

THERAPY

Surgical repair of peripheral nerves in lower extremities

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Outline: Present study reports the results of 48 operations performed on 48 nerves of lower extremities in 48 patients during the period of 15 years from 1985 to 1999. Basic lines of surgical treatment of various injuries of nerves in lower extremities are presented in the study.

Patient population and methods: 24 patients were treated by external neurolysis, 24 patients were treated by reconstruction operations. Reconstruction operations were performed either by suture of peripheral nerve (10 cases) or more frequently, by neural graft (14 cases). Complete and persisting neurological deficit and the absence of nerve action potentials were the indications for the surgical repair. The absence of nerve electrical properties potentials was an important criterion for the determination of the type of surgical intervention. Analysis of the effectiveness of surgical treatment was performed with respect to following parameters: period between the injury and operation, patient age, character of the injury, type of injured nerve, type of surgical intervention.

Results: The best results were observed for external neurolyses. Improved results of reconstruction operations were achieved for operation by suture compared to operations by nerve graft. Good and excellent results (not dependent on the character of surgical treatment, character and location of the injury, time period between the injury and surgical repair and on the age of the patient) were typical for treatment of n. tibialis.

Conclusion: Early surgical revision associated with neurolysis and eventually with reconstruction surgery is very important in indicated cases. (Tab. 5, Ref. 10.)

Key words: lower extremity nerve lesions, neurolysis, nerve suture, nerve graft.

Injuries of the nerves in lower extremities are less frequent than injuries of nerves in upper extremities (7). Injuries of n. ischiadicus and of its rami represent the largest and the most important portion of this type of injuries in lower extremities (6). In our hospital we were in fact faced with only 4 cases of injury of n. femoralis. We call to the attention the treatment of these patients since the majority of surgeons that do not show a particular interest in peripheral nerves has only infrequent experience with this type of injury over many years of surgical practice. We could also find only few reports in the literature dealing with this problem (3, 6, 7, 8, 9). In this retrospective study we present our experience with surgical treatment of nerve injuries in lower extremities in the period of peace. We provide information about clinical characteristics and treatment of affected patients. The aim of this work is to provide basic recommendations for treatment of patients with injuries of peripheral nerves in lower extremities.

Patient population and methods

In the period from 1985 to 1999 we treated totally 685 patients with peripheral nerve injuries on the Clinic of Neurosurge-

ry, Faculty of Medicine, Comenius University in Bratislava. Out of them 48 patients (7.0 %) were subject to surgical intervention on peripheral nerves in lower extremities.

Careful and timely treatment of injured nerve (most frequently performed by external neurolysis) constitutes the elementary condition for shortening of the time period required for functional recovery of nerve after posttraumatic axonotmesis.

24 patients (50 %) were treated by external neurolysis. This treatment was indicated in the cases involving the development of posttraumatic fibrosis caused by posttraumatic hematoma — edema which caused nerve damage by persisting compression. In such cases neurolysis represents a procedure leading to nerve restoration. Especially in the cases of preserved nerve continuity, neurolysis is the preferred surgical intervention.

Remaining 24 patients underwent reconstruction operations. 10 operations were performed by suture of peripheral nerve and 14 operations by neural grafts.

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Tab. 1. Dependence of the outcome of surgical treatment of peripheral nerves in lower extremities on the time period between the injury and operation.

Nerve	Period from injury Type of treatment No of pts	Up to 3 months			4 and more months		
		Neurolysis	Suture	Nerve graft	Neurolysis	Suture	Nerve graft
		13/13	3/3	5/3	11/9	7/4	9/1
Ischiadicus	6/6	2/2	–	2/2	1/1	1/1	–
Tibialis	5/5	–	–	–	3/3	1/1	1/1
Fibularis	33/20	10/10	2/2	2/1	7/5	4/2	8/0
Femoralis	4/2	1/1	1/1	1/0	–	1/0	–

Patient population of 48 individuals consisted of 32 males and 16 females with the average age of 37 years. The average time period between the injury and operation was 7.7 months.

