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MORTALITY AFTER MAJOR AMPUTATION FOLLOWING GANGRENE OF THE LOWER LIMB

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Major amputations were performed on 310 patients because of gangrene of the lower limb. The mean age was 70 years and 58 per cent of the patients were males. Females were on average 5 years older.

The primary levels of amputation were above-knee (AK) in 33 per cent (103/310), through-knee (TK) in 21 per cent (66/310) and below-knee (BK) in 46 per cent (141/310).

Mortality during hospitalization was 18 per cent and the average hospitalization time 68 days. Mortality during hospital stay was primarily dependent on the occurrence of somatic complications, secondarily on the level of the amputation (as an expression of the extent of the gangrene) and finally on the age of the patient.

The long-term survival rate was correlated primarily to the level of the amputation and secondarily to age. A high excess mortality was noted during the first few postoperative years, especially among AK amputees, but after this period the survival curve ran parallel to the expected survival rate. Mortality after 1 year was 34 per cent, comprising 17 per cent after BK amputation, 39 per cent after TK and 54 per cent after AK amputation.

Key words: amputation; epidemiology; gangrene; mortality

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Over the past 15 years several reports have been published on the postoperative mortality after amputation of the lower limb. However, it is difficult to make a comparison of most of these studies not only because of the lack of definition of "postoperative mortality", but also because of the differences in patient series concerning age, reasons for amputation, levels of amputation and occurrence of somatic complications.

Only a few studies have considered the long-term prognosis for lower extremity amputees (Hansson 1964, Christensen 1976). In these works a high mortality rate after amputation on the lower limb was observed. Ebskov & Josephsen (1980) found a surprisingly low mortality rate in the comprehensive material recorded in the Danish Amputation Register.

In the present paper the main risk factors determining short-term and long-term postoperative mortality are presented and discussed.

PATIENTS AND METHODS

During the period April 1st, 1971 to March 31st, 1979 amputation of the lower limb was performed in 310 patients over 40 years of age. As bilateral amputation was performed in 10 cases, there were a total of 320 limbs.

Age and sex distributions are shown in Figure 1. The mean age was 70 years (range 40–94) but nearly two-thirds of the patients were over the age of 70. Males

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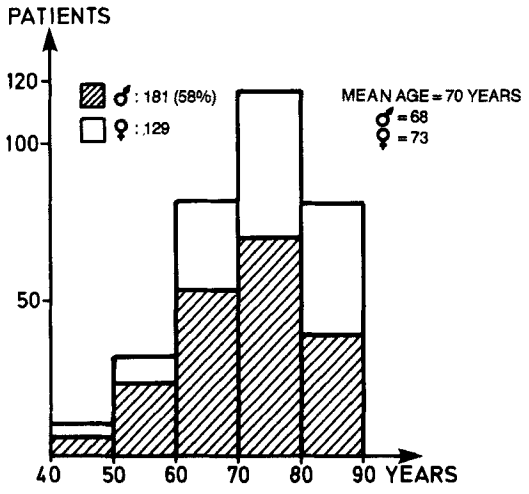


Figure 1. Age distribution of 310 amputees.

with a mean age of 68 years (range 42–90) constituted 58 per cent (181/310) of the series. Females were on average 5 years older, their mean age being 73 years (40–94). This difference was significant ($P < 0.04$).

The reason for amputation was gangrene due to chronic arteriosclerotic vascular disease or acute thrombosis in 74 per cent of the cases (230/310), whereas the remainder had concomitant diabetes mellitus.

The primary level of amputation was above-knee (AK) in 33 per cent of the cases (103/310), through-knee (TK) in 21 per cent of the cases (66/310) and below-knee (BK) in 46 per cent of the cases (141/310).

The records of the patients were examined retrospectively for the following information: date of admission, duration of hospitalization, mortality and occurrence of severe somatic complications (i.e. severe cerebrovascular, cardiopulmonary, renal or gastroenterological diseases and electrolyte derangement).

From the Central Bureau of Personal Registration, in which all Danish residents are recorded by means of an identification number, patients who had died before August 25th, 1980 were identified. From these data, life tables were calculated by decrement analysis and compared using Gehan's modified Wilcoxon test.

