Reconstructive Surgery for Complications after Lower Limb Trauma

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INTRODUCTION

The management of post-traumatic lower extremity complications represents a challenging field of orthopedic surgery and becomes a controversial subject particularly when the option of amputation is present. Advancements in medicine and surgery have greatly improved the ability to reconstruct severely injured legs and, generally, improve functional outcome. However, limb salvage and major limb reconstructions often result in a protracted course of treatment and rehabilitation with long-term functional, psychosocial, and financial consequences. Some investigators suggest that functional outcome is often poorer after successful limb reconstruction than after treatment with early amputation and a functional below-the-knee prosthesis (1-5). Others found the results to be typically equivalent or better for reconstruction when compared to amputation (6, 7). Reconstruction is associated with a longer rehabilitation time and a higher risk of complications, additional surgeries, and rehospitalization (6, 7), whereas amputation is associated with high dissatisfaction rates because of prosthetic device discomfort, phantom pain, and residual limb skin problems (8, 9).

Numerous variables should be weighted by both surgeon and patient before reaching a decision regarding management of severe lower extremity complications. One of the key factors that should be taken into account in the process of decision making is long-term outcome expectation. Reports on long-term outcome following treatment of these complications are relevant for the current management debate and essential for improving management of expectations. Several authors have reported on outcome and decision making for acute leg-threatening injuries (1-5, 10), but long-term outcome for late post-traumatic lower extremity complications has not been thoroughly documented.

Key words: Lower Extremity, Complications, Reconstructive Surgery, Long-term Outcome

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The aim of the present study was to evaluate the long-term functional and psychosocial outcome in a series of patients that have been treated with reconstructive surgery for post-traumatic complications of the lower extremity. The results were evaluated with use of validated outcome scores.

MATERIAL AND METHODS

Inclusion and Exclusion Criteria

Between 1982 and 1996, over two hundred patients were secondarily referred to our institution (Massachusetts General Hospital, Boston, USA) for post-traumatic lower extremity complications, and the vast majority of these patients were treated by the senior author (J.B.J.). Many of these patients had undergone treatment elsewhere that had failed and were facing amputation. The inclusion criteria for participation in the present retrospective case series were (1) skeletally maturity and (2) treatment at our institution for post-traumatic lower extremity complications, defined as any complication located in the lower extremity as a result of treatment of a traumatic injury to the femur, tibia, fibula, and/or hindfoot. Post-traumatic complications included osteomyelitis, malunion, nonunion, and acquired osseous deformity including segmental bone defects. The exclusion criteria included a follow-up of less than 60 months after complication treatment, mental disability, and inability to return for clinical evaluation.

A manual search of medical records identified 182 patients who were treated for post-traumatic lower extremity complications by the senior author at our institution. The Partners Institutional Review Board approved the present study protocol but prohibits any form of private search services for purpose of retrospective research studies. Therefore, patients could solely be located through medical-record identification. Of the 182 patients, fifty-five (30%) were located using this method, and 127 were lost to follow-up. All patients were invited to return for assessment of the lower extremities. Of the fifty-five located patients, nine had died, and sixteen declined to participate. The remaining thirty patients met the inclusion criteria and were included in the study. All participants gave consent to participate.

Patients

The study group included ten women and twenty men with an average age of 56 years (range, 31 to 85 years) at the time of the latest follow-up examination. The initial injury resulted from a motor vehicle collision in eleven patients (37%), a motorcycle collision in four (13%), collisions involving pedestrians and motor vehicles in three (10%), falls in ten

(30%), and an industrial crush accident in one (3%). The post-traumatic complications involved the tibia in twenty-two (73%), the femur in six, and both the fibula and hindfoot in one case. Complications consisted of nonunion in thirteen patients, combined osteomyelitis and nonunion in seven, malunion in four, and acquired osseous deformity including segmental osseous defects in four (Figure 1). Moderate to severe post-traumatic arthritis in the ankle and hindfoot was present in four cases.

The majority of patients (twenty-four, 80%) had internal fixation as their initial fracture treatment and were referred to our department because of failure, deformity, and/or infection. Two patients were initially treated with an external fixator, one with percutaneous pinning, and the remaining three patients were initially treated with cast immobilization. There were large variations between the time of injury and referral to our clinic, with a mean of 40 months (median 18, range 1.5 to 360 months). At time of the first referral visit at our clinic, the cohort of patients had undergone a mean of six prior surgeries (median 3, range, 0 to 28).