Extremely long period between injury and operation (over 12 months) occurred in 12 patients. Injuries of n. ischiadicus and its rami represented 91.3 % of all cases. Injury of n. femoralis was present only in 4 cases.

Injuries of n. ischiadicus included injuries from the level of gluteal muscle down to the macroscopic ramification of n. ischiadicus to n. tibialis and n. fibularis.

The most frequent injuries were present in the knee and crural areas (30 patients, i.e. 62.3 %). With respect to the character of injury, the dominant category was represented by iatrogenic damage of n. fibularis (15 of 30 cases). Injuries of nerves in the thigh area (14 cases) were usually of secondary character. One of major causes of these injuries were femoral fractures (7) and gunshot wounds (3). Femoral fractures caused frequently variable degree of damage of both nerves (n. fibularis, n. tibialis). All patients with this type of injury showed complete or severe lesion of n. fibularis and only partial impairment of n. tibialis.

4 cases of injury of n. ischiadicus in the gluteal muscle area included 2 cases of iatrogenic damage and 2 cases of traumatic incisive wounds. We conclude that injuries of n. fibularis were highly dominant (33 patients, i.e. 68.8 %).

All patients underwent a detailed clinical examination. Pre-treatment EMG examination indicated denervation in all patients subjected to reconstruction treatment and in 15 patients treated by external neurolysis. The absence of nerve action potentials even 2–3 months after the injury indicated the presence of neurotmesis with a minimal chance of recovery without a surgical treatment.

Follow-up post-treatment EMG was performed in all patients. The follow-up monitoring period was at least 1 year, majority of patients (44, i.e. 91.6 %) were monitored for 3 and more years.

All patients received primary care in other hospitals. Iatrogenic injuries, incised wounds or gunshot wounds were treated within first days after the injury.

The definite indication for the operation was total or severe motor deficit in the absence of spontaneous recovery within several (2–3) months. Intense pain not responding to medicinal therapy was the indication for surgical treatment also in cases with only partial loss of function (2 patients).

Operations started always by external neurolysis that helped to determine the degree of nerve damage. External neurolysis was the major treatment in 24 cases.

Reconstruction operations were performed by a microtechnique. Nerves were treated by suture in cases where neural suture was possible without tension after the mobilisation of the nerve or extremity. Separation and “end-to-end” suture (10 patients) was less frequent than a suture by means of nerve graft (14 patients).

In all cases, n. suralis was used as the autotransplant. Nerve grafts were deposited loosely between two nerve endings in such a way that an overlap of 5–10 mm (depending on the length of the graft) between the graft and nerve endings was achieved. Number of grafts varied between 2 and 4. Fascicles or fascicle groups were connected by sewing material of the value “8.0”; 2–3 stitches were usually used per one fascicle.

All patients underwent several post-treatment tests aimed at determination of the degree of recovery of sensory and motor activity. The actual evaluation was based on the classification suggested by Kline D.G et al. (1987). Motor recovery was evaluated by a 5-point scale. Recovery scaled in the M3 category was considered as good while M4 and M5 were evaluated as excellent. Results scaled as M1–M2 were considered to be insufficient.

Analysis of the results of post-operational examinations of patients was performed with respect to general factors affecting results of operation with respect to:

- time period between the injury and operation,
- patient age,
- character of the injury,
- type of injured nerve,
- character of the surgical intervention.

Results

A complete recovery of the strength and motility as well as of EMG finding was observed in 18 of 48 patients (37.5 %). This group consisted of 14 patients treated by external neurolysis and 4 patients treated by reconstruction operations involving suture.

Complete recovery of strength, motility and EMG was not observed in any of patients subjected to nerve graft surgery. Complete restoration of sensitivity was observed in 11 patients treated by external neurolysis (45.8 %) and in only one patient (4.2 %) treated by reconstruction surgery involving suture.

