Lower Extremity Amputations in Chronically Dialysed Patients: A 10 Year Study

Asher Korzets MD[1,5], Yaacov Ori MD[1,5], Mauro Rathaus MD[3,5], Nora Plotnik MD[3,5], Shlomo Baytner MD[2,5], Uzi Gafter MD PhD[1,5] and Eli Isakov MD[4,5]

[1] Institute of Nephrology and Hypertension and [2]Vascular Surgery Unit, Rabin Medical Center (Golda Campus), Petah Tiqva, Israel
[3] Department of Nephrology and Hypertension, Meir Hospital, Kfar Saba, Israel
[4] Department of Orthopedic Rehabilitation, Loewenstein Hospital, Raanana, Israel
[5] Affiliated with Sackler Faculty of Medicine, Tel Aviv University, Ramat Aviv, Israel

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Abstract

Background: Lower limb critical ischemia is a major problem in dialysed patients.

Objective: To evaluate the results of revascularization procedures, amputations and prosthetic rehabilitation in dialysed amputees.

Methods: In this retrospective study we examined the charts of selected dialysis patients. Forty-eight patients had undergone major amputation (4.5% of the dialysis population), and 24 patients entered the rehabilitation program. Widespread arterial calcification was common and led to falsely elevated ankle-brachial pressure indices in 9 of 14 limbs. Eight patients underwent revascularization. Subsequent major amputation was carried out 4 $\pm$ 4.5 months after the revascularization (above knee in 5 patients and below knee in 3). Of the 16 patients who underwent primary amputation, only 2 were above-knee amputees. Seven patients with toe or metatarsal amputation went on to a major amputation 1.8 $\pm$ 1.2 months after the distal amputation.

Results: No differences were found between diabetic and non-diabetic patients regarding the number of revascularization operations performed, the level of major amputation, or overall survival. Prosthetic rehabilitation was considered successful in 12 patients, partially successful in 8, and failed in 4 patients. Patient survival time was shortest in those patients with failed rehabilitation. A younger age confirmed favorable rehabilitation results, while long-standing diabetics and bilateral amputees were poor rehabilitation candidates. Patients who underwent primary amputation had more successful rehabilitation. A comparison between 24 dialysed amputees and 138 non-uremic amputees revealed similar rehabilitation results, although hospitalization time was longer in the dialysed patients.

Conclusions: Early definitive therapy is essential when dealing with critical ischemia. After diagnostic angiography, proximal revascularization should be performed where feasible. Primary amputation is indicated in patients with extensive foot infection or gangrene. Prosthetic rehabilitation is warranted in most dialysed amputees.

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The last decade has seen both a prolongation of life for many dialysis patients and an increasing number of aged and diabetic patients being accepted into chronic dialysis programs. These patients have atherosclerotic disease that may manifest as peripheral vascular disease; two recent articles have reviewed this problem [1,2]. Critical ischemia of a lower limb, even in non-uremic patients, has a poor prognosis with a 1 year mortality rate of 15–20% [3]. Although long-term survival is limited in some patients with end-stage renal failure, revascularization surgery has been attempted [4–14]. However, renal failure often implies calcific arteriopathy, increased perioperative infection rate and mortality, and an increased incidence of major amputations.

The present study attempts to answer questions regarding preoperative evaluation, results of revascularizations and amputations, and the role of prosthetic rehabilitation in dialysed patients with severe peripheral vascular disease.

Patients and Methods

This 10 year retrospective study (1990–1999) examined the charts of patients who met the following criteria: treated with long-term dialysis for at least 6 months, underwent either a below-knee or above-knee amputation, and were admitted for prosthetic rehabilitation. Minimum follow-up after attempted rehabilitation was 6 months.

The following parameters were taken from each patient: age (at amputation), gender, dominant form of dialysis performed (hemodialysis, peritoneal dialysis), duration of dialysis before amputation, smoking status, and the presence of co-morbid conditions – diabetes mellitus, heart disease, past cerebrovascular events, calcificed lower limb arteries as seen on plain X-ray, secondary hyperparathyroidism, anemia and malnutrition. Heart disease was defined as one or more of the following: a myocardial infarction in the year preceding amputation, active angina pectoris, overt heart failure or significant valvular pathology.

