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Peripheral nerve injury cases in King Chulalongkorn Memorial Hospital over 10 years

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Objective : *To report cases of peripheral nerve injury admitted to King Chulalongkorn Memorial Hospital during the ten years from1989 – 1998 by emphasis on factors influencing recovery and revealing current problems in peripheral nerve injury treatment.*

Setting : *Department of Anatomy, Faculty of Medicine, Chulalongkorn University.*

Design : *Retrospective descriptive study*

Subjects : *All patients diagnosed with peripheral nerve injuries and admitted to King Chulalongkorn Memorial Hospital during 1989 – 1998 that could be collected except those with brachial plexus injuries.*

Method : *Review and analyze data collected from outpatient records and admission charts for factors influencing nerve regeneration and recovery: ages, mechanisms of injury, locations, extents of nerve damage, associated injuries, and duration between time of injury and repair. Furthermore, major problems in treatment were revealed.*

Results : *There were 43 cases included in this study. Most were in adolescent and early adulthood periods. Cuts were the most common mechanism responsible for injury with 29 cases (67 %), and 18 of these cases were injured by mirror fragments. 38 cases(88%) had nerve injuries in the upper extremities. As a result, patients with median, ulnar and radial nerve injuries were most frequently found (37 cases). Complete lacerations were*

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more common than partial lacerations or neurapraxia with 33 and 5 cases, respectively. Associated vascular injuries were also seen in nerve injuries of the upper limbs (18 of 38 cases). Lastly, duration from injury to repair of most of the patients (27 cases) was not more than 3 months. Five cases underwent surgery after 3 months. Major causes of delayed repair were not noting the nerve injury at the patients' first presentations and also wound infections.

Conclusions : *Young age, frequently found cut injuries and severed nerves at distal portions were the good prognostic factors found in this study. Conversely, commonly seen complete lacerations, associated vascular injuries and unreasonable delays of nerve repair could impede axonal regeneration and functional recovery. Hence, the author recommends that studies on internal topography of major nerves in the upper extremities should be conducted in order to improve surgical treatments. Early diagnosis of nerve injury and good wound care must also be emphasized for better results after neurorrhaphy.*

Key word : *Peripheral nerve injury.*

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สิทธิพร แอกทอง. การบาดเจ็บของเส้นประสาทส่วนปลายในช่วงระยะเวลา 10 ปีในโรงพยาบาลจุฬาลงกรณ์. จุฬาลงกรณ์เวชสาร 2543 ธ.ค; 44(12): 927 - 38

วัตถุประสงค์ : *เพื่อรายงานผู้ป่วยที่มีการบาดเจ็บของเส้นประสาทส่วนปลายที่เข้ารับการรักษาในโรงพยาบาลจุฬาลงกรณ์ในช่วงระยะเวลา 10 ปี ตั้งแต่ พ.ศ. 2532-2541 โดยเน้นถึงปัจจัยที่มีผลต่อการคืนหน้าที่ของเส้นประสาทและปัญหาหรืออุปสรรคในการรักษาการบาดเจ็บของเส้นประสาทส่วนปลายในปัจจุบัน*

หน่วยงาน : *ภาควิชากายวิภาคศาสตร์ คณะแพทยศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย*

รูปแบบการศึกษา : *การศึกษาเชิงพรรณนาย้อนหลัง*

ผู้ป่วยที่ทำการศึกษา : *ผู้ป่วยที่มีการบาดเจ็บของเส้นประสาทส่วนปลายทั้งหมดที่มีการวินิจฉัยเท่าที่จะรวบรวมได้ โดยเข้ารับการรักษาในโรงพยาบาลจุฬาลงกรณ์ในช่วงปี พ.ศ. 2532–2541 ทั้งนี้ไม่นับรวมผู้ป่วยที่มีการบาดเจ็บของร่างแหประสาท brachial (brachial plexus injury)*

วิธีการศึกษา : *รวบรวมและวิเคราะห์ข้อมูลที่ได้จากบัตรผู้ป่วยนอกและแฟ้มประวัติผู้ป่วยที่รับไว้รักษาในโรงพยาบาล*

