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Использование системы оценки тяжести повреждения >7 при сохранении конечностей в случаях раздробленных переломов со сдавлением мягких тканей

В.К. Кельман, С.Е. Шафит

Traumatology and Orthopaedics Research Institute, Russia, Nizhny Novgorod, Director - professor V.V. Azolov

Травмы со сдавлением (пять конечностей у четырех пациентов) при наличии обширных разрывов и нежизнеспособных участков кожи, подкожной ткани, фасций и мышц, отделении надкостницы, обнажении кости и массивном загрязнении по системе оценки тяжести повреждения конечности >7 лечили в период с 1980 по 1992 гг., комбинируя неоднократные хирургические обработки ран, метод Илизарова и постепенное закрытие раны. Травма по Gustilo III степени Типа В отмечалась в четырех случаях, травма III степени Типа С - в одном случае. Отдаленные результаты от трех до пятнадцати лет. Продолжительность госпитализации варьировала от 86 до 247 дней. Общая продолжительность лечения составляла от 9-ти до 38 месяцев. Результат сращения кости был отличным в трех случаях и удовлетворительным в одном случае. Функциональный результат был отличным в одном случае и удовлетворительным в трех случаях. Все пациенты возобновили свою прежнюю деятельность, все работают, за исключением одной пациентки (она уволилась еще до травмы) и удовлетворены лечением. Метод Илизарова является методом выбора при тяжелых раздробленных переломах со сдавлением мягких тканей, он дает возможность сохранять конечности, которые прежде подвергались ампутации.

Ключевые слова: травмы с синдромом сдавления, оскольчатые травмы, рубленые поражения, балльная оценка, метод Илизарова, клинический результат, функциональный результат, контроль, сохранность конечности, больной, метод выбора.

Injuries that mangle or crush an extremity are devastating and has always been a challenge to orthopedic surgeons. The possibilities of multiple operations, medical and psychological disability, and protracted rehabilitation loom from one side and primary amputation from another are before these patients. Mangled Extremity Severity Score (MESS) is a rating scale for lower extremity trauma, based on skeletal/soft tissue damage, limb ischemia, shock, and age⁸ (Tab. I). In these authors,

MESS value ≥ 7 predicted amputation with 100% accuracy. Ilizarov technique is designed specifically for the cases with loss of bone, leg-length discrepancy, comminuted fractures with severe tissue loss^{6,7}. We have an experience of successful treatment of four patients with MESS score 8-9 by combination of successive debridements, Ilizarov fixation and gradual skin covering as a leading elements of the management.

MATERIALS AND METHODS

From 1980 through 1992 four tibia open-fracture patients (three males and one female) with MESS score ≥ 7 , estimated retrospectively (case one, four) and prospectively (case two and three) were seen and treated in Nizhny Novgorod Traumatology and Orthopaedics Research Institute with adequate follow-up. Fractures were oblique-transverse (case one and four), butterfly (case three), transverse (case two). Four limbs were Gustilo III B Type, one - III C. Patients charts and X-rays were reviewed and patients were followed from three to fifteen yrs. Details of wounds and fracture healing and all complications were recorded (Tab. II). In one patient both limbs were injured, MESS score was 6 and 8 in right and left shin respectively. Motorcycle accident, pressing by bulldozer blunt blade, 500-kg metal part drop, running over the leg of bus were causes of injury. All were crushed with extensive laceration and devitalization of skin, subcutaneous tissue, fascia and mus-

cles, with periosteal stripping, bone exposure and massive contamination. Three patients had been managed initially elsewhere (cases one, two and three), one (case four) was admitted in our institution in thirty five min after the accident. Before hospitalization in our institution autovenous grafting of damaged popliteal artery in one patient (case two) was performed. In another two cases (case one and three) only debridement were accomplished. In these three cases all wounds were sutured. In our opinion, inadequate debridement and suturing considerably worsen patients status and contributed to quick development of severe wound infection and sepsis (in cases one and three). In case one and three skeletal traction by calcaneus were applied, in case two - plaster cast immobilization. After deterioration of general condition of these three patients they were admitted at the Institute in two-three days after injury (Tab. III). Just after admittance all patients were operated. In cases one, two and three

