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Perioperative and rehabilitation outcome after lower-limb amputation in elderly Chinese patients in Hong Kong

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ABSTRACT

Purpose. Major amputation of the lower limb is considered the last resort when limb salvage is impossible. The aim of this study is to determine the morbidity, mortality, and rehabilitation outcome of patients that underwent a lower-limb amputation.
Methods. A retrospective cohort study was conducted among 100 elderly patients who underwent a total of 120 lower-limb amputations in a regional hospital in Hong Kong from 1996 to 2001.
Results. The mean age of the amputees was 77.9 years; 58 were female. 95% of the amputations were performed because of infection with or without vascular compromise; 55 transfemoral and 60 transtibial amputations contributed 96% of the case mix. Some 43% of patients experienced early complications and 12% required re-amputation. The early (30-day) mortality rate was 15%. Only 55% of the amputees survived after 4 years. A 44% return-home rate was achieved. However, only 11% of the amputees could walk without help from other people. Although prostheses were issued to 42% of the survivors, compliance was only 53%; 24% of the survivors lost their remaining leg within 2 years.
Conclusion. The outcome of major lower-extremity amputation remains poor. Efforts should be made to retain these limbs. When it is proven impossible, one should strive to preserve the knee joint whenever feasible.

Key words: *amputation; Hong Kong; rehabilitation*

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INTRODUCTION

Therapeutic amputation has a history of more than 2500 years. In 500 BC, Hippocrates advocated amputation of infected limbs as a means of preserving lives. Supporting evidence came in the form of a 300 BC Roman leg prosthesis made of wood, bronze, and leather, which was unearthed in 1858.[1] Despite the long history of this surgery, the outlook for patients remains poor—namely, a high mortality rate,[2–4] frequent complications concerning stump healing,[5] and difficulty in rehabilitation.[6–9]

Knowledge of amputation outcomes can enhance our understanding of the optimal care that patients need. However, most studies have been based on patients in the western population and are outdated.[9] The aim of this study was to determine the early and late morbidity associated with amputation, the mortality rate, and the rehabilitative outcome of amputation among Hong Kong Chinese patients.

MATERIALS AND METHODS

In 1995, a dedicated multidisciplinary team was established at the Kwong Wah Hospital—a regional hospital serving 590 000 people—with the mission of providing holistic care. The team consisted of orthopaedic surgeons, physicians, community nurses, occupational therapists, physiotherapists, prosthetists, and medical social workers. In this retrospective cohort study, we retrieved and examined medical records of 100 consecutive elderly patients (those older than 65 years) who underwent amputations at or proximal to ankle level between 1996 and 2001 in the Kwong Wah Hospital.

The level of amputation was at the discretion of the attending surgeon under the supervision of a consultant. Primary transfemoral amputation was performed when extensive ischaemic necrosis or infection precluded transtibial amputation or when significant knee joint contracture was present. A long posterior flap was used in 95% (57/60) of transtibial amputations. A sagittal flap was used in the remaining 3 cases. Through-knee disarticulation made use of the sagittal flap as described by Kjoble,[12] whereas a fish-mouth coronal flap was used exclusively in amputations above the knee. Syme amputations were performed as depicted in *Campbell's Operative Orthopaedics*.[11] Depending on the rehabilitative potential and social function of patients, the clinician referred those amenable to the use of a prosthetic limb for a more detailed assessment unless obvious contra-indication was encountered. The final decision on who received a prosthetic limb was made jointly by orthopaedic surgeons, physiotherapists, and prosthetists.

For transfemoral or through-knee amputations, the prosthetic device consisted of a quadrilateral socket, a mechanical safety knee joint, and a solid ankle-cushion heel (SACH) foot. The suspension was by means of either a suction socket or a pelvic belt. Prosthesis for hip disarticulation had an similar structure but was mechanically self-suspended. For transtibial amputations, the prostheses featured a light patellar tendon-bearing (PTB) socket and an SACH foot. The suspension was either via mechanical self-suspension or a PTB belt. Syme amputees were fitted with a Syme prosthesis equipped with a Syme-type SACH foot.