ผลการศึกษา : *มีผู้ป่วยที่ได้รับบาดเจ็บต่อเส้นประสาทส่วนปลายทั้งสิ้น 43 คน พบว่าส่วนใหญ่มีอายุไม่มาก คือ อยู่ในช่วงวัยรุ่นและผู้ใหญ่ตอนต้น สาเหตุของการบาดเจ็บส่วนมากเกิดจากถูกของมีคมบาด คือ 29 ราย (67%) โดยเฉพาะกระจกพบถึง 18 ราย และเมื่อพิจารณาถึงตำแหน่งการบาดเจ็บ 38 ราย เป็นการบาดเจ็บต่อเส้นประสาทของแขนขณะที่ขาพบเพียง 5 ราย เท่านั้น ดังนั้นเส้นประสาท median ulnar และ radial รวมทั้งแขนงของเส้นประสาท radial จึงมีการบาดเจ็บเกิดขึ้นจำนวนมากคือ 37 ราย โดยเฉพาะเส้นประสาท median เส้นเดียวพบมากที่สุดเป็นจำนวน 19 ราย การบาดเจ็บที่มีการฉีกขาดอย่างสมบูรณ์ของเส้นประสาทเกิดขึ้นเป็นจำนวนมาก คือ 33 ราย เมื่อเทียบกับการฉีกขาดบางส่วนหรือการซอกช้ำ ซึ่งพบในผู้ป่วยจำนวน 5 ราย นอกจากนี้การบาดเจ็บของเส้นประสาทที่แขนมีจำนวนไม่น้อยที่มีหลอดเลือดแดงฉีกขาดร่วมด้วย คือ 18 จาก 38 ราย โดยเฉพาะเส้นประสาทและหลอดเลือดแดง ulnar ระยะเวลาตั้งแต่เกิดเหตุจนได้รับการผ่าตัดซ่อมเส้นประสาทอยู่ในช่วง 3 เดือน จำนวน 27 ราย อีก 5 ราย เกิน 3 เดือนไปจนถึง 9 เดือน สาเหตุส่วนใหญ่ที่ทำให้มีการล่าช้าของการเย็บ*

ซ่อมคือ ตรวจไม่พบการบาดเจ็บของเส้นประสาทตั้งแต่ต้นและการติดเชื้อที่แผล

วิจารณ์และสรุป : *จากการศึกษาเบื้องต้นดังที่รายงานนี้ พบว่าผู้ป่วยที่เส้นประสาทได้รับบาดเจ็บจะมีทั้งปัจจัยที่เกื้อหนุนต่อการคืนหน้าที่ของเส้นประสาท ได้แก่ อายุน้อย กลไกการบาดเจ็บที่เกิดจากของมีคมและการบาดเจ็บที่ตำแหน่งปลายของเส้นประสาท และปัจจัยที่ขัดขวางหรือไม่เหมาะสมต่อการคืนหน้าที่ คือ การขาดกันอย่างสมบูรณ์ของเส้นประสาท การมีหลอดเลือดฉีกขาดร่วมด้วย และการผ่าตัดซ่อมเส้นประสาทที่ล่าช้าในผู้ป่วยจำนวนมาก ดังนั้นผู้ทำการศึกษาจึงได้เสนอแนวทางในการแก้ไข โดยควรจะมีการศึกษาการเรียงตัวของเส้นใยประสาทตลอดทางเดินของเส้นประสาทที่แขนเพื่อประโยชน์ในการผ่าตัด และควรจะวินิจฉัยการบาดเจ็บของเส้นประสาทให้ได้ตั้งแต่ต้นรวมทั้งการดูแลรักษาบาดแผลที่ดีเพื่อโอกาสที่เส้นประสาทจะคืนหน้าที่หลังการเย็บซ่อมจะมีมากขึ้น*

Nowadays, crime and violence are dramatically increasing with terrifying rates. More people are injured and trauma patients are commonly encountered in emergency rooms.