Summarized points pertaining to the amputation included: results of ankle-brachial pressure index examinations [15], pharmacologic therapies for critical ischemia, arteriographies performed, revascularization procedures and results, previous minor (metatarsal or isolated toe) amputations, reasons for major amputation, and level of major amputation. All bilateral amputees were evaluated separately.

Relevant points relating to rehabilitation included the following time intervals: from amputation to admission to the rehabilitation center, from amputation to the first prosthetic fitting, from admission to discharge, from amputation to patient death, and from prosthetic fitting to patient death. Subjects with BK amputation were fitted with patellar tendon-bearing modular

BK = below knee

prosthesis with a solid ankle-cushion-heel foot. AK amputees were fitted with an ischial tuberosity-bearing modular prosthesis with pelvic belt, safety knee and single-axis foot.

Patients were assigned to one of three groups depending on their discharge status from the rehabilitation center. Group 1 patients had an independent activity of daily living, were able to walk for at least 50 meters with or without a cane, ascend or descend at least five stairs, and capable of donning and removing their prosthesis. Group 2 patients needed assistance with activities of daily living, were able to walk indoors only, did not have the ability to use stairs, and needed assistance with their prosthesis. Group 3 patients were unable to use their prosthesis.

The results of rehabilitation in the ESRF patients were compared with the results of rehabilitation obtained over the same period in 138 non-uremic patients.

Statisical analysis

Results are expressed as mean ± SD. Statistical analyses were performed by SPSS for Windows, Release 10.0 (1999). Analysis of variance was used to find differences of average among the three groups. The Wilcoxon test was performed to compare medical parameters within the same group at the time of admission and discharge to the rehabilitation center. Chi-square test was performed to find the differences between the groups in nominal and ordinal variables. Student's *t*-test was used to compare rehabilitation results between the dialysed and non-dialysed groups. $P < 0.05$ was considered significant.

Results

During the study period 1,072 patients were chronically dialysed in the two referring units. The predominant mode of dialysis therapy was hemodialysis in 764 patients (72%) and peritoneal dialysis in 308 (28%). Forty-eight patients (4.5%) underwent amputations. Of these, 26 (58%) were admitted for rehabilitation. Hemodialysis (17/26, 65%) and peritoneal dialysis (9/26, 35%) were equally "represented" at the rehabilitation unit. Two patients were excluded from the study because of faulty documentation, leaving 24 patients to form the basis for this study. Of the 24 patients, 17 (~70%) were diabetic and 21 were male. Fourteen underwent amputation during the preceding 3 years. During the period studied about 10–15% of the entire dialysis population were diabetic. ESRF causes in the non-diabetic patients included nephrosclerosis in three patients, chronic glomerulonephritis in two, chronic interstitial disease in one and renovascular disease in one.

In 11 patients bilateral ankle-brachial pressure index examinations were carried out 12 months or less before amputation. Of the 22 limbs examined, 14 were eventually amputated. Of these 14 limbs, 9 limbs had falsely elevated (>1.0) values of ABPI. The ABPI in only five patients showed results indicative of severe PVD. Eight of the 11 patients were subsequently investigated with digital subtraction angiography. A correlation between the ABPI and the arteriographies was seen in only three patients; in the other five patients the arteriographic findings were worse than anticipated by ABPI.

Table 1. Revascularization procedures and level of amputation carried out in eight patients, and time interval between revascularization and amputation

Revascularization procedures	Level of amputation	Time between revascularization and amputation (mos)
Rt./Lt. SFA-peroneal	Bilateral AK	2
Femoro-peroneal	AK	9
PTA to SFA	AK	1
PTA to SFA and popliteal	BK	1
Femoro-popliteal	BK	2
Femoro-posterior tibial	BK	1
PTA to SFA	AK	13
Femoro-popliteal	AK	3
Mean time between revascularization and amputation		4 ± 4.5 months

SFA = superficial femoral artery, PTA = percutaneous transvascular angioplasty

Fourteen patients underwent lower limb arteriography. Eight had revascularization procedures [Table 1]. The eight procedures were carried out in 5 of 17 diabetics and in 3 of 7 non-diabetic patients – a non-significant difference. All five patients with predominant proximal arterial disease were revascularized. Three patients with significant distal arterial disease were also revascularized (two femoro-peroneal bypasses, one distal femoro-posterior tibial bypass). The mean time between revascularization and major amputation was 4.0 ± 4.5 months (range 1–13 months). Five of the eight patients (62.5%) who underwent bypass surgery required an AK amputation. In the other 16 patients who had primary amputation, only 2 (12.5%) required AK amputations ($P < 0.05$). Primary indications for major amputation were severe rest pain/gangrene in 13 patients and uncontrolled infection in 11. The level of the major amputation was similar in both diabetic and non-diabetic patients (BK amputation 13/17 vs. 4/7 patients).

