



Factors Influencing Late Functional Outcome After Lower Extremity Vascular Injury

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Original article

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Summary

Background: The aim of the study is finding out factors influencing patients' ability following surgical treatment of lower limb trauma combined with vascular injuries.

Methods: Thirty five patients were treated by surgical vascular reconstructions. Sixteen of those patients (45.7%) underwent follow-up after a mean time lasting ab. 8 years. There were 14 men and 2 women who were subduced to examinations by means of the originally developed locomotion grading system (LGS).

Results: Patients were scored at a mean value of 30.1 points, while the maximal value in the LGS is 40 points. Significant dependence has been found between the late functional outcome and the following factors: severity of injuries expressed in the Mangled Extremity Severity Score [MESS] ($p < 0.01$), coexistence of other injuries [bone-fractures; joint dislocations; muscle, tendon and nerve injuries] ($p < 0.01$), limb amputation ($p < 0.01$), ischemia time ($p < 0.01$), results recorded by the end of the hospitalization ($p < 0.01$).

Conclusions: Poor late functional outcome following lower limb vascular trauma is significantly influenced by the severity of injuries, coexistence of other soft tissue lesions, limb amputation and prolonged time of ischemia. Results recorded by the end of the hospitalization may be regarded as important predictors of the late functional outcome.

Key words: lower extremity trauma, vascular injuries, late functional outcome

INTRODUCTION

The functional outcome of patients after vascular reconstruction for lower extremity arterial injury is of great concern since a vascular reconstruction is possible but frequently result in considerable disability and decreased function [1-2]. While the early results of arterial reconstruction for lower extremity arterial injuries have attracted much attention the late functional outcome is rarely addressed [3-4].

The key factors that determine the early success of a peripheral arterial reconstruction after trauma are the time from injury, the use of prophylactic fasciotomy to prevent compartment syndrome, external fixation of fractures, and the intraoperative use of systemic anticoagulation [5-7]. Atherosclerosis and inexperience of a surgeon are associated with final poor result [3]. Popliteal artery injury is considered by some authors as predictors of poor outcome [8-10].

While most attention is focused on early limb salvage, little is known about the factors affecting late functional outcome after arterial trauma. The issue is complicated by the fact that peripheral arterial trauma is often associated with injuries to bones, soft tissue or nerves - all of which may have a major impact on the functional outcome of the limb [1,11]. It has been stated that the final effects of treatment are not satisfactory because of decreased function and ability to earn a living [12].

The aim of this study was to identify the diagnostic and therapeutic factors that affect functional outcome following vascular reconstruction for lower extremity arterial injuries.

MATERIALS AND METHODS

Between 1983 and 2002, 35 patients with lower limb blood vessel injuries were treated in our department, 16 underwent a remote follow-up examination. This group includes 14 men (87.5%) from 16 to 52 (mean age 33.9) and 2 women: 16 and 43 years old. The data has been reviewed retrospectively. Severity of trauma has been evaluated by Mangled Extremity Severity Score (MESS) [13]. Majority of the patients sustained blunt trauma (68.75%). Coexisting venous injuries were found in 5 patients. The time of ischemia varied from 3 to 89 hours (mean value 19.3). Seven patients (43.75%) were admitted directly to our department, the remaining persons were transferred after initial management in other units which caused elongation of ischemic period.

A mean value of the MESS was 6.6 points (4-9 p.). Amputation procedures were performed in 4 patients (25%) with previously reconstructed arteries. Fasciotomy was performed in 8 patients (50%).

Early results were evaluated on the basis of pulse palpation, warmth of distal parts of the limbs, neurological examination and a range of movements of the limb. Well-palpable pulse, normal warmth assessment of distal parts of the operated limb comparable with healthy limb, absence of neurological disorders and a full range

of movements of limb joints were regarded as a very good result. A good result was recorded in persons with a normal warmth and reduced pulse in the distal parts in comparison with a healthy limb, slight paresthesia as a result of nerve damage or slight limitation of limb mobility resulting from coexisting bone fracture or joint dislocation (after osteosynthesis or conservative therapy). A satisfactory result of the treatment was noted in patients with impalpable pulse but without any signs of chronic ischemia, in patients with significant neurological loss or significant limitation of the limb range of movements. The necessity of limb amputation was considered as a bad result.