Survival rates for a comparable number of patients with a similar age and sex distribution were calculated from further data obtained from the Danish Central Bureau of Statistics.

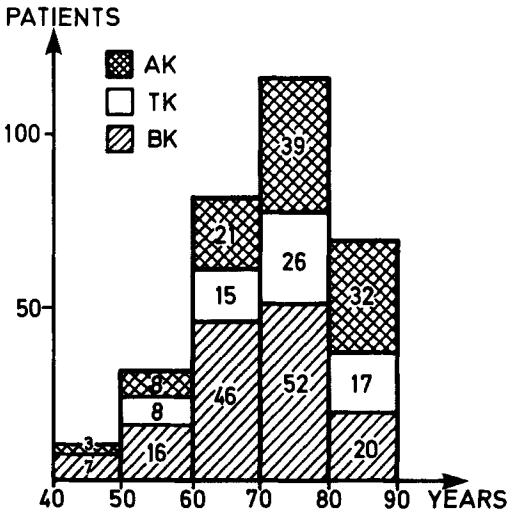
For supplementary statistical analysis the Chi-square test, multivariable logistic analysis, or multiple contingency table analysis was applied.

RESULTS

Age was found to be significantly related to the level of amputation ($P < 0.03$), i.e. the number of BK amputations decreases and the number of AK amputations increases with age, whereas the number of TK amputations is constant (Figure 2). Sex was not significantly related to the level of amputation.

The average hospitalization time in the present series was 68 days, ranging from 29 to 306 days. Patients with amputations at BK level had the longest hospitalization time, i.e. 81 days, as compared to 77 days after TK amputation and 47 days following AK amputation.

The overall mortality in hospital was 18 per cent (55/310). The mortality rate was highest among AK amputees, being 28 per cent (29/103), as compared to 15 per cent (10/66) among TK amputees and 11 per cent (16/141) following BK amputation. A multivariate logistic analysis revealed that mortality in hospital was primarily related to the occurrence of somatic complications ($P < 0.05$). The subsequent steps of the analysis showed that the next most important factor influencing the mortality was the level



Level significantly related to age ($P < 0.03$), i.e. BK decreases, AK increases, TK constant.

Figure 2. Level of amputation in relation to age among 310 amputees.

Table 1. Mortality in relation to postoperative course

Uneventful course	4/161	2%
Local complications	6/ 88	7%
Somatic complications	45/ 61	74%

$P < 0.05$

Table 2. Somatic complications in relation to level of amputation

AK	38/103	37%
TK	9/ 66	14%
BK	14/141	10%

$P < 0.0005$

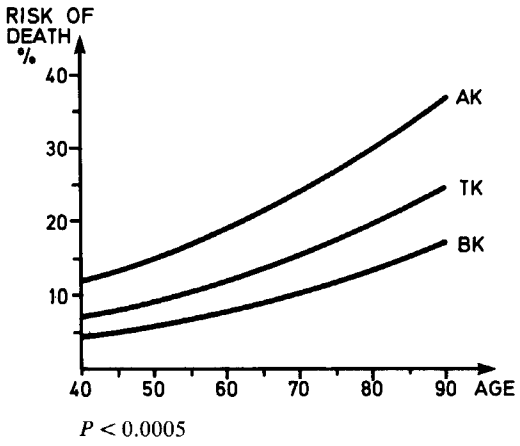


Figure 3. Estimated probability of death during hospitalization in relation to age.

of the amputation ($P < 0.0005$) and the third factor was age ($P < 0.01$).

Somatic complications (i.e. mainly cardiopulmonary complications or cerebrovascular disease) were observed in 20 per cent of the cases (61/310). Table 1 demonstrates the mortality in hospital in relation to the postoperative course. It is seen that 74 per cent of the patients with severe somatic complications died during hospitalization. There was a highly significant correlation ($P < 0.0005$) between the level of the amputation and somatic complications as is shown in Table 2. Only every seventh to tenth patient was suffering from a severe somatic disease postoperatively after TK or BK amputation, as compared with every third one following AK amputation.