The surgical procedures for complication treatment were based upon the location and nature of the presenting problem and are summarized in Table 1. Skeletal fixation was obtained in twelve patients by open reduction and internal fixation, in eleven patients by external fixation (including nine with an Ilizarov fixation device), and in six patients by cast immobilization. One patient underwent a girdlestone procedure of the hip. Moreover, seven patients underwent arthrodesis of the tibio-talar joint. Bone grafting was performed in fifteen patients and consisted of iliac crest bone (ten), local bone (three), or vascularized fibula graft (two; lengths: 22cm and 25cm).

Seven patients had an infected nonunion of the tibia (five) or femur (two), of which five had at least one prior surgery (range 1 to 28 surgeries). The surgical approach used in these patients, as previously reported by the senior author, consisted of sequential debridements (11, 12), external fixation (in most patients) (13), and free flap coverage followed by autogenous bone grafting (14, 15) (Figure 2).

Fourteen of the thirty patients underwent additional surgery, including hardware removal (four), revision internal fixation for persistent nonunion or hardware failure (four), total hip arthroplasty (two), total knee arthroplasty (two), Achilles tendon lengthening and capsular release for ankle contracture (one), and internal fixation for a re-fracture (one).

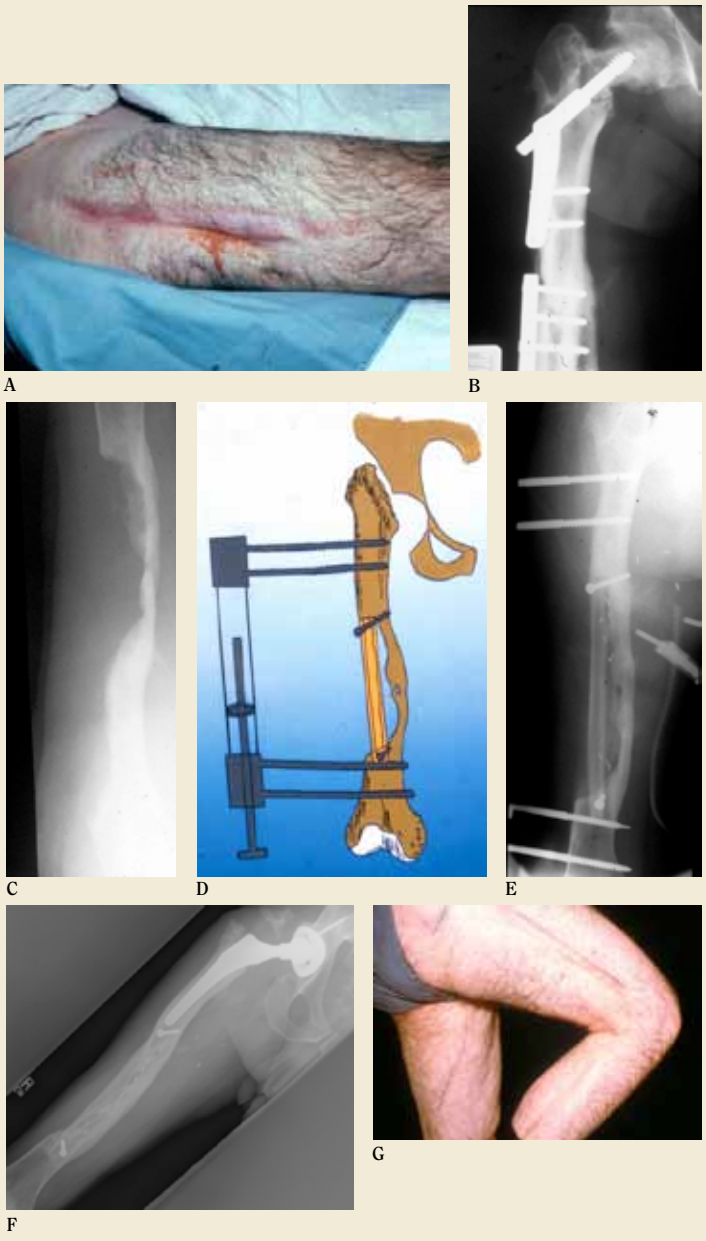

Figure 1. A., B. Fifteen months after injury, a 25-year old male with osteomyelitis and necrosis of the right femoral shaft and neck was secondarily referred to our institution (Table 1, case 25). **C.** Initial treatment consisted of hardware removal, extensive debridement, and sequestrectomy of the femur and a 6-weeks course of antibiotics. **D., E.** Secondly, a girdlestone arthroplasty of the hip was performed, and the patient was immobilized in a hip spica cast for 3 months. Subsequently, a vascularized 25 cm fibular bone graft was transferred to the femur with autogenous on-lay cancellous bone graft and was fixed with 4.5mm AO-screws proximally and distally. **F.** Finally, a hip arthroplasty was performed. **G.** At 25 years after injury, range of motion at the hip and knee was near normal. Despite the fact that the patient feels most limited in daily function because of persistent upper leg pain (8/10) but realizing he had faced amputation, he was overall very satisfied with the outcome (8/10).

Clinical Evaluation

At the time of the latest follow-up, all subjects were assessed by an independent physician (G.A.B.) who was not involved in the subject's care. Evaluation consisted of a personal interview and physical examination of the lower extremities. Subjects were interviewed about pain and overall function of the lower extremities and about the psychosocial consequences of their injury and treatment. Physical examination of the lower extremities consisted of assessment of the hip, knee, and hindfoot; range of motion of the adjacent joints; muscle strength; neurovascular status; and presence or absence of tenderness and swelling. Muscle strength was rated subjectively with use of a 6-point Likert scale ranging from 0 (no contraction) to 5 (normal strength). The contra-