The observation time between a discharge from the department to a distant examination lasted from 1 to 16 years (mean 8 years). In most of the patients, rehabilitation was introduced but the intensity and frequency of physiotherapeutic cycles varied.

A group of 16 follow-up patients have been examined. For the purpose of late functional assessment, we have developed a locomotion grading system (LGS) to quantify the functional outcome of the patient (tab.1). The scoring varies from 0 to 4 points in each functional category with a possible maximum score of 40 points.

Statistical analysis was performed by means of the Mann-Whitney U test, Fisher exact test, ANOVA, t test and correlation coefficient of Kendall using Statistics 7.1 for Windows (Statsoft, Poland). The kind of test, value of statistical test and p-value was presented if significance was found. Statistical significance was defined at $p < 0.05$.

RESULTS

Characteristics of the analyzed 16 patients who sustained traumatic vascular damage and underwent late examination are presented in table 2.

Early surgical results at the time of discharge are presented in table 3.

In the LGS which has been performed during the late follow-up examination, the patients' score ranged between 18-40 p.; the mean score for the whole group was 31.1 points (SD=8.74), which is 78% of the maximal score. Running was the most difficult activity for the patients. A mean score for running was 35% of the maximal score. Only 2 patients (12.5%) have achieved the maximal possible score of 40 points. Standing and walking within the interior have been found the easiest activities to perform (ab. 85%) while walking outside the interior is a bit more difficult (79.5%) (Fig.1).

The relations between the results of the LGS and the factors connected with diagnostic and therapeutic process have been analyzed and presented in table 4.

The severity of lower limb injury described by the MESS influences the results of the LGS. The more severe injuries, the worse are the results of the LGS (t-Kendall=-0.493; $p < 0.01$; N=16). The mean value of the LGS in patients with MESS \geq 6 was 26.5 points while in patients with MESS $<$ 7 it was 35.6 points. The difference is statistically significant (t test; $t=2.4$; $p < 0.05$).

Table 1. Locomotion grading system (LGS)

Functions	4 points	3 points	2 points	1 points	0 points
	Performs without difficulty	Performs without assistance but with difficulty	Performs with an orthopedic supply	Performs with assistance	Doesn't perform
A Standing					
1. 10 sec. on both legs	4	3	2	1	0
2. on one leg	4	3	2	1	0
3. bending to reach an object	4	3	2	1	0
B Walking within the interior	4	3	2	1	0
C Walking outside the interior					
1. on the flat surface	4	3	2	1	0
2. on the uneven surface	4	3	2	1	0
3. upwards and downwards	4	3	2	1	0
4. upstairs and downstairs	4	3	2	1	0
5. getting on the means of transport	4	3	2	1	0
D Running	4	3	–	–	0

Table 2. Data concerning 16 patients with lower extremity vascular injury who underwent remote follow-up examination

Data	Lower extremity n=16	%
1 - Causes of trauma		
Vehicle accident	8	50
Work related accident	4	25
Fall from the height	3	18.75
Self-mutilation	1	6.25
2 - Damaged arteries		
Superficial femoral a.	6	37.5
Popliteal a.	7	43.75
Tibial anterior a.	3	18.75
5 - Type of arterial injury		
Total disruption	6	37.5
Partial disruption	5	31.25
Contusion, thrombosis	4	25
Spasm	1	6.25
6 - Kind of surgical reconstruction of the vessels		
Interposition vein graft	10	62.5
“End to end” anastomosis	1	6.25
Prosthesis interposition	1	6.25
Lateral suture	2	12.5
Vein patch	1	6.25
Revision of the spasmed vessel	1	6.25
10 - Coexisting injuries		
Fracture	10	62.5
Articular dislocation	4	25
Laceration of muscles and tendons	5	31.25
Damage to nerves:	4	25
– ischiadic	2	12.5
– peroneal	2	12.5

