Diabetic Foot: Mortality Rates After Major Amputation

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ABSTRACT

Introduction: Major amputations cause a high rate of morbidity and mortality. Our objectives were to evaluate the mortality rate in the first month, and 2 and 5 years after amputation for diabetic foot and to compare the mortality rate in patients with below-the-knee (BKA) and above-the-knee amputations (AKA). **Materials and Methods:** Sixty patients with 64 major amputations, operated on between 2010 and 2018, were retrospectively evaluated. The following information was collected: personal data, laterality, University of Texas classification score, biochemical analysis results, Doppler studies, comorbidities, survival, and cause of death. The overall mortality rate and the mortality rate by type of amputation in the first month and after 2 and 5 years were calculated. **Results:** 58 amputations were performed in men and 6 in women (37 right, 27 left), 39 were AKA and 25 were BKA. The average age was 68 years. There were 28 deaths: 15 patients with AKA and 13 with BKA. Mortality rates were: 13.33% in the first month, 33.3% after 2 years, and 46.42% after 5 years (patients with AKA, 26.78%; patients with BKA, 19.64%). The differences in the creatinine levels of the patients who died were statistically significant. The main causes of death were cardiovascular complications. **Conclusions:** Mortality rates were significantly higher in patients with above-the-knee amputation. The sepsis-related mortality rate in the first month was high. Patients with kidney disease had a higher mortality rate.

Keywords: diabetic foot, amputation, mortality

Level of Evidence: IV

Pie diabético: tasas de mortalidad en pacientes con amputaciones mayores

RESUMEN

Introducción: Las amputaciones mayores provocan una elevada tasa de morbimortalidad. Los objetivos de este estudio fueron evaluar la tasa de mortalidad al mes, y a los 2 y 5 años de una amputación por pie diabético y comparar la tasa de mortalidad en pacientes con amputación infrarrotuliana o supracondílea. **Materiales y Métodos:** Se evaluó retrospectivamente a 60 pacientes con 64 amputaciones mayores, operados entre 2010 y 2018. Se reunió la siguiente información: datos personales, lateralidad, puntaje de la clasificación de la Universidad de Texas, análisis bioquímicos, estudio Doppler, comorbilidades, supervivencia y causa del óbito. Se calculó la tasa de mortalidad general y por tipo de amputación al mes, a los 2 y 5 años. **Resultados:** Se realizaron 58 amputaciones en hombres y 6, en mujeres (37 derechas, 27 izquierdas), 39 fueron supracondíleas, y 25 infrarrotulianas. La edad promedio era de 68 años. Hubo 28 óbitos: 15 pacientes con amputación supracondílea y 13 con amputación infrarrotuliana. Las tasas de mortalidad fueron: 13,33% al mes; 33,3% a los 2 años y 46,42% a los 5 años (pacientes con amputación supracondílea 26,78%; pacientes con amputación infrarrotuliana 19,64%). Las diferencias en los niveles de creatinina de los pacientes que murieron fueron estadísticamente significativas. Las principales causas de muerte fueron las complicaciones cardiovasculares. **Conclusiones:** Las tasas de mortalidad fueron significativamente superiores en los pacientes con amputación supracondílea. La tasa de mortalidad al mes relacionada con sepsis fue alta. Los enfermos renales tuvieron una tasa de mortalidad mayor.

Palabras clave: Pie diabético; amputación; mortalidad.

Nivel de Evidencia: IV

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INTRODUCTION

Major amputations due to diabetic foot are procedures with high morbidity and mortality rates. Awareness of these rates and their related factors is especially important for designing diagnostic and treatment strategies that reduce complications and deaths in these patients. Published studies on this subject differ in their methodology, but report very high mortality rates[1,2] which vary according to the level of amputation.[3] Likewise, the populations studied are diverse and the results are not necessarily applicable to our population.

The objective of this study was to evaluate the mortality rate one month, two, and five years after a major amputation due to diabetic foot. The secondary objectives were to assess the differences in mortality rates between patients with below-knee or above-knee amputations, and to relate them to their possible causes.