Minor amputations, before major amputations, were carried out in seven patients. Three minor amputations were carried out after revascularization. The mean time lag between distal amputation and major amputation was 1.8 ± 1.2 months (range 0.5–4 months).

Intravenous iloprost failed to save limbs in three patients. Lumbar sympathectomy and the use of hyperbaric oxygen had no beneficial effects. Seven patients became narcotic users before amputation. In all patients amputation led to a marked relief of pain.

Twelve patients were considered to be successfully rehabilitated (Group 1), 8 patients had partial success in the prosthetic rehabilitation program (Group 2), while 4 patients failed rehabilitation (Group 3). Table 2 shows the demographic and clinical features for the study population as a whole, and for the three separate groups. A younger age confirmed favorable rehabilitation results, while patients with long-standing diabetes were poor candidates for rehabilitation. In this study, the presence of active heart disease,

AK = above knee
ESRF = end-stage renal failure
ABPI = ankle-brachial pressure index

smoking, or a previous cerebrovascular event did not have a negative impact on rehabilitation. Following amputation, patient survival time was short (17 ± 12 months). Patient survival time was shortest in patients in whom rehabilitation failed (6 ± 5 months). No difference in survival was seen between diabetics and non-diabetics (18.7 ± 14.5 months vs. 14.3 ± 8.8 months). During the study 20 patients died – 13 from cardio/cerebrovascular causes. One year mortality rate for the 24 patients was 33%; 2 year mortality rate was 70%. This is far worse than the 10–15% one year mortality rate for all ESRF patients on chronic dialysis.

Table 3 summarizes the clinical parameters obtained during the rehabilitation program. Mode of dialysis during rehabilitation and the level of amputation were not significant predictors of rehabilitation outcome. Serum hemoglobin and albumin levels were low at admission in all groups and increased significantly at discharge. Patients who underwent primary amputation had more success in rehabilitation (Group 1, 11/16 patients) than patients who were initially treated by revascularization and afterwards by amputation (Group 1, 1/8 patients). Table 4 compares the parameters between dialysed patients and patients without ESRF who had attempted inpatient rehabilitation. The prevalence of mild degrees of chronic renal failure in this control group is not available. No statistical differences were found between the two groups regarding eventual rehabilitation outcome. Hospitalization stay for the purpose of rehabilitation was significantly longer in the dialysed patients (67 ± 39 vs. 50 ± 27 days, $P < 0.01$), as was the interval between admission and initial fitting of the prosthesis (53 ± 37 vs. 29 ± 13 days, $P < 0.0001$). Seven patients became bilateral amputees. One was successfully rehabilitated (still alive 20 months after his second major amputation); the other six patients failed rehabilitation. The six bilateral amputees who failed prosthetic rehabilitation died with a mean survival time of 6.6 ± 6 months (range 1–17 months).

Table 2. Demographic and clinical features of the study population as a whole and for the separate subgroups

	Study population	Group 1	Group 2	Group 3
No. of amputees	24	12	8	4
Age (yrs)	59 ± 13	51 ± 12	70 ± 7 *	64 ± 11
Gender (M/F)	21/3	11/1	6/2	4/0
Smoking (yes/no)	9/13	3/7	5/3	1/3
Heart disease (yes/no)	12/12	4/8	5/3	3/1
Diabetes (yes/no)***	17/7	11/1	5/3	1/3
Duration of diabetes to amputation (yrs)	17 ± 9	16 ± 7**	14 ± 7**	34 ± 5
Duration of dialysis to amputation (mos)	44 ± 44	43 ± 37	33 ± 21	73 ± 88

Group 1 = successful rehabilitation, group 2 = partially successful rehabilitation, group 3 = failed rehabilitation.
* $P = 0.003$ (group 1 vs. group 2)
** $P < 0.05$ (vs. group 3)
*** $P < 0.05$ (for all groups)

Table 3. Clinical parameters observed during the rehabilitation program in the study population as a whole, and in the separate subgroups