Peripheral nerve injury is one of those conditions found in the patients with injuries from various causes such as fighting, suicide or occupational accidents. Some involve major nerves of the upper and lower extremities. Unless the existence of nerve injury is rapidly diagnosed and repair is performed within an appropriate time, these patients will suffer from disabilities. Moreover, methods of nerve repair and preservation of favorable conditions for axonal regeneration are also crucial in restoring limb functions.

Patients with residual nerve palsies will encounter difficulties in daily activities and, more important, their occupations. Available treatments are time-consuming and cause major expenses[1] whereas the results are sometimes disappointing. These people are apt to become burdens for their families and the country.

This study aimed to examine the cases with peripheral nerve injuries, especially in the upper and lower extremities. Causes of injury and related factors influencing functional recovery were reviewed and analyzed. Furthermore, unfavorable but corrigible conditions and further essential studies needed for improving prognosis are emphasized. This information will be very helpful in developing treatments of nerve injury, thus more satisfactory results can be anticipated.

Materials and Methods

All collectible patients diagnosed with peripheral nerve injuries in King Chulalongkorn Memorial Hospital between 1989 – 1998 were reviewed. However, various types of brachial plexus injury were excluded due to the differences in several aspects such as anatomical position, etiologies of injury and factors concerned in the treatment.[2]

There were only 43 cases which the complete file could be retrieved and included in this study. The outpatient records and admission charts were reviewed to determine: ages, mechanisms of injury, locations, extents of nerve injury, associated injuries and duration between time of injury and repair. These were further analyzed and discussed. Moreover, major problems in treatment were revealed.

It is interesting about the low number of patients diagnosed peripheral nerve injury. The author supposes that the probable reason is the miss of noting nerve injury in the summary record due to paying attention to other more serious problems.

Results

There were 43 cases with peripheral nerve injuries included in this study. Most of the patients were male, 39 of 43 cases, and only 4 were female. The average age was 26.3 +/- 11.5 years with 65 years and 9 years as the oldest and youngest.

Regarding the mechanisms responsible for the nerve injuries, they were classified into four types: cut, saw, crush and avulsion, according to Zachary's study.[3] Additionally, a combined type was added because some kinds of accidents had two or more mechanisms of injury. This classification was closely associated with the extent of nerve damage and also the regeneration of the injured nerves.

Cuts were the most frequent mechanism found in this study with 29 cases (67 %). Mirror cuts

were the most common cause, 18 cases (62 %), among three objects responsible for this mechanism, as shown in Table 1. There were 6 patients with combined mechanism of nerve injury. In addition, one case had insufficient data to determine the mechanism of injury. There were no cases where the injury was only by avulsion. Other mechanisms and their causes are summarized in Table 1.

Regarding the locations of the nerve injury, the upper extremities were involved in 38 cases (88 %) whereas the lower extremities were affected in only 5 cases. Furthermore, there was no significant difference between right and left extremities, with the figures of 25 and 18 cases, respectively.

Table 1. Mechanisms and related causes of nerve injuries.

Mechanism	Related cause	No. of cases
Cut	Mirror	18
	Knife	10
	Sharp metal	1
	total	29
Saw	Ceramic	3
	Metal-cutting saw	2
	total	5
Crush	Gear head	1
	Lift door	1
	total	2
Combined	Fractures	3
	Bullet	1
	Animal bite	1
	Explosion	1
	total	6
Unidentified	Car accident	1
Total		43

In the upper extremities, the median nerve was the most commonly involved (19 cases) including simultaneous adjacent nerve injuries. Moreover, in these 19 cases, 12 had median nerve injuries of the wrists, compared with 5 cases involving arms and the remainder at other regions of the upper extremities,

Table 2. Distribution of nerve injuries in the upper extremity.

Part and injured nerve	No. of cases
Arm	
Median nerve	5
Radial nerve	2
Ulnar nerve	1
Elbow or cubital fossa	
Ulnar nerve	1
Radial nerve	1
Forearm *	
Median nerve	1
Superficial radial nerve	2
Posterior interosseous nerve	2
Ulnar nerve	5
Wrist **	
Median nerve	12
Ulnar nerve	9
Superficial radial nerve	1
Hand	
Median nerve	1
Ulnar nerve	1
Superficial radial nerve	1
Digital nerve	1
Total	38

* One case had injuries to median, superficial radial and ulnar nerves.