A

B

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D

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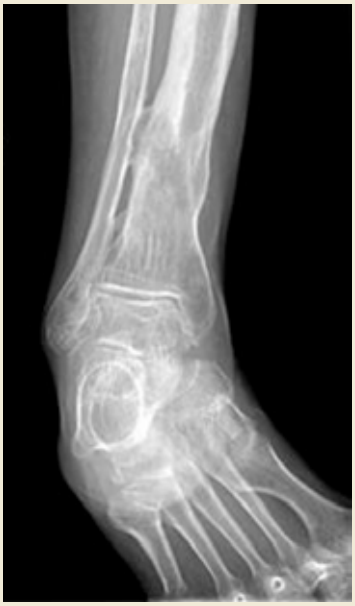

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Figure 2 A. Eighty-four months after an open crural fracture, a 29-year old female model with a longstanding infected nonunion and valgus/anterior deformity of the right distal tibia was secondarily referred to our institution (Table 1, case 1). She had undergone 28 prior surgeries at multiple institutions consisting of unsuccessful attempts to eradicate the infection, correct the deformity, and achieve union. The three indexed surgical procedures consisted of 1) debridement, sequestrectomy, realignment, and application of an AO external fixator **B.**, 2) a latissimus dorsi muscle flap and skin graft reconstruction **C., D.**, and 3) an iliac crest cancellous bone graft (2 months after first surgery). **E.** Eighteen months later, despite her moderate gait impairment, she returned to an intense 5 day/week aerobics training schedule and later won an aerobics award. **F.** At 32-years after the injury, she had a 10° varus deformity at the ankle joint with Grade 2 osteoarthritis, moderate impaired function (LEFS: 39) and pain (7/10), but realizing she had faced amputation, she was overall very satisfied with the outcome (9/10).

Case	Age	Gender	Occupation	Bone
1	61	F	Self employed	tibia
2	53	M	Administrative worker	tibia
3	62	M	Company owner	tibia
4	47	M	Heavy equipment operator	tibia
5	64	M	Retired	tibia
6	43	M	Manager	tibia
7	48	F	Unemployed	tibia
8	85	M	Retired	tibia
9	70	F	Administrative worker	tibia
10	57	M	Garage holder	tibia
11	73	F	Retired	tibia
12	61	M	Lab manager	tibia
13	62	M	Garage holder	tibia
14	47	M	Construction worker	tibia
15	53	M	Manager	tibia
16	67	M	Engineer	tibia
17	37	M	Unemployed	tibia
18	49	F	Administrative worker	tibia
19	85	F	Retired	tibia
20	42	M	Sawmill worker	tibia
21	39	F	Nurse	tibia
22	72	F	Retired	tibia
23	70	F	Artist	tibia
24	42	M	Administrative worker	hindfoot
25	50	M	Unemployed	femur
26	44	M	Lawyer	femur
27	52	F	Administrative worker	femur
28	55	M	State trooper	femur
29	49	M	Unemployed	femur
30	31	M	Electrician	femur

Table 1. Patient demographics, type of complication, treatment and outcome.AVN: avascular necrosis; HR: hardware removal; ID: irrigation and debridement; BG: bone graft; FBG: fibular bone graft; ORIF: open reduction and internal fixation; Ex-fix: External Fixator; arthrodesis: tibio-talar joint arthrodesis

lateral extremity was used as a control. Gait was recorded on videotape and assessed by both the treating physician and an independent physician.