	Study population	Group 1	Group 2	Group 3
No. of amputees	24	12	8	4
Mode of dialysis				
Hemodialysis	16	7	6	3
Peritoneal dialysis	8	5	2	1
Level of amputation				
Below knee	17	9	5	3
Above knee	7	3	3	1
Revascularization followed by amputation	8	1	5	2
Primary amputation	16	11**	3	2
Hemoglobin (g/dl)				
At admission	10.2 ± 1.1	9.7 ± 1.2	10.6 ± 0.8	11.0 ± 0.9
At discharge *	11.6 ± 1.6	10.8 ± 1.5	12.6 ± 1.1	12.9 ± 2.2
Albumin (g/L)				
At admission	3.2 ± 0.4	3.2 ± 0.5	3.2 ± 0.5	3.0 ± 0.4
At discharge *	3.7 ± 0.6	3.5 ± 0.5	4.1 ± 0.5	3.6 ± 1
Parathyroid hormone at admission (pg/ml)	184 ± 170	228 ± 198	138 ± 155	171 ± 107
Cholesterol at admission (mg/dl)	190 ± 57	181 ± 57	224 ± 57	161 ± 34

Group 1 = successful rehabilitation, group 2 = partially successful rehabilitation, group 3 = failed rehabilitation.
* $P < 0.05$ (between admission and discharge, in all groups)
** $P < 0.05$ (between Group 1 patients treated by primary amputation vs. those treated by revascularization and then by amputation)

Discussion

Ultimately, 3–5% of dialysed patients will have a lower limb amputation [1,16,17] and this problem is growing in magnitude, which is borne out by the fact that in this study 14 of 24 amputations were carried out during the last 3 years. Presumably this is because the chronic dialysis population is becoming older and more and more diabetics are reaching ESRF.

The use of the ankle-brachial pressure index proved to be of little value because of falsely elevated results in a significant number of patients. Arterial calcifications, which are known to produce falsely elevated recordings of ABPI in diabetics [2,15], are widespread in dialysed patients [2,4,18]. Indeed, 23 of the 24 patients studied had arterial calcifications of their lower limbs. On the other hand, an extremely low (<0.4) ABPI indicates severe distal arterial disease, for which some authors recommend primary

Table 4. Comparison of rehabilitation outcome between two groups: on dialysis (24 amputees) and without the need for dialysis (138 amputees)

	Dialysed amputees	Non-dialysed amputees
No. of amputees	24	138
Age (yrs)	59 ± 13	63 ± 12
Gender (M/F ratio)	7.0*	2.1
BK/AK amputation ratio	2.4	2.9
Time		
Amputation to admission to rehab (days)	37 ± 54	25 ± 26
Admission to receiving prosthesis (days)	55 ±37 **	29 ± 3
Prosthetic rehab (days)	67 ± 39 ***	50 ± 27
Rehab outcome		
Complete independence	12 (50%)	52 (38%)
Partial independence	8 (33%)	67 (48%)
Failed rehabilitation	4 (17%)	19 (14%)

* $P < 0.001$
** $P = 0.05$
*** $P < 0.01$

amputation [7]. Importantly, these medial calcifications are not a contraindication for bypass surgery [16,18].

The study yielded results of revascularization procedures that need to be addressed. First, only 8 of 14 patients who underwent diagnostic arteriography were considered suitable for revascularization, reflecting both widespread and distal disease in these patients. Second, revascularizations were followed by major amputations after a mean period of only 4 ± 4.5 months. Third, 5 of 8 patients after attempted revascularization went on to require an AK amputation, as compared to only 2 of 16 patients treated with primary amputation who went on to AK amputation. This increased incidence of AK amputation following revascularization has not been previously described [19,20]. Fourth, rehabilitation results were worse in patients treated by revascularization and subsequent amputation, as compared to those patients treated by primary amputation [Table 3].

A number of centers have summarized their results of infrainguinal procedures in ESRF patients [5–14]. Perioperative mortality is high, and postoperative wound sepsis may be life-threatening. However, limb salvage rates are 60–70% at 2 years post-revascularization [4,5,6,9,11,16]. Therefore, indications for lower limb proximal bypasses in ESRF patients are essentially the same as in non-uremic patients [5,8,9]. Distal bypasses in dialysed patients have uncertain benefits – possibly because of the heavily calcified media and thick small distal vessels [7,11,14,18]. Secondary procedures to save distal grafts are not warranted [21].