Table 3 shows the correlation between age and severe somatic complications. As is demonstrated, the patients suffering from severe somatic complications were not significantly older.

The probability of death during hospitalization

Table 3. Somatic complications in relation to age

	Mean age	Range
Somatic complication	74	(50–93)
Local complication	69	(40–93)
Uneventful course	72	(40–93)

could be estimated according to age and level of amputation, by means of a multivariate logistic analysis (demonstrated in Figure 3). It is seen that the risk of death is related significantly to the level of the amputation ($P < 0.0005$), but also increases with age. A BK amputee of 85 years thus runs a 15 per cent risk of dying during hospitalization, whereas a TK amputee running an equivalent risk is 70 years of age and an AK amputee only 50.

The overall mortality after major amputation following gangrene of the lower limb is demonstrated by the life tables in Figure 4. The uppermost curve demonstrates the expected survival rate for a population cohort of the same age and sex as the present series, determined from data obtained from the Danish Central Bureau of Statistics. The lower, fully-drawn curve represents the total long-term survival rate of the amputees. In addition three further curves represent the life tables according to the primary level of amputation.

The statistical analysis revealed that long-term mortality was primarily dependent on the level of amputation ($P < 0.0005$) and secondarily on age ($P < 0.01$). The life tables clearly demonstrate that the highest mortality was related to the AK level and the lowest to the BK level, whereas mortality after TK amputation was on average midway between the other two levels.

It is noted from the graphs that the average

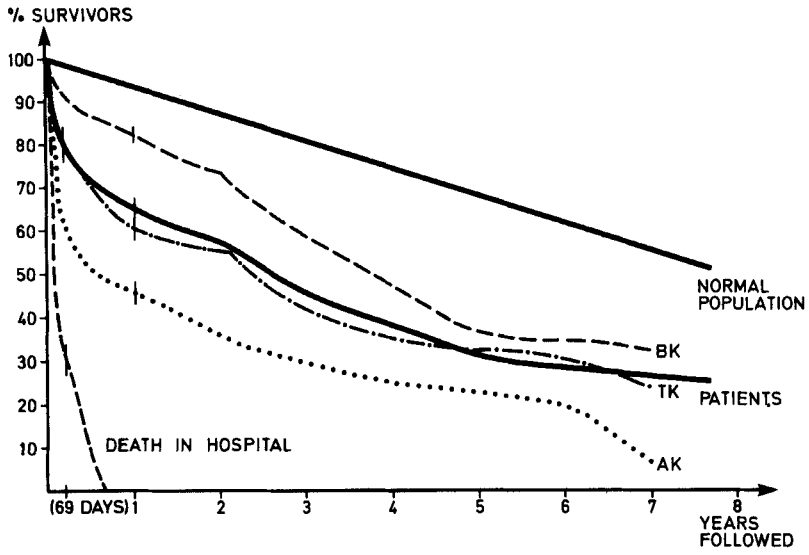


Figure 4. Life tables for 310 amputees.

curve runs parallel to that of the population cohort from the third to the fifth year, but after that time the amputees have a higher survival rate than the general population. It is also seen that the life table for AK amputees after an initial period of very high mortality already parallels that of the general population after 6 months, whereas the life table for TK amputees shows an excess mortality during the first year, as compared to 5 years after BK amputation.

After 1 year expected mortality was 6 per cent but was determined to be 34 per cent for the total patient series. After 1 year the mortality rate was 17 per cent following BK amputation, 39 per cent following TK and 54 per cent after AK amputation. After 3 years, 54 per cent of all the amputees had died; 31 per cent after BK, 58 per cent after TK and 70 per cent after AK amputation.

DISCUSSION

A number of authors (see Table 4) have described mortality after major amputation for gangrene of the lower limb as "in-hospital mortality" or "postoperative mortality", without defining the hospitalization time or postoperative period. In addition a comparison of these figures is made difficult by the variations in patient material as regards important determinants such as age, amputation level, aetiology of gangrene and occurrence of somatic complications. Thus "in-hospital mortality" ranges from 8 per cent (Chapman 1959) to 26 per cent (Kolind-Sørensen 1974).