Table 3. Early surgical results recorded in 16 discharged patients with vascular injuries

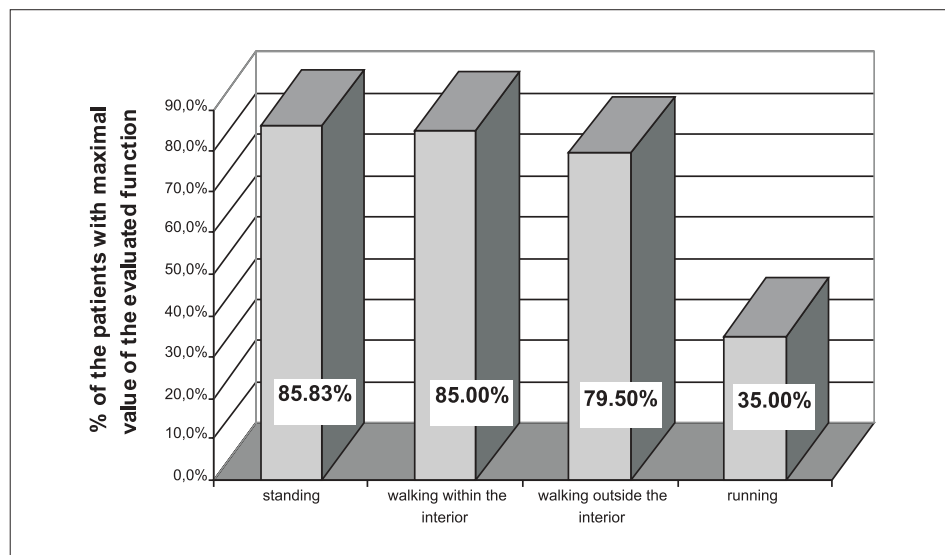
Early treatment results	Number of persons No (%)
Very good	7 (43.75)
Good	4 (25.0)
Satisfactory	1 (6.25)
Bad	4 (25.0)

Table 4. Variables and functional state of the patients evaluated by means of the LGS

Variables	Relation between a variable and LGS
*MESS	p<0.01
Mechanism of injury- blunt vs. penetrating	n.s.
*Time of ischemia	p<0.01
*Coexisting injuries: bone fracture, joint dislocation, laceration of muscles and tendons, damage to nerves	p<0.01
Type of arterial injury	n.s.
Causes of trauma	n.s.
Kind of surgical reconstruction	n.s.
*Amputation	p<0.01
Fasciotomy	n.s.
*Early treatment results	p<0.01
Time of observation	n.s.

* – factors significantly statistically influencing the functional state of the patients
n.s. – non significant

Fig. 1. Percentage of the patients achieving maximal values in separate functions in the LGS



Worse results of the LGS are significantly connected with amputations (amputations: mean value of the LGS=18.75; SD=0.5; N=4; no amputation: mean value of the LGS=35.15; SD=5.54; N=12; Fisher test, $F=33.45$; $p<0.01$).

Patients with isolated vascular injuries score higher values in the LGS (mean value 39.5 points; N=2; SD=0.71) in comparison with the patients with coexisting injuries (fractures, joint dislocations, nerve, muscle, tendon lesions), (mean value 29.86 points; N=14; SD=8.7). Student's t test was used to compare with significance inferred at $p<0.01$.

Total ischemia time significantly correlates with the result of the LGS. The longer the ischemic time, the worse the results of the LGS in a distant time from the trauma (t-Kendall= -0.543; N=16; $p<0.01$).

Patients with a very good or good early results had statistically better scores of the LGS (U test; $Z=-2.9$; $p<0.01$).