Best results were observed in patients treated by neurolysis where recovery of functional grade M3 and better was achieved in 22 cases (91.7 %). Similar positive result was observed in 7 patients subjected to reconstruction surgery involving suture (70 % and only in 4 patients after operation involving nerve grafts (21.4 %). When the

Tab. 2. Dependence of the outcome of surgical treatment of peripheral nerves in lower extremities on patient age.

Nerve	Patient age Type of treatment No of pts	Up to 20 years			over 20 years		
		Neurolysis	Suture	Nerve graft	Neurolysis	Suture	Nerve graft
		5/4	1/1	4/2	19/18	9/6	10/2
Ischiadicus	6/6	1/1	–	1/1	2/2	1/1	1/1
Tibialis	5/5	–	–	–	3/3	1/1	1/1
Fibularis	33/20	3/2	1/1	3/1	14/13	5/3	7/0
Femoralis	4/2	1/1	–	–	–	2/1	1/0

Tab. 3. Dependence of the outcome of surgical treatment of peripheral nerves in lower extremities on the character of injury.

Nerve	Character of injury Type of treatment No of pts	Incisions			Other injured		
		Neurolysis	Suture	Nerve graft	Neurolysis	Suture	Nerve graft
		3/3	3/3	3/2	21/19	7/4	11/2
Ischiadicus	6/6	2/2	–	1/1	1/1	1/1	1/1
Tibialis	5/5	–	–	–	3/3	1/1	1/1
Fibularis	33/20	1/1	2/2	2/1	16/14	4/2	8/0
Femoralis	4/2	–	1/1	–	1/1	1/0	1/0

Tab. 4. Dependence of the outcome of surgical treatment of peripheral nerves in lower extremities on the type of injured nerve.

Nerve	Character of injury Type of treatment No of pts	Incisions			Other injured		
		Neurolysis	Suture	Nerve graft	Neurolysis	Suture	Nerve graft
		3/3	3/3	3/2	21/19	7/4	11/2
Ischiadicus	6/6	2/2	–	1/1	1/1	1/1	1/1
Tibialis	5/5	–	–	–	3/3	1/1	1/1
Fibularis	33/20	1/1	2/2	2/1	16/14	4/2	8/0
Femoralis	4/2	–	1/1	–	1/1	1/0	1/0

treatment was performed within first three months after the injury, good and excellent results were achieved in all cases of neurolysis and neural suture and in 3 patients (60 %) that were subjected to reconstruction surgery involving nerve graft. Increasing the time elapsing from the injury caused worsening of the results particularly for reconstruction operations (Tab. 1).

Values are expressed as number of surgically treated cases/number of cases with functional recovery M3 and better.

With respect to patient age, the best results were observed in patients younger than 20 years (Tab. 2).

Clean wounds (incisions, penetrating wounds) provided much more favourable conditions for the recovery than other more complicated injuries (e.g. lacerations and contused or comminuted wounds). The success rate for the first mentioned type of wounds was 100 % for neurolysis and suture and 66.7 % for nerve grafts (3 patients) (Tab. 3).

One of the most important factors affecting the outcome of regeneration process was the type of injured nerve. Functional recovery of n. tibialis was observed in all treated cases, irrespective of the type of operation. In the cases of lesions of n. ischiadicus,

the complete recovery of n. tibialis was achieved in all treated cases irrespective of the type of operation (Tab. 4).

In reconstruction operations by nerve grafts best results were observed for nerve grafts shorter than 5 cm (2 patients). In cases with graft length over 5 cm we registered functional recovery in one case — n. tibialis.

It is necessary to emphasize the relatively high number of iatrogenic lesions — 19 patients (39.6 %) that represented for n. fibularis almost one half of all treated lesions (Tab. 5).