** Simultaneous median and ulnar nerve injuries in 4 cases. Median, ulnar and radial nerve injuries in one case.

as shown in Table 2. The second most frequently involved nerve was the ulnar nerve and was found in 17 patients. The wrist was not only the most common location of median nerve injuries, but also for the ulnar nerve cases (9 of 17 cases). As a result, the wrist was the most susceptible area exposed to injury in the whole upper extremities with involvement in16 of 38 cases.

The radial nerve and its branches, superficial radial and posterior interosseous nerves, were the third most frequently severed. In contrast with the median and ulnar nerves, the forearm was the major site of radial nerve injuries.

In the lower extremities, nerve injuries did not occur as frequently as in the upper extremities with 5 and 38 cases, respectively. However, a striking fact was that 3 of 5 cases had trauma to common peroneal nerves, as shown in Table 3. Other nerves involved in the lower extremities were the sciatic and superficial peroneal nerves.

Table 3. Distribution of nerve injuries in the lower extremity.

Part and injured nerve	No. of cases
Hip	
Sciatic nerve	1
Thigh	
Common peroneal nerve	1
Knee or Popliteal fossa	
Common peroneal nerve	2
Ankle	
Superficial peroneal nerve	1
Total	5

Regarding association between the mechanisms of injury and each traumatic nerve, cut was the major cause. Cut mechanism was responsible for 12 cases of median nerve injuries (63 %), 15 cases of ulnar nerve injuries (88 %) and 6 cases of radial nerve injuries (67 %). Saw and combined mechanisms were the second most common cause, as shown in Table 4.

Furthermore, extents of nerve injury were also reviewed. Complete laceration or discontinuation of nerve occurred much more often than partial laceration or without gross laceration, as shown in Table 4.

In addition to nerve injuries, associated vascular traumas, especially of arteries, were reviewed. There were 19 cases (44 %) that had complete or partial arterial lacerations. Arteries in the upper extremities, again, were involved much more than those in the lower extremities. Compatible with the sites of injury, the wrist was the most frequent site (10 of 19 cases) among the areas that had both nerve and arterial injuries. Therefore, ulnar arteries were injured in 13 cases that had associated arterial injuries, and 7 cases were at the wrists. In these 13 cases, the ulnar nerves were involved in 10 cases (77 %). In addition, brachial arteries were lacerated nearly as frequently as radial arteries with 3 and 4 cases, respectively. Two cases of radial arterial laceration had simultaneous superficial radial nerve injuries. The anterior tibial artery was the only artery of the lower extremities found lacerated in one case.

Duration from time of injury until nerve repair was also collected for analysis. Of the 43 cases with nerve injuries, 38 cases underwent surgery. For 2 of these, there were no details about time of injury and neurorrhaphy. Hence, the data of 36 cases was gathered and is shown in Table 5.

Table 4. Mechanisms and extents of injuries in frequently involved nerves.

Nerve	No. of cases									Total
	Mechanism of injury					Extent of injury				
	cut	saw	crush	combined	unknown	partial laceration	complete laceration	no laceration	no rec	
1. Median	12	3	1	2	1	2	15	-	2	19
2. Ulnar	15	2	-	-	-	2	12	-	3	17
3. Radial	6	1	-	2	-	-	7	2	-	9
4. Common peroneal	1	-	1	1	-	-	2	1	-	3

Table 5. Duration between time of injury and nerve repair in 36 patients

Duration	No. of cases
< 8 hours	9
8 – 24 hours	8
> 1 – 7 days	3
> 7 days – 3 weeks	2
> 3 weeks	10*
not certain	4
Total	36

* 1 month in 2 cases, 2 months in 2 cases, 3 months in one case, 4 months in 2 cases, 6 months in one case, 8 months in one case and 9 months in one case.

As shown in the table, 17 cases (47 %) were operated on within the first 24 hours after their injuries. In another large group, durations of operation of more than 3 weeks were obvious. There were 10 cases (28 %) in this group with duration ranging from 1 to 9 months. The underlying causes for the delays of nerve repair were: nerve injuries not noted in 6 cases, wound infections in 3 cases and extensive soft tissue injury with bone fracture in one patient. However, histories of 4 of 36 cases had no information about the length of time between injury and presentation. As a result, these 4 cases could not be categorized to the groups.

