



Limb Salvage in Patients With Diabetes Is Not a Temporary Solution but a Life-Changing Procedure

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Our limb salvage protocol for patients with diabetes at risk for amputation due to critical limb ischemia, foot ulcer, or gangrene includes early and aggressive surgical debridement, immediate broad-spectrum antibiotic therapy, and peripheral transluminal angioplasty as the first-choice revascularization procedure (1). In 2010 (2), we described the long-term outcomes (mean follow-up 20 ± 13 months) of 456 patients treated with this protocol: ulcers were healed in 62.3% (group A), major amputations performed in 14.7% (group B), death occurred in 14.9% (group C), and ulcers remained unhealed for >12 months in 8.1% (group D). As the long-term efficacy of this approach is still controversial (3), we have now evaluated the limb- or life-related outcomes in the same cohort of patients after a further follow-up of 66 months.

Among the 396 (85.1%) surviving patients of our original cohort, we reevaluated outcomes in 379 (96%) (283 from group A, 62 from group B, 34 from group D). Among these, 294 (77.6%) had at least three clinic visits/year while 85 had only a yearly telephone follow-up.

The outcomes of interest for this study were 1) previous outcome persistence (POP), defined as persistence of healing, amputation, or nonhealing; 2)

new major amputations (NMA); 3) new deaths (ND); or 4) new healings (NH) (for group D). Table 1 shows the clinical characteristics and outcomes after a total duration of follow-up of 82.6 ± 26.5 months. Follow-up was mainly clinical for group A (91%) and group D (56%) and telephone for group B (71%) patients. Time to death of group B (16.7 ± 19.6 months) was significantly shorter than for groups A (51.2 ± 28.2) and D (46.5 ± 20.2 months) ($P < 0.0001$).

By multivariate analysis, type of follow-up was significantly associated with POP ($P = 0.006$, hazard ratio [HR] 0.62 [−1.12 to −0.17]), NMA ($P = 0.008$, HR 2.26 [0.29–5.4]), and ND ($P = 0.0005$, HR 0.78 [0.34–1.21]). Outcomes in patients with telephone compared with clinical follow-up were worse in groups A ($P < 0.0001$) and D ($P < 0.0001$), but not in group B, to which the majority of patients with telephone follow-up belonged.

The results of our study demonstrate the following:

1. Limb salvage can provide long-term benefits. In most patients, wound healing persists over time, few require an amputation, and the mortality rate is close to that recorded in the general diabetic population (4).

2. Although clinically similar at baseline, patients undergoing an amputation have a shorter life span than nonamputee patients.
3. Patients receiving clinical, as compared with telephone, follow-up have better outcomes. This may be related to improved control of glycemia, nutrition, cardiac and peripheral arterial risk factors, other comorbidities, and monitoring for foot complications.

Our limb salvage protocol is shared by many others in Italy (1) and has probably contributed to the reduced lower-limb amputation rate observed here over the past 10 years (5). Using a limb salvage protocol combined with close clinical follow-up appears to increase the rate of foot ulcer healing and to improve other long-term outcomes. This very long follow-up demonstrates that using a limb salvage protocol is not just a temporary solution, but can change the patient's life.

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Table 1—Patient characteristics