wounds had features of purulent complications, such as swelling, edema, purulent wound discharge with a sour odor, cinereous muscles, multiple necrosis of tendons, fascia and fatty tissues. In case two crepitation was revealed. In case four massive crush injury in patient of eighty two yrs did not allow to perform amputation just in admittance. The first priority for this patient's treatment was the efficient and aggressive resuscitation. Debridement and Ilizarov fixation in this case we considered at first as life-saving procedure less dangerous than femur amputation. Tibialis anterior artery injury was discovered in case one and three. In case one it led to ischemia and eventually lost of distal part of foot and toes. When we discovered this injury from the trauma passed two days and attempts to restore the vessel was futile and dangerous. In case three it was a lot of necrotic tissue and tissues with doubt viability near the vessel, defect was of ten sm. and above the defect thrombosis of artery spreading in popliteal artery was revealed. Ischemic disorders were not so serious, and restoration of the artery was not also performed. All patients were managed with repeated every one-three days excision on necrotic tissues, liizarov fixation, continuing closing of wounds by traction, split skin grafting. In case four with circular skin detachment cutting off the detached skin and perforated split skin grafting (by the graft taking from this futile flap) was accomplished. Intraosseous perfusion by Reopoliglucini 400 ml, S. Novocaini 0,25%-400 ml, Penicillini 10.000.000 U in 500 ml S. Natrii chl., 0,9%-500 ml

were performed during debridements. In case four to this mixture *Pseudomonas* and *Staphylococcus* bacteriophage (25 ml) were added. Most part of this mixture pour through the wound. In case I five hypervolemic hemodilution procedures (Pentamin, Polides, Reopoliglucin, Hemodes) for improving microcirculation were performed. Wound closure carried out gradually. Debridements were followed by open packing in all cases. Approximation sutures (case one and two), or wires conducting through wound edges (case two) for there traction and dermatotension (case one and two), split skin grafting (case one, three and four), suturing with irrigation drainage when it was possible were done. Plaster cast immobilization for three- four weeks after fixator removing was applied. Partial limb loading began on 247, thirty second, thirtieth and twenty first days from trauma in first, second, third and fourth cases respectively. In all cases antibiotics were given. Infection occurred in all cases. In case three on ninety first day after trauma tibia osteoclasia was done and on twelfth day after this bone transport began for bifocal osteosynthesis (0.25 mm four times per day). In case of wire track infection (case one) fixator was removed two times, plaster cast was applied before subsiding of inflammation. Prolonged fixation in this case was made on 223 day after trauma.

The duration of hospitalization ranged from eighty six to 247 days. The total duration of treatment ranged from nine to thirty eight months.

RESULTS

Duration of follow up was from three to fifteen years. The results were divided into bone results and functional results, according to the classification of the Association for the Study and Application of the Method of Ilizarov^{1,3} and as described by G. K. Dendrinis et al.⁴ Consolidation was achieved eventually in all cases (Tab. IV). Bone result was excellent in cases two, three and four; fair (axial deformation, leg-length inequality, compensatory equinus 30°) in case one. At the beginning the parents of this boy (case one) refused from bifocal lengthening, then he himself was reluctant to continue a long treatment. Shortening was compensated by special insole two sm. height, about five years after trauma he walked with cane. Functional result

was fair in case one, three and four (limp, ankle rigidity, pain were observed in this patients; in case three also soft-tissue sympathetic dystrophy, venous insufficiency and in case four stiffness if knee joint occurred). Excellent result was in case two. All patients returned to previous activity, patient in case one graduated from the University, was married, all but case four (she was retied before trauma) have a job. In case four additional fixator applying was necessary in thirty nine months after trauma for equinus correction. It would be possible to correct it early, but the patient insisted on removing of the wires which were conducted through foot. All patients were satisfied by the treatment.

COMPLICATIONS

Four patients had a total ten complications. Sepsis occurred in case one and three in admittance. It resolved to seventh day after trauma. Signs of infection arose around some wires in two patients. In case one wire track infection appeared on eleventh day after applying Ilizarov fixator. Conservative

attempts to abort the process were futile and fixator was removed and reapplied. The process relapsed and on sixty third day after the trauma fixator was removed again. Immobilization by plaster cast was accomplished before 223 day after the trauma, when Ilizarov fixator was applied in the third time.

On the 357th day after trauma reconducting of two wires instead of infected was performed because wire track infection appeared once again. In case three this infection developed to the time of removing fixator (total time affixation in this case was 575 days, bifocal lengthening of the ten sm. defect was accomplished). Transplant lysis after split skin grafting occurred in case one on the twenty eighth day after trauma (30%) and in case four on the fourth day after trauma (40%). Regenerate fracture sustained in case one in ninety seven days after

removing of fixator. About in a month after the refracture fixator was reapplied for 248 days. It was the last operation of fixator applying in this case. Eczema occurred in case four in about five months after the trauma and fully subsided only after fixator removing. All patients had severe pain after the trauma and needed analgesics and medication for sleep. Two-three days after operations they were prescribed narcotic analgesics, then occasional analgesics (pirazolone derivatives).