Discussion

The results were tabulated according to the factors influencing nerve regeneration and functional recovery.

1. Age

Age has previously been demonstrated to have considerable influence on the rate and degree of nerve regeneration. Most of the evidence is from several studies on soldiers such as Omer 's[4] and Kankaanpaa's[5] studies. These studies found that recovery after neurorrhaphy in patients under 20 years of age was more favorable.

In this study, most of the patients were in their adolescent and early adulthood periods. There were 14 patients (33 %) aged below 20 years. Hence, one of three patients presenting with peripheral nerve injuries had a good prognosis when only age was considered.

2. Mechanism of nerve injury

According to Zachary's study[3], cut and crush groups had the least amount of injured nerves and the extent of their injuries could be accurately assessed during the initial operation. In contrast, when time elapsed, the pathologic parts requiring resection of the severed nerves from avulsion significantly increased.

As a result, accurate evaluation of the extent of nerve damage and good results after primary repair could be anticipated in nerves injured due to cut or crush mechanisms.

In this review, cuts were responsible for 29 cases (67 %), as shown in Table 1. Therefore, many patients with peripheral nerve injuries had promising prognoses after neurorrhaphy when only the injury mechanism was considered.

However, it was striking that there were only 3 cases of bone fractures complicated with nerve injuries during the ten year period. The cause was probably under-detection or poor record keeping and this could affect the noted frequency of each mechanism. Regarding cause of injury, most of the patients in this study were injured from fighting, accidents and suicide attempts.

3. Level or location of injury

From Sakellarides's study,[6] peripheral nerve injury occurring above an elbow had more rapid recovery of function than below the elbow.

This study found many more nerve injuries in the upper limbs than in the lower limbs. The possible causes were the events responsible for most of the injuries: violence and self-inflicted injuries.

In the upper limbs, as shown in Table 2, injuries of the elbows and above them were found in only 10 of 38 cases. In comparison, trauma of nerves below the elbows were seen in 28 cases, and 16 were at the wrists. Therefore, when considering only level of injury, functional recovery prognostication was not good.

Furthermore, two or more nerve injuries in the wrists of the same patient were found in 5 cases. Closeness of the nerves in this area was likely the cause. These multiple nerve injuries rendered poorer prognosis for return of function in each nerve, and thus overall hand function return.

In the lower limbs, although the number of cases was less, most of the nerve injuries (4 of 5 cases) occurred above the knees. This is opposition to the proportions observed in the upper extremities.

4. Extent of nerve injury

Complete lacerations were found much more frequently than partial lacerations in nerve injuries of both the upper and lower extremities with 33 and 5 cases, respectively. Frequently found sites of cut injuries (67 %) such as wrists, forearms and knees where the nerves were close to the skin could be a reasonable explanation. Consequently, increased likelihood of fascicular malalignment after neurorrhaphy in completely transected nerves was unavoidable. Poor or crossed alignment of various fascicles in the nerve impedes regeneration and makes satisfactory recovery difficult.

Moreover, motor and sensory functions of the hands are indispensable for skilled occupations and a lot of other activities. As a result, complete laceration of nerves caused increased chances of incomplete recovery of hand function and more burdens to society.

However, fortunately, Williams's[7] and Jabaley's[8] studies have demonstrated the decreased

complexity of fascicular arrangement in the more distal nerves. In this study, although many complete lacerations were seen, most of them were in distal parts such as the forearms and wrists.

5. Associated vascular injury

Simultaneous vascular trauma affects nerve regeneration to some degree, perhaps from tissue ischemia. In this study, completely and partially lacerated vessels were found in 19 cases (44 %). Again, the most common location was the upper extremity with 18 of 19 cases. It was likely that adjacent arteries could be injured when there were nerve transections. The most common location was the wrist. The ulnar artery was the most highly involved with 13 cases.

From the results shown above, it can be seen that there were many vascular injuries complicating nerve traumas. These hinder axonal regeneration and, thus, return of functions.