Patient-based assessment questionnaires

Patients rated their outcome with use of the Lower Extremity Functional Scale (LEFS), the Short-Form 36 (SF-36), and 10-point visual analog scales for patient satisfaction and pain. These instruments were utilized to determine each subject's activity limitations, disability, and pain, and to determine the interaction of each of these factors with the clinical and radiological findings.

The LEFS was used to measure patient-rated overall lower extremity function (16). It evaluates disability experienced during daily activities as a result of the specific lower extremity condition, and it has been shown to be reliable, valid, and sensitive for general lower extremity conditions (16). Twenty items are rated individually on a 5-point Likert scale indicating the degree of difficulty associated with performing that activity, ranging from 0 (extreme difficulty or unable to perform the activity) to 4 (no difficulty). The overall score ranges from 0 to 80, with higher scores indicating better function.

The SF-36 was used to measure health-related quality of life (17). This widely-used, short-form health survey includes one multi-item scale that assesses eight health concepts:

Type of complication	Chronicity (months)	Prior surgeries	Complication treatment	Time off work (months)	SF-36	LEFS
osteomyelitis, nonunion, acquired deformity	84	28	ID, free flap, BG, Ex-fix	102	48	39
osteomyelitis, nonunion	4	1	ID, arthrodesis, BG, Ilizarov	48	68	52
osteomyelitis, nonunion	60	3	ID, arthrodesis, cast	0	58	49
osteomyelitis, nonunion	1.5	0	ID, free flap, ORIF	7	67	67
osteomyelitis, nonunion	6	3	ID, cast	6	44	49
nonunion, acquired deformity	48	23	Ilizarov	120	52	53
nonunion, acquired deformity	28	2	BG, ORIF	0	34	41
nonunion, arthritis	4	1	HR, arthrodesis, BG, cast	retired	46	49
nonunion	7	3	ID, BG ,ORIF	12	65	39
nonunion	6	3	free flap, BG, cast	1.5	95	79
nonunion	36	3	HR, Ilizarov	12	42	56
nonunion	4	0	Ilizarov	1	76	62
nonunion	6	1	HR, re-ORIF	3	57	69
nonunion	22	15	ORIF	48	40	51
nonunion	11	9	BG, ORIF	18	76	59
nonunion	6	2	ORIF	1	57	55
nonunion	20	10	ID, free flap, Ex-fix	0	71	51
malunion, AVN, arthritis	15	1	HR, arthrodesis, BG, cast	1.5	67	53
malunion	24	0	Ilizarov	retired	77	47
acquired deformity	48	5	HR, Ilizarov	24	42	28
acquired deformity, arthritis	9	20	arthrodesis, BG, Ilizarov	2	86	64
acquired deformity, arthritis	33	1	Achilles lengthening, arthrodesis, BG, cast	retired	80	55
acquired deformity	360	5	Ilizarov	0.25	29	26
nonunion	12	0	arthrodesis, BG, cast	20	63	52
osteomyelitis, nonunion	15	6	ID, HR, Girdlestone, FBG (25cm), THR	0	34	35
osteomyelitis, nonunion	13	6	ID, HR, FBG (22cm), ORIF	6	96	70
nonunion	192	5	ID, BG, ORIF	6	86	62
nonunion	24	7	HR, BG, re-ORIF	36	92	67
malunion, acquired deformity	54	11	Ilizarov, BG, ORIF	0	68	59
malunion	36	1	ORIF	6	71	61

physical function, role physical, bodily pain, general health, vitality, social function, role emotional, and mental health. The physical and mental component summary scores represent weighted composite scores derived from the eight health concept scales. Each component score, as well as the overall summary score, ranges from 0 to 100, with higher scores indicating better health.

The 10-point visual analog scales for patient satisfaction and pain were used to assess the overall satisfaction with the results of their post-traumatic lower extremity complication treatment and lower extremity pain, respectively.

