13 sustained global brachial plexus injury. One of the 14 was a gunshot injury. Head injury was noticed in 5% of the brachial plexus injury patients.

Patients underwent various index procedures like neurolysis, nerve transfers with and without grafts, trapezius transfers, tendon transfers and free functioning gracilis transfer according to the time of presentation, intra-operative findings and patient's demand. Table 10 shows the distribution of various index procedures, which the patients underwent. Seventy seven of them underwent a second procedure at our centre.

The average time interval from the date of injury to exploration of the brachial plexus was 127 days. Table 11 shows the level of the lesion in 273 patients who underwent brachial plexus exploration. Seventy three (24%) complained of neuropathic pain at the time of presentation, 47 (65%) of these had global brachial plexus injuries and 42 (58%) had some pain relief after brachial plexus exploration.

The average speed of the two wheelers associated at the time of accident was 47 km/h (29 miles/h). When considering the type of two wheelers involved, 93% of the two wheelers were of 100 CC engines.

## DISCUSSION

There are varying statistics about the epidemiology of traumatic brachial plexus injuries in different parts of the world. The report by Narakas is considered as an important

reference. It is a larger series with 1068 patients over a span of 18 years elucidating the type of presentation and treatment of brachial plexus injuries.<sup>[5,7,8]</sup> Narakas had stated the rule of seven seventies, which frequently forms the guidance values; our results were compared and variation in our population were noted.

Terzis from USA studied the outcomes of 204 patients who underwent reconstruction for brachial plexus

**Table 5: The distribution of brachial plexus injury due to non road traffic accidents**

Non-road traffic accident	Number of patients (n=17)
Industrial	7
Fall from height	2
Fall of heavy object on shoulder	3
Others	5

**Table 6: The age-wise distribution of the post-traumatic brachial plexus injury**

Age in years	Number (n=304)	Percentage
1-10	1	0.003
11-20	41	13.48
21-30	139	45.72
31-40	77	25.32
41-50	27	8.88
51-60	15	4.93
61-70	4	1.31

**Table 7: Distribution of injury to the affected side**

Affected side	Number (n=304)	Percentage
Right	212	69.74
Left	92	30.26

**Table 8: The distribution of paralysis**

Pattern of paralysis	Number of patients (n=304)	Percentage
Global	146	48.02
C5, C6, C7	73	24.01
C5, C6	70	23.02
C5	7	2.30
C6, C7, C8, T1	2	0.65
C6, C7	2	0.65
C5, C6, C7, C8	2	0.65
C7, C8, T1	1	0.32
Global with phrenic nerve	1	0.32

**Table 9: The associated fractures with brachial plexus injury**

Associated fractures	Number of patients	Percentage
Lower limb	59	19.40
Upper limb	51	16.77
Clavicle	31	10.19
Facial	20	6.57
Spine	15	4.93
Rib	8	2.63
Pelvis	2	0.65

**Table 10: The distribution of the index procedures**

First surgical procedure	Number of patients (n=304)	Percentage
Neurolysis	10	3.28
Nerve transfer	135	44.40
Nerve transfers with nerve graft	128	42.10
Tendon transfer	7	2.30
Trapezius transfer	7	2.30
Pedicle latissimus dorsi	2	0.65
Free functioning gracilis	15	4.93

injuries over the period of 18 years and enumerated few of the epidemiological aspects in her study like the gender ratio, injured side, vehicle associated with brachial plexus injury, speed of the vehicle at which the accident occurred and the associated injuries.<sup>[9]</sup> Kim from USA studied the outcome of surgery in 1019 brachial plexus lesions but this study included tumours and thoracic outlet syndrome.<sup>[10]</sup> Our study group involves only post-traumatic brachial plexus injuries and does not include iatrogenic injuries or tumours of the brachial plexus. This study is also a retrospective study as other studies, but in addition we have the data from 144 patients as to their long-term status. Though we are able to contact only about half of the study population, the contactable number in itself is a good sample size to know as to what happens regarding work status and their adaptability with the other hand in the long term.