MATERIALS AND METHODS

We retrospectively studied 60 patients with insulin-dependent type 2 diabetes. 64 amputations were performed between January 2010 and January 2018 in a highly complex hospital in the Autonomous City of Buenos Aires. The inclusion criteria were: amputation due to diabetic foot and surgery performed in our hospital, by personnel from the trauma service. The exclusion criteria were: traumatic, primary vascular, or tumor cause, or any other etiology not related to diabetic foot. A form was prepared with detailed information on the patient, including personal data, age, sex, date of surgery, laterality, University of Texas classification score, biochemical analyses at the time of surgery, results of the arterial and venous Doppler study, survival, survival time, and causes of death. Associated comorbidities were also recorded, such as nephropathy, arterial hypertension, dyslipidemia, peripheral vascular disease, and neuropathy. The association of comorbidities between the groups of living and deceased patients was evaluated to analyze if there were statistically significant differences. Serum creatinine values were recorded at the time of surgery, and the difference between the values of the living and deceased patients was analyzed using Student's t-test. The overall mortality rate and the mortality rate by type of amputation were calculated one month, two and five years after the amputation. In addition, we studied whether or not there were statistical differences between the groups with above-knee or below-knee amputations. We devised a value that we define as "mean time to death", which is calculated by averaging the time in years from amputation to death, and we evaluated the comorbidities of each group and those common to both groups.

All amputations were carried out by surgeons from the orthopedics and trauma service. The indication and level of amputation were agreed upon by the institution's diabetic foot committee. All amputations, both BKA and AKA, consisted of dissection by planes, hemostasis, triple arteriovenous ligation of each bundle, nerve phenolization and section under traction, bone cutting with a hand saw, rasping of edges, and closure by planes. The Burgess technique[4] was used for BKAs and the fish-mouth incision[4] for AKAs. The average surgery time was 1.5 and 1 h, respectively. None of the amputations in this study group were performed with the guillotine modality.

RESULTS

64 amputations were performed on 60 patients (58 on men, 6 on women), 37 were in the right limb and 27 in the left limb. In 39 patients, a supracondylar level of amputation was indicated and, in 25, an infrapatellar level. The average age of the sample was 68 years (range 44-92). The total number of deaths was calculated, taking into account the level of amputation (supracondylar or infrapatellar), in a period of time (one month, two years and five years). There were 28 deaths (Table 1), of which 15 (61%) were in patients with AKA and 13 (39%) were in patients with BKA. Mortality rates are shown in Figure 1.

Likewise, the mortality rate was calculated according to the level of amputation and the results are shown in Figure 2. A significant difference was found between the mortality rates of patients with AKA or BKA ($p \leq 0.03$).

The average overall time until death was 1.7 years, the average time until death was also calculated in patients with supracondylar (1.27 years) and infrapatellar (2.19 years) amputations.

Serum creatinine levels were compared between living and deceased patients, and a statistically significant difference ($p \leq 0.02$) was obtained, with an average of 1.05 mg/dl in the living and 2.5 mg/dl in the deceased. The causes of death are detailed in Table 2.

Table 1. Mortality rate and number of deaths one month, two years and five years after amputation

	Mortality rate			Deaths		
	After one month	**After 2 years**	**After 5 years**	**After one month**	**After 2 years**	**After 5 years**
Overall	13.33	33.34	46.43	8	20	26
Below-knee amputation	1.67	15	19.64	1	9	11
Above-knee amputation	11.67	18.34	26.79	7	11	15

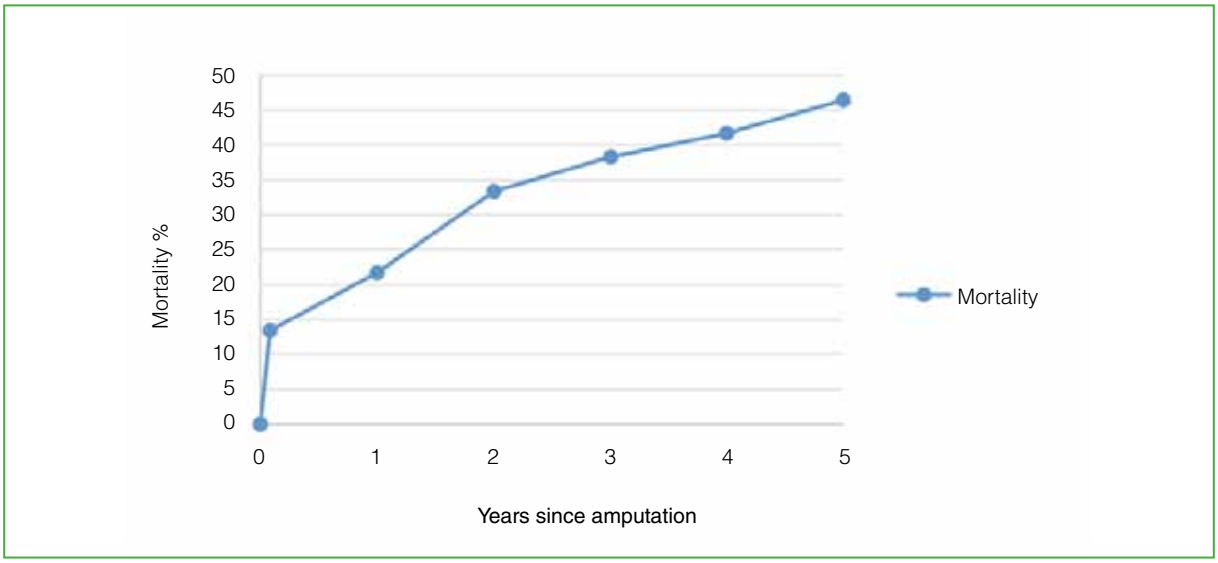

Figure 1. Mortality rate as a function of time since amputation.