Results of the LGS do not significantly differ in relation to the cause of injury, however worse results have been recorded after falls from height (mean value 27.3; N=3; SD=3.8) and following motor vehicle crash (mean value 30; N=8; SD=9.8). Better results have been recorded in patients after work related trauma (mean value 33.8; N=4; SD=9.8) and self-mutilation attempts (mean value 40; N=1).

Mechanism of injury also does not influence the distant result. The difference in patients after blunt and penetrating trauma is not significant (t test; $t=-2.06$; n.s.).

Surgical repair procedure and performed fasciotomy also seem not to influence the result of the LGS.

An interval of time between discharge and the follow-up examination does not have any significant influence on lower limb ability. In patients examined within 5 years after the injury a mean value of the LGS is 34.2 points (N=6; SD=7) while in the group examined after a longer time than 5 years is 29.2 points (N=10; SD=9.5).

DISCUSSION

A group of the studied patients is a typical civilian vascular trauma series, with the same incidence of associated injuries and nerve damage as other reported series in the literature [4,7-8,14-15].

The late functional outcome of lower extremity vascular trauma is determined by the time of ischemia and severity of limb injuries - the same factors that predict early limb salvage. There is no doubt that ischemia time is one of the most important factors influencing the final treatment results [3,6-8,16].

Our patients with isolated vessel injuries achieve better late functional outcome. It is generally accepted that most vascular injuries of the lower extremities can be managed successfully unless associated with severe concomitant damage [2,7]. Moniz et al. had 90% of the very good treatment results in isolated vessels injuries [2]. Our series has proven that late functional results correlated significantly with the severity of limb injuries. It is important to emphasize that vascular injuries are often accompanied by bones, nerves or soft tissue damage which influence the final results of surgical treatment [14-16]. Some authors have shown that, in extremity vascular injuries, the functional outcome is determined by associated injuries rather than by the vascular injury [3,7,11]. A significant influence of the coexisting injuries on the final treatment results has been observed in our materials and it has been confirmed by the LGS. Our observations also correspond with the opinion of other authors, who seek the causes of the later patients' disability in the frequent coexistence of other injuries [1,11].

Our study shows that majority of patients with lower extremity vascular trauma do not return to their preoperative functional status. Only two of our 16 patients were able to run while 9 persons were not able to run at all. The rest of the group suffer from certain dysfunction of different degree. The increasing difficulty measured by the LGS reduced the number of patients who are able to

perform the activities without assistance and efficiently. Otherwise Menakuru et al. had 88% full functional recovery one year after discharge, but they assessed only ability to walk, climb 12 stairs and change from sitting to standing position and vice-versa [7]. Severity of lower limb injuries evaluated by means of the MESS and the treatment results at the end of hospitalization significantly correlate with the late functional outcome. This confirms the value of the MESS, early function evaluation at the end of hospitalization may be regarded as strong predictors of the late functional state. Some authors criticize the value of the MESS as predictive factor of late results [17]. On the other hand, Lin et al. are of the opinion that although MESS does not provide an ideal scoring system, there is a strong relation between the MESS and the final functional results [1].

Patients with amputated lower limb achieved significantly worse functional results than those who had limb salvage. Taking into consideration degree of locomotion impairment in patients with a prosthesis (each amputa-

tion at thigh level), this result cannot be surprising. However, it seems evident that the type of injury, injured vessel or repair procedure, do not influence the distant functional result. There are no significantly better functional outcome in patients who underwent fasciotomy. Fasciotomy is recommended by many surgeons in case when the exertional compartment syndrome can develop [5,8-9,16]. As a general rule, fasciotomy is performed in patients with more severe injuries or with longer ischemia time.

We conclude:

1. Lower limb injuries with vascular damage are associated with significant level of disability in a late evaluation.
2. Severity of limb trauma, coexistence of other injuries, limb amputation and limb ischemia time are the main factors influencing the late functional outcome.
3. Early treatment results recorded at the end of the hospitalization after the trauma may be regarded as a useful prognostic predictor of the late functional outcome.

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