Road traffic accidents are the predominant cause of traumatic brachial plexus injuries in most of the studies but the contribution of road traffic accidents towards the brachial plexus injuries varies in different studies. Songcharoen reported that 91% of the brachial plexus injuries in Thailand were due to road traffic accidents and 82% were due to motorcycle accidents.<sup>[11]</sup> Dubuissou from Belgium reported that 60% of the traumatic brachial plexus injury were due to road traffic accident and 31% occurred while riding a two wheeler.<sup>[12]</sup> Kandenwein from Germany found that 81% traumatic brachial plexus injuries were due to road traffic accidents and 65% of the injuries involved two wheelers.<sup>[13]</sup> In our study, we found that 94% of the traumatic brachial plexus injuries were due to road traffic accidents and 90% of these road traffic accidents are associated with two wheelers, which is similar to the Thailand report but different from the western literature. This clearly indicates the kind of vehicles used and the economic status of the country. Other cause for brachial plexus injuries in the study done by Narakas and Dubuissou, which was not seen in our study, was sports-related injury.

**Table 11: The level of the lesion in patients who underwent brachial plexus exploration**

Level of the lesion	Number of patients (n=273)	Percentage
Supraclavicular	264	96.70
Infraclavicular	2	0.73
Supraclavicular and Infraclavicular	6	2.19
Retroclavicular	1	0.36

We had only 2 open injuries out of the 304 brachial plexus injuries in our study, whereas the study done by Dubuissou had 23 open injuries out of 100 patients.<sup>[12]</sup> Kim from USA reported 19% open injuries in the form of laceration and gunshot injuries to brachial plexus.<sup>[10]</sup> In our study, 54% of the patients were part of polytrauma and 46% were isolated brachial plexus injuries. This study gives an idea of the pattern of brachial plexus injury which a referral centre will see. Terzis showed that 57% had some fracture and 20% had clavicle fracture in the involved extremity.<sup>[9]</sup>

There were 14 vascular injuries out of 304 patients which is 4.6% in our study, but Terzis reported 28% associated vascular injury. Van der Werken found that 20% had associated vascular trauma.<sup>[14]</sup> In centres which receive more high-velocity trauma, vascular injury appears to be more common. Clavicle was the most frequently associated fracture reported by Kandenwein, which was 20.9%, whereas in our study we found clavicle fracture in 11% of the patients.<sup>[13]</sup> There were two individuals who had a clavicle fracture and an associated vascular injury. Lesser number of associated injuries suggests that the injuries sustained in our population could be due to low velocity when compared to the west. Femur was the most common bone to be fractured, followed by humerus, clavicle and tibia in our series.

Eighty-nine per cent had at least one of the roots avulsed. Of the avulsed roots, 59% involved C7, C8 and T1. Ninety-six per cent of the patients who underwent brachial plexus exploration had supraclavicular lesion. Brophy had found that 70-75% of the lesions were supraclavicular.<sup>[15]</sup> A study by Narakas in 1977 found that 86.6% had brachial plexus injury in the supraclavicular level.

The dominant arm was found to be the most commonly injured, which is the right side. This is similar to many other studies. This reinforces that the side of the road used for driving does not determine the side of the arm affected.<sup>[16]</sup>



When considering the speed of the vehicle during which the accident occurred, we found that the study done by Terzis provides some information, Terzis reported that the speed at which the accidents occurred ranged from 25 to 120 mph and the average speed was 54.5 mph.<sup>[9]</sup> In our study, speed ranged from 10 to 120 km/h and the average speed at which the accident occurred was 47 km/h (29 mph). Four of them were stationary and four of them did not remember the speed at which they were travelling. Two wheeler accidents were the most frequent mode of injury. The principal factors determining the extent of injury are the energy imparted by the blow and to a lesser degree, the direction and the relationship of the arm to the neck during the injury.<sup>[17]</sup> The speed at which the brachial plexus injuries occur due to road traffic accidents in our study is lower than the other studies.