DISCUSSION

G. V. Poole et al.⁹ reviewed their experience with forty eight mangled lower extremities in forty six patients. Twenty-one penetrating wounds and twenty five blunt injuries occurred in thirty seven men and nine women. Severity of injuries to muscle, skin, and major nerves were strongly interrelated, but there were no correlation between injuries to these tissues and severity of bone injury. Twenty-four limbs were salvaged, and twenty four were amputated. Increased severity of soft tissue injury was associated with a greater probability of limb loss, but limb salvage or amputation could not be predicted in these authors, accurately by any variable or group of variables such as age, mechanism of injury. Injury Severity Score, presence of shock, level of injury, venous injury or repair, sequence of repair (vascular vs. skeletal), time of fasciotomy, arteriography, blood requirement, or duration of ischemia. Amputation was best predicted by severity of injury to the sciatic or tibial nerves ($P < 0.001$), and by failure of arterial repair ($P < 0.01$). Primary amputations, in our opinion, should be performed only in cases of motor and sensory loss with ischemia >8 h, absence of capillary refill, when trial of arterial and venous repair is futile and may be dangerous due to possible renal failure and in devastating bone and soft tissue lost. F. Bonanni et al.² described fifty-eight lower limb salvage attempts over a ten-year period. Injuries were retrospectively scored using the Mangled Extremity Syndrome Index (MESI), Mangled Extremity Severity Score (MESS), Predictive Salvage Index (PSI), and the Limb Salvage Index (LSI). Cross-validation sensitivity and specificity analyses revealed no predictive utility in any of the four indices. They conclude that efforts must be directed at more precisely determining the factors that aid in the decisions to terminate futile salvage efforts. But primary amputations were excluded in this study.

Iizarov technique is done in an attempt to solve the problem of non-union, deformity, leg-length discrepancy, joint stiffness, soft-tissue atrophy and disuse osteoporosis. The method is also useful in comminuted fractures with massive soft tissue damage especially when purulent complications occur.

In all four patients with $MESS > 7$ consolidation had been successfully obtained and weight bearing restored. An excellent bone result was in three patients, and functional results seemed to be inferior: in three patients they were fair. However this series included most severe trauma. Condition of muscles, vessels, joints, nerves severe purulent complications due to inadequate debridement just after the trauma affected the functional result in most degree, than bone damage. Even extensive loss of muscles if debrided good, may allow to leave enough muscle to provide adequate function. Injury of vessels if there are not features of irreversible ischemia such as cool, paralyzed, insensate limb is not also an indication for amputation. In our opinion nerve injury, including tibial nerve, especially neurapraxia is not an indication for amputation too. In case of wire track infection, or any other local inflammatory complication when the fixator interfere with its treatment, it is possible to remove the fixator. Immobilization continued by plaster cast. After subsiding of acute inflammation fixator can be reapplied. We did not consider also a refracture as an indication for amputation. Restitution of weight bearing ability in case one, when it was necessary to apply successive Iizarov fixator three times, third fixation continued 508 days, after its removing refracture occurred and only after additional fourth fixation for 248 days stable consolidation came, confirms this opinion. These patients were not able to walk and bear weight immediately after the application of the fixator, because of extensive injury of soft tissues and severe purulent infection. While infection subsided and wounds healed the patients begin to bear the leg. It is worth mention about one more imperfection of MESS scoring scale. We observed a 9 year old patient with multiple trauma and severe glomerulonephritis with proteinuria till 6,2%. This patient was admitted with shock, but his BP was 150 and 80 mm Hg due to skull trauma and accompanying disease. He had degloving shin injury Gustilo IIIB with extensive laceration and devitalization of subcutaneous tissue, fascia and muscles, with periosteal stripping, comminuted bone exposure and massive contamination. MESS score was

of 6, despite general condition and local damages was more severe then in cases were described above. Appropriate tactic allow to rescue the limb in this case too.

Combination of repeated debridements, Ilizarov technique, gradually performed wound coverage is a method of choice in severe comminuted, crush or mangled injuries and allows to save limbs consid-

ered formerly as hopeless and subjected to amputation. MESS scoring system does not allow to predict exactly indications to amputation when this technique is used and should to be revalued. This makes necessary further search for elaborating of scoring system for predicting the possibility of limb salvage.