Radiological evaluation

An independent observer assessed anteroposterior and lateral radiographs of the adjacent joints to determine alignment and the presence of arthritis. Osteoarthritis was classified according to the grading system of Knirk and Jupiter (18) as Grade 0 (none), Grade 1 (slight joint-space narrowing), Grade 2 (marked joint-space narrowing, osteophyte formation), and Grade 3 (bone-on-bone, osteophyte formation, cyst formation).

Statistical Analysis

Basic descriptive statistics were used to summarize study sample demographics. Pearson and Spearman correlations were performed (for continuous and categorical data, respectively) in order to correlate the outcome scores of the LEFS, SF-36, pain and patient satisfaction with demographic, treatment, and outcome parameters. This analysis was performed to establish which parameters are predictors of functional and psychosocial outcome and satisfaction.

RESULTS

The patients were evaluated at an average of 20 years (range 12 to 35 years) after the injury. The study group was divided in two subgroups for complications located above the knee (femur) and below the knee (tibia, fibula, and hindfoot). Complications, treatment and outcome of the thirty patients included in the study group are summarized in Table 1. All patients healed following treatment of their complications.

Clinical evaluation

At clinical evaluation, the range of motion and percentage of the contralateral side in patients with upper leg complications were as follows. The arc of hip rotation was from a mean external rotation of 50° (range 30° to 80°, 100%) to a mean internal rotation of 17° (range 10° to 30°, 74%). The arc of hip flexion was from a mean extension of 29° (range 0° to 45°, 91%) to a mean flexion of 98° (range 90° to 110°, 96%). The arc of hip abduction and adduction was from a mean abduction of 54° (range 45° to 60°, 113%) to a mean adduction of 28° (range 20° to 30°, 93%). The arc of knee flexion was from a mean extension deficit of 3° (range 0° to 10°, 98%) to a mean flexion of 119° (range 95° to 140°, 86%).

In patients with lower leg complications, range of motion and percentage of the contralateral side were as follows. The arc of knee flexion was from a mean extension of 0° (range -10° to 5°, 95%) to a mean flexion of 132° (range 100° to 150°, 98%). The mean arc of ankle flexion was from a mean dorsal flexion of 5° (range 0° to 20°, 36%) to a mean plantar flexion of 28 ° (range 0° to 60°, 53%). The mean arc of ankle eversion

SF 36 Subscale	Total study group		Upper leg subgroup		Lower leg subgroup		US Norm	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
General Health	70	19	75	20	68	20	72	20
Physical Functioning	62	26	78	21	58	26	84	23
Role Physical	52	42	75	42	46	40	81	34
Role Emotional	72	40	78	40	71	41	81	33
Social Functioing	76	20	85	17	74	21	83	23
Bodily Pain	57	25	70	29	54	24	75	24
Vitality	56	20	59	19	55	20	61	21
Mental Health	73	21	77	19	72	22	75	18

Table 2. SF-36 results categorized per subscale and comparison with the US Norm(19).

	LEFS		SF-36		Pain		Satisfaction	
Variable	Correlation	P Value	Correlation	P Value	Correlation	P Value	Correlation	P Value
Age at follow-up (yr)	-0.19	0.31	-0.17	0.38	-0.36	0.05	0.13	0.49
Sex	0.26	0.17	0.03	0.89	0.33	0.08	-0.16	0.42
Range of motion (% of uninjured)	0.28	0.17	0.1	0.63	0.1	0.64	0.07	0.73
Muscle strength	0.46	<0.05*	0.41	<0.05*	-0.27	0.18	0.52	<0.01**
LEFS	1		0.75	<0.01**	-0.5	<0.01**	0.25	0.19
SF-36	0.75	<0.01**	1		-0.37	<0.05*	0.21	0.27
PCS	0.8	<0.01**	0.94	<0.01**	-0.47	<0.05*	0.27	0.17
MCS	0.58	<0.01**	0.92	<0.01**	-0.25	0.19	0.18	0.35
Pain	-0.5	<0.01**	-0.37	<0.05*	1		-0.35	0.06
Satisfaction	0.25	0.19	0.21	0.27	-0.35	0.06	1	
Osteoarthritis	-0.08	0.67	0.03	0.9	-0.04	0.85	-0.24	0.22
Chronicity of complication (months)	-0.4	<0.05*	-0.26	0.16	0.02	0.91	-0.25	0.18
Time to follow-up (months)	-0.04	0.84	-0.07	0.74	-0.04	0.83	-0.08	0.69
Number of prior surgeries	-0.1	0.59	-0.08	0.67	0.24	0.2	-0.18	0.35
Number of additional surgeries	-0.06	0.76	0.11	0.58	-0.02	0.92	-0.08	0.68
Gait impairement	-0.29	0.13	-0.074	0.7	-0.09	0.62	-0.2	0.29
Skeletal malalignment (degrees)	-0.2	0.29	-0.34	0.06	-0.1	0.6	-0.14	0.47

Table 3. Correlation of LEFS, SF-36, pain and patient satisfaction with demographic, treatment and outcome parameters.

and inversion was from a mean eversion of 4° (range 0° to 10°, 47%) to a mean inversion of 11° (range 0° to 30°, 45%).