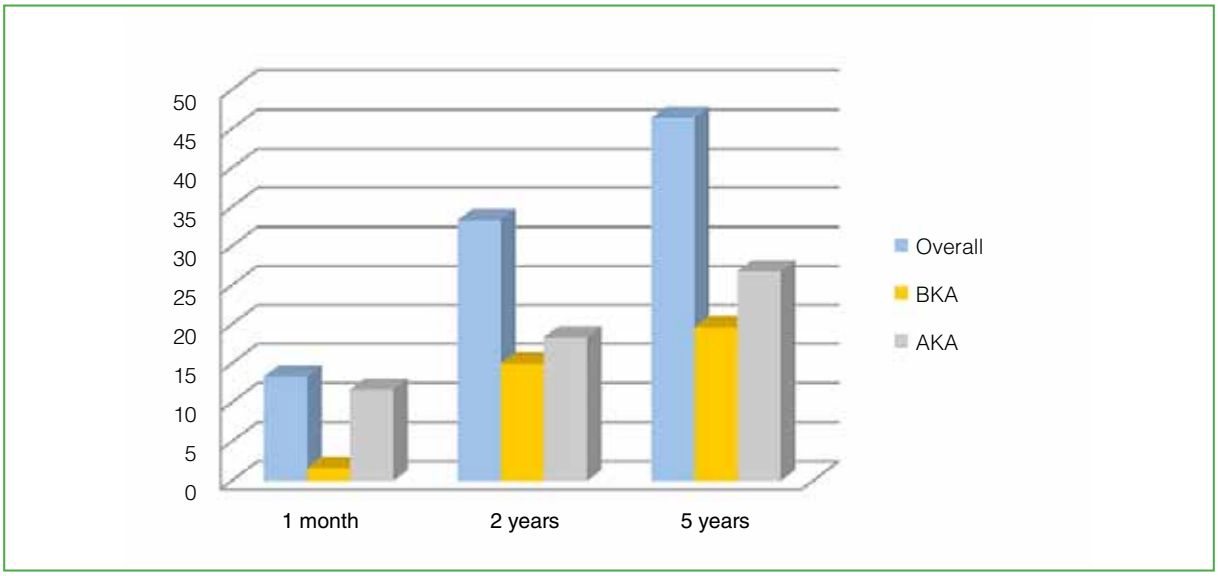

Figure 2. Comparative graph of the general mortality rate and by type of amputation, one month, 2 and 5 years after a major amputation.

Table 2. Quantity and causes of death

Deaths/ Cause	Diabetes	Septic complication	Vascular	Community-acquired acute pneumonia	Acute myocardial infarction	Unknown	Other
28	5	4	3	5	5	4	2
100%	17.86%	14.29%	10.71%	17.86%	17.86%	14.29%	7.14%

DISCUSSION

Approximately 20% of diabetic patients will develop an ulcer at some point in their lives, and 20% of these will require a major amputation. It is estimated that an amputation is performed every 30 seconds in the world[5] and, according to data from the World Health Organization, more and more people suffer from diabetes, so it is necessary to know, in detail, the evolution in the short and long term of each therapeutic treatment.

Amputation is reserved for those feet that are non-viable or infected by germs whose resistance makes them untreatable.

Most research studies on diabetic foot address issues of ulcer prevention and treatment.[2] Different studies have reported the mortality rate after a major amputation,[2] but we did not find national publications on the matter. The comorbidities studied and the study methodology differ, and the surgical techniques used are not mentioned, all of which make it difficult to compare the results and raise the need to carry out more detailed investigations. Published mortality rates are high, but differ from one another. Some authors, such as Hoffman et al., reported that the prognosis of patients amputated due to diabetic foot is comparable to that of those with malignant diseases,[1,2] and the five-year mortality rate is only surpassed by that of lung cancer.[1]

According to Jupiter et al., five years after the appearance of the ulcer, the mortality rate reaches 40%,[3] so a higher value is to be expected for amputees, as occurs in our sample with a five-year rate of 46.4%.

The authors who address the subject of deaths usually do so after a month, and after 1, 2 and 5 years.