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Table I

Mangled Extremity Severity Score⁸

MESS	POINTS
A. Skeletal/soft tissue injury	
Low energy (stab, simple fracture; «civilian» gun shot wounds)	1
Medium energy (Open or multiple FXS, dislocation)	2
High energy (Close-range shot-gun or "military" gun shot wounds, crush injury)	3
Very high energy (above+gross contamination, soft-tissue avulsion)	4
B. Limb ischemia	
Pulse reduced or absent but perfusion normal	1*
Pulseless, parasthesias, diminished capillary refill	2*
Cool, perelyzed, insensate, numb	3*
*- score doubled for ischemia > 6 h	
C. Shock	
Systolic BP always > 90 mm Hg	0
Hypotension transiently	1
Persistent hypotension	2
D. Age (Yrs)	
<30	0
30-50	1
>50	2

Table II

Details of trauma and healing of wounds and fractures

Case	1	2		3	4
Sex, Age	m, 15	m, 21		m, 40	f, 82
Mechanism of Trauma	Rode on motorcycle, collided with the car	Pressed by blunt of bulldozer to tractor		Metal part weighting 55 kg dropped on the leg, and stayed on it about 20 min.	Limb was run over by bus wheel
Time from Trauma to Hospitalization at the Institute	2 days	2 days		3 days	35 min
Time from Trauma to Consolidation (Mos)	38	9		25	14
Duration of Hospitalization	246	86		149	247
Number of Previous Operations	1	1	1	1	0
Total Number of Operations	11	4	3	7	5
Limb	right	right	left	right	left
Localization	middle third	upper third	upper third	middle-lower third	middle third
Fracture of Fibula	lower third	upper third	upper third	middle-lower third	middle third
Hypotension <90 mm Hg	-	-	-	+	+
Muscle Crushing	Exten. Dig. Lon., exten.halluc.lon, tib. Ant., gastroc., soleus, tib. Post., flex. Halluc. Long muscles	Gastrocs., soleus, tib. Post., flex. Halluc. Long., peroneus longus, brevis muscles	Gastrocs., soleus, tib. Post., flex. Halluc. Long., peroneus longus, brevis muscles	Exten. Dig. Lon., exten. Halluc. Lon, tib. Ant., peron tert., peron. Long., peron. Brev. muscles	Exten. Dig.lon., exten. Halluc. Lon, tib. Ant., peron tert., peron.long., peron brev., gastrocs., soleus, tib. Post., flex. Halluc. Long., muscles
Wound Size	35*25 sm, 8*10 sm	25 sm**	25sm**	Almost Circular Detachment	Almost Circular Detachment***
Arterial Injury	a. tibialis ant	-	a. poplitea	a. tibialis ant	-
Pulse on Foot	Absent	+	Reduced	Reduced	Reduced
Sensitivity	Dissociation	Normal	Dissociation	Absence	Dissociation
Nerve damage*	Deep+sup.peron.nerve s	-	Deep+sup.peron .nerves	Deep+sup.peron.nerve s	Deep+sup.peron.ner ves
Limb Ischemia	Distal Phalanx of I-V Toes, Back of the Foot	-	-	-	-
Organism Grown on Culture	S.epidermidis, Pseudomonas, E.coli, Proteus mirabilis	S.aureus, Actinomycetaceae	S.aureus, Actinomycetaceae	Corinobacterium ulcerans, Neisseria perflava, Klebsiella ozaenae, Peptococcus anaerobicus	Proteus mirabilis
Duration of Antibiotic Treatment (Days)	13	14		9	21
Gustilo Type	IIIB	IIIB	IIIC****	IIIB	IIIB
MESS Score					
A	4	4	4	4	4
B	2*2	1*2	2*2	1*2	2
C	0	0	0	2	0
D	0	0	0	1	2
TOTAL	8	6	8	9	8