Lower extremity muscle strength was normal (5/5) in all patients except for two: one patient with a traumatic peroneal nerve injury scored 3/5 for ankle motion of the injured leg, and one patient with a sedentary lifestyle because of osteogenesis imperfecta scored 4/5 for both knee extension and ankle motion of the injured leg. With the exception of the one patient who had a traumatic peroneal nerve injury, all patients had intact neurovascular function. Two patients had tenderness and swelling in the knee and five patients in the ankle.

In the upper leg cohort, five of the six patients had a slight limp, whereas in the lower leg cohort, ten of the twenty-four patients had a slight limp, one had a moderate limp, and one a severe limp requiring bilateral crutches. All patients were able to bear full weight and to walk for short distances without limitations. Four patients used a walking aid; two used a cane, one used bilateral crutches, and one patient used a walker. Two patients wore a brace on daily basis. The remaining twenty-four patients did not use any support for walking. Six patients (three in each cohort) had slight-to-moderate leg discrepancies (ranging from 1 to 4 cm), which could be corrected with lifts and only one patient with the 4cm tibial discrepancy found it to cause substantial discomfort.

Patient-based assessment questionnaires

The LEFS outcome tool revealed that twenty-one patients (70%) experienced moderate to severe difficulties (scores lower than 60) in activities because of their lower limb disability. The mean LEFS score in patients with upper leg complications was 59 (range 35 to 70) and in patients with lower leg complications 53 (range 26 to 79).

The SF-36 results revealed that most patients were limited secondary to their general health perceptions with regards to their participation in vigorous activities (twenty-six), moderate activities (sixteen), and walking more than 1 mile (sixteen). Twenty-four patients experienced bodily pain to some extent and in almost all of them (twenty-three) it interfered with their normal work. The SF-36 scores per health component subscale are compared to the scores of the general U.S. population in Table 2 (19).

General health was comparable to the U.S. norm, indicating that there was minimal influence of other significant health problems on outcome of the other scales. In comparison to the general US population, the differences in profiles were largest among SF-36 scales sensitive to differences in physical health status, particularly physical functioning, role limitations due to physical health, and bodily pain. The role of physical health revealed the lowest average scores, with a substantial lower average in the lower leg complication subgroup. The mean SF-36 score in patients with upper leg complications was 75 (range 34 to 96), with a mean physical component score of 71 (range 32 to 94) and a mean mental component score of 75 (range 40 to 95). The mean SF-36 score in patients with lower leg complications was 62 (range 29 to 95), with a

mean physical component score of 56 (range 26 to 92) and a mean mental component score of 68 (range 35 to 97).

The mean visual analog scale for satisfaction rating was 9.0 (range 1 to 10), with 10 representing complete satisfaction. With the exception of one patient who had a protracted treatment course and higher expectations, all patients were moderately to very satisfied with the final result. Notably, several patients with moderate to poor functional outcome were very satisfied as they had faced amputation and found the salvaging of their legs to be of greater importance. The mean visual analog scale pain rating was 2.8 (range 0 to 10), with 0 correlating with no pain and 10 correlating with the worst pain. Two patients who had undergone major femoral reconstructions had continuous moderate to severe pain (7 and 8 out of 10), but even though their pain dominated their daily functioning, they were very satisfied with the outcome (8 and 10 out of 10).

Radiographic Evaluation

In the upper leg complications group, Grade 1 osteoarthritis in the hip was present in one of four patients, and the remaining two patients had undergone total hip arthroplasty for osteoarthritis (one) and girdlestone (one). Osteoarthritis in the knee was present in four of five patients, including Grade 1 (two), Grade 2 (one), and Grade 3 (one). The remaining patient underwent total knee arthroplasty for osteoarthritis at 44 years of age. The femur had perfect alignment in all but one patient with 10 degrees valgus angulation at the distal femur.