The majority of patients who require amputation after revascularization do so within the first 6 months, either because of graft failure or uncontrolled infection. But, at least one-third of all major amputations in dialysed patients are carried out despite the presence of a patent bypass [7–10,13,14,18]. Therefore, primary major amputation, and not revascularization, may be the treatment of choice in a subgroup of patients with extensive forefoot or heel gangrene, or in patients in whom deep-seated infection of the foot is not controlled [4,8,9,11–14,16]. Primary amputation in these patients will remove the infective foci and will alleviate pain. The results of distal amputations in this cohort of patients were disappointing. All seven patients who underwent a distal amputation had futher BK/AK amputation carried out within 4 months after the initial surgery.

Chronically dialysed amputees represent a relatively new group of patients undergoing prosthetic rehabilitation. In 1986, Greenspun and Harman [22] described successful rehabilitation in five dialysed patients. These patients were young diabetics. Although prosthetic fitting was a problem, four of them were independent at discharge [22]. In 1994, 19 ESRF patients were compared to 19 patients without ESRF [23]. Although the dialysis group had more co-morbid conditions, the results were similar in both groups. The authors concluded that inpatient prosthetic rehabilitation was effective in renal patients and did not incur greater costs.

The present study is the largest to examine prosthetic rehabilitation results after lower limb amputation in dialysed patients. The overall time periods from admission to prosthetic fitting and final successful rehabilitation were significantly longer in the dialysed amputees – probably due to the need for the patient to travel to and from the hemodialysis therapy and also because the patient is often fatigued after hemodialysis, making meaningful rehabilitation a problem. Importantly, changes in stump diameter, due to acute changes in fluid balance, make proper fitting of the prosthesis socket problematic. This can be resolved by taking measurements for the prosthesis socket just before the patient leaves for a hemodialysis session. If the stump is less edematous following hemodialysis, the amputee should be taught to add stump socks as necessary [22]. Despite all these problems, short-term rehabilitation results for the dialysis patients in this study were excellent. Half were independent on discharge, 33% achieved partial ambulation with the prosthesis, and only 4 of the 24 patients failed rehabilitation. Surprisingly, prosthetic rehabilitation results in the dialysed group were as good as in the non-uremic group. Failed rehabilitation is a dismal prognostic factor. It occurs in the very elderly, in long-term dialysis patients, in patients with long-standing diabetes, and in bilateral amputees [2].

There is uniform consensus that BK amputees are easier to rehabilitate than AK amputees [24]. This has been confirmed in dialysis patients, where 1 year mortality rates were lower and prosthetic ambulation more successful in BK amputees [1,16]. Although this study did not show differences in rehabilitation results between AK and BK amputees, survival was longer in the BK amputees.

Retrospective studies have drawbacks. The most important of these is the lack of a control group, i.e., the number of successful revascularizations performed during the study period was not studied. Secondly, referral bias may have affected the results since only 50% of the amputated dialysis population were referred for rehabilitation. Despite these drawbacks, this study allows a number of recommendations for dealing with lower limb critical ischemia in the chronically dialysed patient:

- Perform digital subtraction angiography, at the first sign of critical ischemia. On the whole, ABPI should be regarded as an insensitive way of measuring distal perfusion.
- Perform proximal revascularization wherever possible.

- Carefully consider the benefits vs. the problems associated with distal revascularization.
- Perform primary amputation in patients with extensive foot infection or gangrene. Revascularization or primary amputation should be carried out quickly, before the patient becomes infected and catabolic. Very recently, Reddan et al. [25] reported a case-control analysis of lower extremity revascularizations in patients with ESRF. This study also shows that outcomes after lower extremity revascularizations in their patients with ESRF were associated with high amputation and mortality rates [25].

Prosthetic rehabilitation is warranted in the majority of dialysed amputees. There are misconceptions regarding the ability of dialysed patients to undergo a succesful prosthetic rehabilitation program – as seen in the results of this study in which prosthetic rehabilitation was not only successful but compared favorably to rehabilitation results in non-uremic patients.

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Correspondence: Dr. U. Gafter, Institute of Nephrology and Hypertension, Rabin Medical Center (Golda Campus), 7 Keren Kayemet Street, Petah Tiqva 49372, Israel.
Phone: (972-3) 937-2224
Fax: (972-3) 937-2311
email: uzig@clalit.org.il