The time of appearance of the first symptoms of restored innervation relied on analysed factors and it varied from several days in the cases of neurolysis to several months in the cases of reconstruction operations (8 months for n. femoralis, 14 months for n. tibialis and up to 2 years for n. fibularis). The presence of positive nerve action potentials is always an undeniable evidence for the regeneration of damaged nerve. A promising motor recovery was observed in the majority of these patients. From 24 patients subjected to neurolysis as the major surgical intervention, both internal and external neurolysis were performed in two patients due to persisting severe pains that did not respond to medical treatment. Retreat of difficulties was observed in these cases.

Tab. 5. Dependence of the outcome of surgical treatment of peripheral nerves in lower extremities on the character of injury.

Injury type		No. pt	Neurolysis				Suture				Nerve graft			
Nerve			Isch	Tib	Fib	Fem	Isch	Tib	Fib	Fem	Isch	Tib	Fib	Fem
Iatrogen	Injection	1	1/1											
	Plast.surg. of coxae	2								1/0	1/1			
	Suture	4			3/3				1/1					
	Other iatr.	12			6/5				2/1			1/1	3/0	
Other	Incision	7	1/1		1/1				1/1	1/1	1/1		2/1	
	Fracture	7			5/4		1/1		1/0					
	Gunshot	3	1/1			1/1		1/1						
	Compress	12		3/3	2/2				1/1				5/0	1/0
Total		48	3/3	3/3	17/15	1/1	1/1	1/1	6/4	2/1	2/2	1/1	10/1	1/0

Discussion

Surgery of the nerves of lower extremities is a direct and often time-consuming method that is aimed at solving the problem of motor defects caused by lesions of peripheral nerves. Deliberation and reconstruction operations provide good conditions for recovery of motor and sensory functions. 48 patients were treated by 24 deliberation and 24 reconstruction operations including 14 operations by autotransplant. N. suralis was used as autograft in all cases. Pre-treatment EMG examinations revealed denervation in all patients treated by reconstruction operations and in 15 cases (62.5 %) of deliberation operations. The objectivisation of the results of operations performed on n. ischiadicus and its rami was based on the classification of Kline et al. (1998). Treatment of n. femoralis resulted in complete recovery in 2 cases and in insufficient recovery in 2 cases. The best results were observed for neurolysis with success rate over 90 %. Average results were achieved for reconstruction operations by suture of peripheral nerve — 70 % success rate.

The worst results were achieved for reconstruction by nerve grafts — only 21.4 % success rate.

Post-treatment examinations were performed in all patients. In some cases, objective examination as well as subjective evaluation by the patient revealed an improvement, however, the EMG examination did not show any change when compared to previous examination. The recovery of motor and sensory functions was dependent on the time period from the injury to operation, on patient age, on the type of injured nerve and last but not least, on the character of reconstruction intervention. We observed a functional recovery in all cases of n. tibialis treatment. The first signs of recovery were observed already after several days in some cases of deliberation operations. This time of first symptom appearance was subject to various factors. It might be 6—8 months for n. femoralis, 14—16 months for n. tibialis and up to 2 years for treatment of n. fibularis. Full recovery of sensory functions was not observed in any of treated patients older than 40 years. All these cases revealed only protective sensitivity.

Iatrogenic injuries were present in 19 cases (39 %). Early surgical treatment showed a 68.4 % success rate (13 patients) in this case. The best results were observed in patients younger than 20 years that were treated within 3 months since the injury, in the cases of

incised wounds and in injuries of n. tibialis irrespective of the character of operation. Similar results on operations of peripheral nerves of lower extremities were reported by other authors (1, 3, 4). In agreement with our results, also other groups reported significantly inferior outcome of the operations of n. fibularis (1, 6, 8, 9, 10).

Early surgical revision associated with neurolysis or (if necessary) the reconstruction surgery are very important factors in indicated cases affecting the outcome of operation and thus the prospects of the patient for everyday life.

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