*. neurapraxia

** - aproximation sutures

*** - posterior flap survived (wide 8 cm.)

**** - autovenous grafting of popliteal artery was performed in 7 hours

Table III

Protocol of Operative Treatment and Postoperative Course

Case	No of Operation	Time from Trauma to Operation (days)	Operations	Drainage/ Suturing	Duration of Fixation by Ilizarov Device	Partial Limb Loading (from Trauma/ from Operation)	Complications
1	2	3	4	5	6	7	8
1	1	2	Wounds are connected through defect in middle third of shin; excised muscles, tendons, fascia, fatty tissues necrosis; Ilizarov fixation	Open packing	31		Sepsis till 7 th day; wire track infection
	2	4	Excised muscles, tendons, fascia, fatty tissues, skin necrosis	Open packing, gradual approximation of wound edges			
	3	6	Excised muscles, tendons, fascia, fatty tissues, skin necrosis	Irrigating tubes			
	4	11	Removed 1 wire				
	5	24	Split skin grafting 100 cm ²				Lysis of 40% transplant
	6	33	2 sm. Of distal fragment were resected in transverse direction, 8 sm. - tangential (back and anterior-external wall), necrectomy on the back of the foot	Irrigating tubes/Approximation sutures	30		Wire track infection
	7	137	Sequesters were removed, tangential anterior bone defect 10 sm., sinus track of the shin upper third revision, back foot necrectomy, amputation of I-III toes, distal phalanx of V toe, resection of I metatarsus head	Irrigation-suction drainage/Suturing			
	8	223	Resection of metatarsus, split skin grafting on foot wound; 4 shin frames and 1 foot for equinus correction	Irrigating tubes/ Suturing	508*	247/24	Wire track infection
	9	357	Reconducting of 2 wires instead of infected				Regenerate fracture (from trauma 828 days from removal of fixation 97 days)
	10	867	Ilizarov fixation of refracture		248	874/7	
2 left	1	2	Excision of cinereous, crepitating muscles of back group, fasciotomy, multiple longitudinal incisions, Ilizarov device with knee joint fixation	Open packing/ Approximation sutures	256**	From 32d day with crutches	
	2	15	Suturing	Gradual approximation of wound edges			
2 right	1	2	Excision of cinereous, crepitating muscles of back group, fasciotomy, multiple longitudinal incisions, Ilizarov fixation	Open packing/ Approximation sutures/ gradual approximation of wound edges	183		
	2	16	Suturing	Gradual approximation of wound edges			
	3	26	Through wound edges 2 Kirshner wires conducted, suturing through the wires	Gradual approximation of wound edges			
3	1	3	Excised cinereous muscles, tendons, fascia, fatty tissues, skin necrosis, removing of free bone, fragments, hematomas, multiple longitudinal incisions, Ilizarov fixation****	Open packing	575***	30	Sepsis till 7 th day

1	2	3	4	5	6	7	8
	2	6	Excised muscles, tendons, fascia, fatty tissues, skin necrosis, bone ends resection by Giggle sew	Open packing			
	3	35	Split skin grafting 500 sm ²				
	4	91	Conducting of additional wires for fixator stabilization, tibia osteoclasia in the upper third*****				
	5	101	Conducting of additional wires for remounting				
	6	272	Conducting of additional wires for remounting				Wire track infection
4	1	1 h	Excised crushed muscles, tendons, fascia, fatty tissues, skin necrosis cutting off the detached skin and perforated split skin grafting (by the graft taking from this futile flap), Ilizarov fixation*****	Open packing	125	21	Lysis of 40% transplant, wire track infection
	2	68	Split skin grafting 350 sm ²				
	3	138	Ilizarov fixation		210		Eczema
	4	163	Wires conducted through foot bones for equinus correction		84		
	5	1166	Applying of fixator for equinus correction		84		

*- frame from foot was removed in 67 days

** - circular ring from femus was removed in 56 days

*** - frame from foot was removed in 98 days after Ilizarov device appliance

**** - bone defect 10 sm.

***** - for bifocal osteosynthesis; bone transport began on 12th day after osteoclasia (0.25 mm four times per day)

***** - contralateral plate defect in fracture site

Table IV

Follow-up results

Case	1	2		3	4
Limb	right	right	left	right	left
Duration of Follow-up	15 yrs	3,5 yrs	3,5 yrs	3 yrs	5 yrs
Bone result	fair	excellent	excellent	excellent	excellent
Infection	-	-	-	-	-
Union	+	+	+	+	+
Deformity	10° recurv.,	-	-	-	-
	30° - equinus				
Shortening	6 sm*	0	0	0	0
Functional result	fair	excellent	excellent	fair	fair
Limb	+	-	-	+	+
Rigidity	ankle rigid.	-	-	ankle rigid.	ankle rigid.
Dystrophy	-	-	-	+	-
Pain	2**	1	1	1	2
Activity	graduated from the university, works now	returned to previous job		returned to previous job	restored

* - is compensated by special insole 2 sm. height, walks without cane

** - 1 indicates no pain; 2 - mild pain that does not interfere with activities or sleep

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