In a review study based on data from 31 publications, mortality rates of 53% to 100% at five years, 40-82% after below-knee amputation, and 40-90% after above-knee amputation were reported,[6] which shows a high overall mortality rate, higher than that obtained in our study (46.4%).

These authors found differences between mortality rates according to the type of amputation, which also occurred in our sample, with values of 19.6% and 26.7% in patients with below-knee and above-knee amputations, respectively.

In a review, Stern[12] found mortality rates of 47.9%; 61.3%; 70.6%, and 62.2% after one, two, three, and five years of follow-up, respectively, which are very high compared to our results and could be due to cardiovascular events, as the authors conclude.

Schofield et al. established that the mortality rate is 55% higher in diabetic amputees than in non-diabetics and that they have a higher risk of suffering cardiovascular events and new amputations.[7] Although this point was not the subject of our analysis, it shows a particularly high mortality rate in diabetic patients.

Soo et al.[8] reported a mortality rate of 60% at five years and 75% at 10 years, highlighting age >70 years as a poor prognostic parameter; in our study, it was not possible to assess it, because the majority belonged to that age group (mean age 68).

The mortality rate after the first month is also recorded as high,[7] ranging between 8% and 25%, and is related to the supracondylar or infrapatellar level (17.5% and 4.2%, respectively).[9]

In our series, the 1-month mortality rate was 13.3% (1.6% in patients with supracondylar amputation and 1.6% in those with infrapatellar amputation).

Causes of death

The causes of death are difficult to assess due to the loss of follow-up.[8,9] Despite this, it is known that cardiovascular events are the first cause.[10] Amputees with diabetes are twice as likely to die from heart failure than non-diabetics,[7] and have a 55% higher mortality rate. The level of amputation also influences the risk of suffering heart attacks, it is higher if the amputation is above the knee,[9] with risk rates of perioperative cardiovascular events of 6.8% and 3.6% for amputations above and below the knee, respectively.[9] Heart failure in diabetic patients is more prevalent and even more serious if it is secondary to a heart attack.[2,7]

In our series, the predominant cause of death was acute myocardial infarction (17.86%) which, despite being an important cause according to the literature, did not have a strong incidence as a separate entity in our sample, but was associated with peripheral vascular diseases (10.71%), adding 28.57% of the causes of death as global cardiovascular complications.

The metabolic complications of diabetes (17.86%) and pneumonia (17.86%) also appear among the main causes of death, followed by sepsis, which represented 14.29% of deaths, mainly in the first month post amputation.

Risk factors

There are risk factors that predispose to a higher mortality rate, such as age, peripheral vascular disease, kidney disease, and previous amputation.[6,8,11] In our series, it was not possible to analyze peripheral arterial disease, dyslipidemia, and age as independent risk factors, because almost all patients had these characteristics, to different degrees, not always specified in the medical records, so it is an aspect to be addressed in the future and prospectively.

Stern et al. mentioned that, in addition to diabetes and peripheral arterial disease, other factors, such as coronary artery disease, stroke, kidney disease, ASA 4, and dementia double the risk of death.[12]

Renal failure, on the other hand, was not a constant and creatinine values showed statistically significant differences between patients who died within five years and those who survived, who had lower values. Renal failure is not always described as a risk factor in the literature,[6] and, in light of our results, it should at least be taken into account. Regarding the cut-off value to consider kidney damage, Davenport et al. take as a parameter a serum creatinine value ≥1.2 mg/dl or the need for dialysis.[13]

Above-knee amputation is a factor associated with a higher mortality rate,[9] which is consistent with our results.

Prolonged hospitalization was reported as a risk factor for death in the first month; it has been reported that when it occurs between 9 and 12 days, it is due to comorbidities and their management.[12]

CONCLUSIONS

In the series studied, the mortality rates were: 13.33% in the first month, 33.3% after two years, and 46.42% after five years. Mortality rates in patients with supracondylar amputation were significantly higher than in those with infrapatellar amputation, in all periods analyzed. The high mortality rate in the first month (13.33%) is mainly related to sepsis.

Patients with kidney disease had a higher mortality rate, so it is recommended to create a protocol for the study and prevention of said disease.

The main cause of death was cardiovascular complications.

Diabetic patients undergoing a major amputation have a higher mortality rate than those with ulcers, so it is suggested to prevent diabetic foot ulcers and implement limb salvage protocols.

Studies on this subject are methodologically heterogeneous; it is difficult to compare them and establish the causes of their high but disparate mortality rates, so prospective trials should be carried out that also analyze hospitalization times, surgical delays, techniques used, and the suitability of the surgeons.

Conflict of interest: The authors declare no conflicts of interest.

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