Furthermore, in 13 cases of ulnar arterial injury, associated ulnar nerve injuries were found in 10 cases (77 %). This observation is useful as a reminder of possible ulnar nerve injury when ulnar arterial injury is diagnosed.

6. Duration between time of injury and repair

Several studies[9,10,11,12] concluded that the greater the delay for nerve repair, the more chance of unfavorable functional recovery. Consequently, it is widely accepted that if the wound was caused by a sharp object, is clean and the patient has no associated life-threatening injuries; primary repair performed within 6 - 8 hours after trauma or even a delay to first 7 - 18 days is acceptable.[2,13]

Conversely, if extensive soft tissue contusion or excessive contamination is encountered, neurorrhaphy should be postponed to 3 – 6 weeks after the injury. This period was endorsed by Ducker's[14] and Omer's[15] studies. However, the duration between time of injury and secondary repair has been quite controversial. Some studies[5,16] have demonstrated that repairs performed at 3 months after injury had satisfactory results. Therefore, neurorrhaphy within 3 months is likely to have a reasonable outcome.

In this study, fortunately, most of the patients (22 of 32) underwent neurorrhaphies within 3 weeks after their trauma. However, only 9 cases were repaired within less than 8 hours and this is the preferred duration when all conditions are suitable.

In addition, there were 10 cases where the surgeries were performed after 3 weeks. In this group, 5 cases had surgeries after 3 months that has been found to be unfavorable time. Careless diagnosis or not detecting the nerve injury was the most common cause responsible for delay in nerve repair and this occurred in 6 patients. Wound infection was the second most common.

Therefore, careful examination for nerve injury in laceration wounds during the patient's first visit will significantly decrease unnecessary delays in nerve repair. Good care of the wounds must also be emphasized. If these two major causes can be reduced, problems of unreasonably delayed neurorrhaphy will be lessened. As a result, higher rates of axonal regeneration and functional return can be achieved.

Nevertheless, this study found that there were other factors contributing to delays in nerve repair. Patients' own unawareness of their abnormalities, full schedules of operating rooms and inadequate inpatient beds were responsible for delays in many

cases. Unfortunately, these are hard to solve and require cooperation from several units.

7. Injury of individual nerves

The median nerve was the most often injured nerve in this study with 19 cases (44 %). The ulnar nerve was slightly less involved with 17 cases(40 %). Twelve and 9 of those who had median and ulnar nerve injuries were traumatized at the wrist. This is probably because the wrist is the narrowest region of the upper extremities where all major nerves converge and thus is more susceptible to cut injury, especially from accidents and suicide attempts.

These results indicate that the nerves in the upper extremities are more vulnerable to injuries, especially the nerves controlling hands. Nerve injury of the upper limbs is obviously important because of the serious adverse effects on the patient's daily activities and working abilities. Their periods of disability will be prolonged if nerve regeneration is interrupted or impeded.

As a result, it is suggested that there must be more comprehensive studies on internal topography or fascicular arrangement of major nerves in the upper extremities for the Thai population, especially median, ulnar and radial nerves. Although there already is information about the internal topography of these nerves, it is from western countries and there are probably some degree of difference between Caucasoid and Mongoloid peoples.

Such studies will enable physicians and surgeons to choose the most suitable method of nerve repair. More successful nerve repairs will increase the chances of favorable functional recovery and also reduce disabilities.

In conclusion, patients presenting with peripheral nerve injuries in King Chulalongkorn Memorial Hospital had both good and unfavorable prognostic factors. The ages, mechanism and location of injury found in most patients were suitable for regeneration and functional recovery.

Conversely, many complete lacerations of nerves are frequently associated with vascular injuries and significant delay of nerve repair in some patients was not good for prognosis.

However, duration between time of injury and repair can partly be improved by emphasis on comprehensive physical examination and correct wound care. These measures will increase the rate of successful recovery.

Furthermore, due to frequent involvement of nerves in the upper extremities, studies on fascicular arrangement of these nerves are recommended. Such information is apt to be very helpful in improving treatment of peripheral nerve injury in order to reduce disabilities in patients.

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