The average time interval from the date of injury to exploration of the brachial plexus was 127 days and 124 (40.78%) patients presented to us within this duration. This reflects the awareness among the patients about centres treating brachial plexus injuries. This is a good trend in a developing country. Patient, public and peer education can even probably reduce this time interval.

The presence of pain has shown a wide range of incidence in various studies. In our study, 24% of the patients had pain at the time of presentation. Eleven per cent had complete relief of pain after surgery and 6.9% continued to have intractable pain. Eleven per cent of the patients consumed medications for pain and one of them even consuming medications up to 3 years. In one of the study by Choi, he reported that 75% had severe pain and 38% of them continued to take medications for pain.<sup>[18]</sup>

There are two reports on quality of life in brachial plexus injury patients, one of them is by Choi and the other one is by Kitajima.<sup>[18,19]</sup> Choi had studied overall satisfaction, employment status and the impact of brachial plexus injuries on other life domains. This study had 32 subjects and had adopted the interviewer form from the US General Society Survey. But this cannot be extrapolated to our society. Kitajima evaluated the correlation between the SF-36 scores and the upper extremity function, and they concluded that SF-36 is not sensitive enough to evaluate regional conditions. We consider joining back to work as an important indicator of successful adaptation after injury. Hence, we assessed return to work in 144 patients. Eighty three (57%) of the 144 were doing some form of gainful employment at an average period

of 8.6 months from the date of surgery. Thirty four of them returned back to the same work and others had a working pattern with lower demanding jobs. 13 patients out of the 83 patients had global brachial plexus injury. This was possible by reallocating the type of work for the employee, like doing a desk job or a job requiring computing skills. These patients who had joined work were more satisfied and integrated with the society. Discussing the social impact of this devastating injury, it is important to note that one committed suicide, the exact reason was not known. He was a 32-year-old male labourer with global brachial plexus injury. Global brachial plexus palsy patients are dependent on their family for a very long time. We encourage the patients and their family members to help them join back work at the earliest. Less rewarding outcomes of the treatment have been noticed by us and also by other surgeons if they are not encouraged to join some form of gainful employment.<sup>[9]</sup>

The other finding of this study is the ability of the injured to get accustomed to write with their non-dominant hand and duration after which they started working. Thirty seven (25.6%) of the 144 patients were able to recollect about the duration which they took to write in the non-dominant hand. Most of them started to write their name and to affix their signature by 3 months, as this was a necessity to do their bank transactions or other routine activities. As the implication of this disability is more in the global brachial plexus palsy rather than the upper brachial plexus palsy, we found that 21 of the 37 patients who had global brachial plexus palsy were able to write with their non-dominant hand by an average of 6.8 months; the earliest was by 1 month and the longest duration was by 18 months from the time of injury.

## CONCLUSION

This study gives an insight into the epidemiological aspects of brachial plexus injuries in our unit which reflects the situation in India and also about the few parameters of quality of life following brachial plexus injuries. Road traffic accidents are the most common mode of traumatic brachial plexus injury which accounted for 94% and of the known causes of road traffic accidents, 90% of the injuries involved two wheelers. Brachial plexus injury formed a part of multitrauma in 54% of this study group and 46% had isolated brachial plexus injury. Associated injuries like fractures, vascular injuries and head injuries are much less probably due to the low velocity nature of

these injuries. Fifty-seven per cent had joined back to work by an average of 8.6 months. It took an average of 6.8 months for the global brachial plexus injured patients to write in their non-dominant hand.

There are very few studies focussing on the quality of life of these injured individuals, which needs to be addressed. This could vary in different populations which could help in rehabilitation. This study reflects the epidemiological parameters of brachial plexus injury in a private teaching hospital. The last 3-year statistics of brachial plexus injured patients from our centre shows an increase in cases by 30%. This helps us to be prepared in treating these patients efficiently, which includes planning the time required for assessment, reducing the surgical time duration with increasing experience, making available man power for their counselling, rehabilitation and to spread awareness about the early treatment. This study will give an idea as to the work load to a new centre, if they start specialization in the management of adult brachial plexus injury.

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