In the present study the mortality rate during the stay in hospital was 18 per cent, and the average hospitalization time was 68 days. The risk of death during hospitalization was primarily determined by the occurrence of somatic complications. Somatic complications were mainly cardiopulmonary or cerebrovascular disease, as was found by Warren & Kihn (1968). Surprisingly, the occurrence of somatic complications did not

Table 4. "In-hospital mortality" after amputation on the lower limb

Authors	Mortality	Period of time
Boontje (1980)	19%	30 days
Kolind-Sørensen (1974)	26%	Not defined
Persson & Sunden (1974)	13%	Not defined
Lindholm (1964)	22%	Not defined
Chapman et al. (1959)	8%	154 days
Warren & Kihn (1968)	22%	77 days
Present study (1981)	18%	68 days

increase with age. The greater number of somatic complications was found for the proximal levels of amputation. This was probably due to the physiological effect of the more severe gangrene found in these patients.

For the calculations in this study the primary level of amputation was preferred to the final level. The final level of amputation is determined by the number of surgical failures and wound healing complications. The primary level is determined by the preoperative assessment of the leg and the condition of the patient as a whole, based on clinical evaluation and supported by skin perfusion pressure: the degree of local ischaemia reflects the general vascular disorder, and the gangrene affects the systemic health of the patient. Thus, in the case of gangrene of the lower limb, the preoperative choice of the level of amputation predicts the risk of somatic complications and also the risk of death. This explains why the risk of death after amputation on a patient at 70 years of age is 2.5 times higher when AK amputation has been performed, in comparison with BK amputation. It is not only a matter of the strain imposed by more extensive surgery, but rather one of the general preoperative condition of the patient. This relationship between hospital mortality and the level of the amputation was also found by Robinson (1976), and the relation between the level of amputation and somatic complications was discussed in detail by Hansson (1964).

Only a few papers have reported on long-term prognosis after major amputation of the lower limb. Table 5 summarizes the combined mortality rates presented by Hansson (1964), Christensen (1976), Ebskov & Josephsen (1980) and the present study. A 5–15 per cent lower mortality rate was noted in this series compared to that in the work by Christensen (1976) and Hansson (1964). Ebskov & Josephsen (1980) had remarkably low mortality rates, observing the highest risk of death (16.6 per cent) within the first 3 months postoperatively, after which the mortality rate was almost constant, tapering off to a total of 22.5 per cent after 4 years. Unfortunately, this comprehensive study did not distinguish between major and minor amputations, and no distribution of age or reason for amputation was presented. This makes any comparison meaningless.

The life tables presented in the papers mentioned in Table 5 reveal the same essential features: an initial very steep slope, representing a readily explainable high mortality rate during the first months following amputation, after which the curves run parallel to the survival curve of the control population and finally, after some years, actually converge towards the curve of expected mortality, representing in fact a lower mortality among the amputees. In the present series this lower mortality was noted after 5 years postoperatively, whereas Hansson (1964) and Christensen (1976) found that this occurred a few years earlier. Ebskov & Josephsen (1980), however, claimed that mortality was already lower after 6 months postoperatively. The same feature has been noted in other cohort studies of elderly patients following major extremity surgery, for example hip fractures treated with internal fixation (Jensen & Tøndevold 1979), and may be tentatively explained as the survival of the fittest.

The selection of the fittest is more pronounced after AK amputation than after BK or TK amputation, as can be seen from the life table. During the period from 2 to 5 years postoperatively the survival rate of the AK amputees parallels

Table 5. Mortality rates after amputation on the lower limb

Authors	Years postoperatively				
	1	2	3	4	5
Christensen (1976)	40%	55%	65%	70%	–
Ebskov & Josephsen (1980)	18%	19%	20%	23%	–
Hansson (1964)	45%	58%	71%	76%	80%
Present study (1981)	35%	43%	55%	60%	70%

that of the control population, whereas the BK and TK amputees have a slightly higher mortality rate during this period.

Statistical analysis revealed that the level of the amputation plays an equally important role as a determinant of long-term as well as short-term survival. The degree of local and systemic affection of the patient is indicated by the selection of the primary level, as discussed above, and this is more important than the age of the patient, with regard to the long-term survival rate as well.

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