| | Total | Group A | Group B | Group D | <i>P</i> value* |
|--|--------------|--------------|--------------|--------------|-----------------|
| <i>N</i> | 379 | 283 | 62 | 34 | |
| Age (years) | 75.4 ± 9.7 | 74.3 ± 9.6 | 75.3 ± 9.6 | 74.2 ± 10.6 | NS |
| Men (<i>n</i> /%) | 251/66.3 | 189/66 | 40/64.6 | 22/70.6 | NS |
| Diabetes type (%) | | | | | |
| Type 1 diabetes | 3 | 3.2 | 3.2 | 0 | NS |
| Type 2 diabetes | 96 | 96.8 | 96.8 | 100 | NS |
| Diabetes duration (years) | 24.9 ± 12.2 | 25.1 ± 12 | 24.4 ± 11.7 | 26 ± 9.9 | NS |
| Diastolic blood pressure (mmHg) | 80.4 ± 8.6 | 81 ± 7.9 | 78.7 ± 10.6 | 79.2 ± 8.9 | NS |
| Systolic blood pressure (mmHg) | 132 ± 14.2 | 136.6 ± 13.4 | 133.3 ± 13.7 | 138.7 ± 14.2 | NS |
| Renal dialysis (<i>n</i> /%) | 48/12.6 | 31/11 | 11/17.7 | 6/17.6 | NS |
| Ischemic heart disease (<i>n</i> /%) | 152/40 | 107/38 | 31/49.2 | 14/42.4 | NS |
| Carotid artery disease (<i>n</i> /%) | 89/23.6 | 63/22.5 | 18/29.3 | 8/23.5 | NS |
| Active smoker (<i>n</i> /%) | 91/24 | 70/24.6 | 14/22.4 | 7/22.6 | NS |
| Fasting blood glucose (mg/dL) | 150.5 ± 60 | 149.3 ± 60 | 149.4 ± 47.8 | 162.4 ± 75.4 | NS |
| HbA _{1c} (mmol/mol) | 59.3 ± 19 | 60.2 ± 19.8 | 55.9 ± 16.3 | 57.8 ± 16.6 | NS |
| HbA _{1c} (%) | 7.5 ± 1.6 | 7.6 ± 1.7 | 7.4 ± 1.3 | 7.5 ± 1.3 | NS |
| Fasting blood glucose (mg/dL) | 150.5 ± 60 | 149.3 ± 60 | 149.4 ± 47.8 | 162.4 ± 75.4 | NS |
| Total cholesterol (mg/dL) | 163.1 ± 45.9 | 153.6 ± 45.4 | 157.9 ± 40 | 168.5 ± 59.4 | NS |
| HDL cholesterol (mg/dL) | 41.2 ± 22.5 | 41.5 ± 23 | 38.5 ± 13.3 | 43.6 ± 30.2 | NS |
| LDL cholesterol (mg/dL) | 87.6 ± 38.9 | 97.7 ± 38.6 | 95.5 ± 34.6 | 101 ± 49 | NS |
| Triglycerides (mg/dL) | 142.5 ± 71.3 | 142.3 ± 69.4 | 133.3 ± 61 | 160 ± 98 | NS |
| Stroke (<i>n</i> /%) | 51/13.4 | 36/12.8 | 11/17 | 4/11.7 | NS |
| Blood pressure therapy (<i>n</i> /%) | 347/91.6 | 261/92 | 56/89 | 30/87.8 | NS |
| New peripheral transluminal angioplasty (<i>n</i> /%) | 45/14 | 27/14 | 11/18.2 | 7/20.7 | NS |
| POP (<i>n</i> /%) | 227/59.8 | 196/69.3 | 26/42.4 | 5/14.7 | <0.001 |
| NMA | 14/3.7 | 2/0.74 | 9/14 | 3/8.8 | |
| NH of ulcer | 16/4.2 | N/A | N/A | 16/47 | |
| ND | 122/32.2 | 85/30 | 27/43.6 | 10/29.4 | |
| Follow-up clinical (<i>n</i> /%) | 294/77.6 | 257/90.8 | 18/29 | 19/56 | <0.001 |
| POP follow-up clinical (<i>n</i> /%) | 201/69 | 192/74.7 | 7/38.9 | 2/10.5 | <0.001 |
| POP follow-up telephone (<i>n</i> /%) | 32/40 | 4/15.4 | 25/54.5 | 3/20 | |
| NMA follow-up clinical (<i>n</i> /%) | 3/0.4 | 0 | 1/5.5 | 2/10.5 | NS |
| NMA follow-up telephone (<i>n</i> /%) | 6/3.5 | 2/7.7 | 3/6.8 | 1/6.6 | |
| NH of ulcer follow-up clinical (<i>n</i> /%) | 15/5.1 | N/A | N/A | 15/79 | <0.000 |
| NH of ulcer follow-up telephone (<i>n</i> /%) | 1/1.2 | N/A | N/A | 1/6.6 | |
| ND follow-up clinical (<i>n</i> /%) | 75/25.5 | 65/25.3 | 10/55.5 | 0 | <0.001 |
| ND follow-up telephone (<i>n</i> /%) | 47/55.3 | 20/76.9 | 17/38.6 | 10/66.7 | |

Data are mean ± SD unless otherwise stated. Data in italic signifies clinical follow-up. **P* value determined by χ^2 or ANOVA test.

L.U. is the guarantor of this work and, as such, had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

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