In the lower leg complications group, knee osteoarthritis was present in six patients including Grade 1 (two), Grade 2 (one), and Grade 3 (three), and ankle osteoarthritis was present in seven patients, including Grade 1 (two), Grade 2 (four), and Grade 3 (one). This excludes patients who could not be graded for knee (one) and ankle (six) osteoarthritis because of total knee arthroplasty and tibio-talar arthrodesis, respectively. Tibial malalignment was present in almost half (ten, 42%) of the patients and consisted of a mean deformity of 15.5 degrees (range 5 to 30 degrees) deviation from the tibial axis.

Return to work and prior activities

Twenty-six patients were able to return to work, within a mean of 22 months after the time of injury (median 7, range 0.3 to 120 months), and four patients remained unemployed. However, most patients exchanged their prior position at one point in their career to a position more suitable to their lower extremity impairment. Nine patients could return to their prior form of athletics within a mean of 28 months post-trauma (median 18, range 6 to 102 months), and only one could return (and exceed) the prior level of athletics despite both a protracted medical treatment and rehabilitation course totaling 102 months and a leg length discrepancy of 4 cm.

Predictors of outcome and satisfaction

In the correlation analysis, the LEFS showed significant correlation with the grade of lower extremity muscle strength ($r_{Spearman}$=0.46; p<0.05), SF-36 (r=0.75; p<0.01), PCS (r=10.8; p<0.01), MCS (r=0.58; p<0.01), and pain (r=-0.5; p<0.01) (Table 3). The SF-36 showed significant correlation with its composite scores PCS (r=0.94; p<0.01) and MCS (r=0.92; p<0.01), LEFS (r=0.75; p<0.01), lower extremity muscle strength ($r_{Spearman}$ =0.41; p<0.05), and pain (r=-0.37; p<0.05). Moreover, there was a near significant correlation with skeletal malalignment (r=-034; p=0.06). The pain score was significantly correlated with the LEFS (r=-0.5; p<0.01), SF-36 (r=-0.37; p<0.05) and PCS (r=-0.47; p<0.05) and near-significantly correlated with age at follow-up (r=-0.36; p=0.05) and satisfaction (r=-0.35;p=0.06). The patient satisfaction score was significantly correlated with lower extremity muscle strength ($r_{Spearman}$=0.52; p<0.01) and near-significantly with pain (r=-0.35;p=0.06).

DISCUSSION

There remains debate regarding the functional outcomes following reconstruction versus amputation of severe trauma-related lower extremity injury and complications as few prospective studies have been conducted with the use of validated outcome scores. The severity of trauma-related injuries and complications appears to play an essential role in long-term functional outcome. However, based on the patient's interviews and physical examinations from the present study group, it is our impression that the functional and psychosocial outcome often had no correlation with the severity of the complication and the complexity of reconstructive treatment. Psychosocial factors, such as patient motivation and ability to cope with pain and disability, were factors that appeared to have higher correlations with outcome and satisfaction, although these correlations have not been statistically verified. This supports our idea that regardless of complexity, reconstruction is a worthwhile option in all motivated patients with post-traumatic complications.

Regardless of pain and disability level, all but one patient was moderately to very satisfied with the final outcome. This is in accordance with our correlation analysis which showed that only lower extremity muscle strength was significantly correlated with patient satisfaction. Moreover, most patients expressed high appreciation of counseling on realistic outcome expectations during the process of decision making. In particular, patients who had faced amputation of their lower extremity reported very high satisfaction rates, even with poor functional outcomes, as they were appreciative of their limb-salvage procedure. Among all patients that had faced and/or personally considered post-traumatic amputation, only one patient reported regrets on his previous decision to salvage his leg as he continued to experience severe pain in his leg since the injury. In his opinion, amputation and use of a prosthesis would have eliminated his pain and allowed for better function. However, studies on prosthetic use for trauma-related limb amputation have reported high rates of phantom pain and discomfort (8, 9). Chronic pain is highly prevalent among persons with limb loss, regardless of time since amputation (20).

The results of the present study support our opinion that reconstruction can be a worthwhile endeavor and should be considered in all motivated patients with post-traumatic complications of the lower extremity, regardless of the magnitude,

number of previous surgeries, and time after injury. Patients should be thoroughly counseled regarding realistic outcome expectations, as this presents an essential factor to the patient in his process of decision making.

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