Soon after the operation, the team approached the amputees. An in-depth interview with the patients and their care providers was then conducted. Information concerning patients' background was collected, including demographic data, indication for surgery, place of residence, mobility level, and Barthel score. Briefly, the Barthel score consists of 10 measures of self-care and mobility. The total score ranges from 0 to 100; a full score implies full functional independence but not necessarily a normal status.[10]

Six months after surgery, patients were once again contacted by telephone or home visit as a routine follow-up. In addition to providing a proactive service, the team documented the amputees' progress as to their place of residence, mobility level, use of a prosthesis (if issued), and Barthel scores. If mortality was the outcome, the date and cause of death were recorded.

Some patients had defaulted the 6-month follow-up. Therefore a cross-section follow-up was conducted in August 2001 by a telephone interview with the patients and their care providers (if available). When an amputee could not be contacted via telephone or mail, a home visit was arranged. If patients still could not be found, their names were checked against the death registry to determine their survival status.

Accuracy of data entry was validated by rechecking a 10% random sample of the crude data source. The error of data entry was estimated to be 0.2%. The Student *t* test, Chi squared test, and Fisher's exact test were used to test for significant differences between subgroups. Pearson's correlation coefficient was calculated to determine the correlation among variables. Reverse stepwise regression analysis was used to determine independent predictors of various outcomes. Regression models were assessed by goodness-of-fit. Life-table analysis and Kaplan-Meier survival curves were used to compute the expected survival rate. All tests were performed with the significance level set at p=0.05.

Table 1
The American Society of Anesthesiologists (ASA) score

ASA score	Amputations No. (%)
1	1 (1)
2	37 (31)
3	65 (54)
4	16 (13)

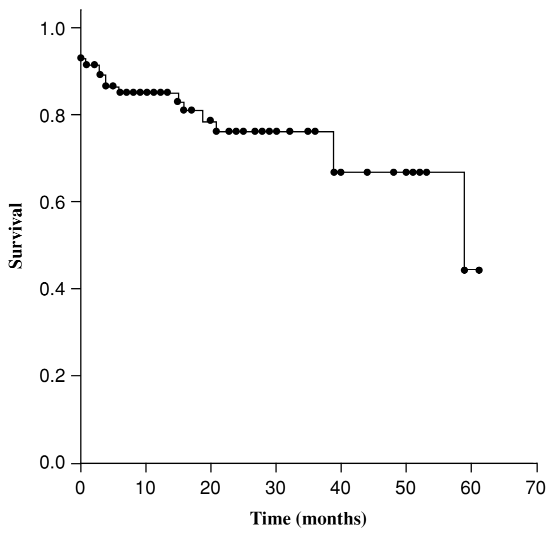

Figure 1 Kaplan-Meier survival curve for opposite lower limb after the index amputation.

RESULTS

From January 1996 to January 2001, 100 patients underwent 120 lower-limb amputations. The mean patient age was 77.9 years (range, 65.0–97.0 years). The mean age of the 58 female patients was 80 years, and that of the 42 male patients was younger, at 74 years.

Co-morbidity status

Of the patients, 66 had diabetes mellitus and 54 had peripheral vascular disease. Most of the patients had multiple chronic medical problems, with each having a mean of 3 disease entities. Two patients had up to 8 diseases diagnosed. The median American Society of Anesthesiologists (ASA) score was 3 (Table 1).

Indication for amputation

In most cases (95%), amputation was indicated because of infection with or without vascular compromise. Wet gangrene accounted for 72 (60%) amputations, whereas 36 (30%) amputations were because of infected ulcers, 3 (3%) because of chronic osteomyelitis of the tibia, another 3 (3%) because of failed bypass with acute lower-limb ischaemia, 2 (2%) because of necrotising fasciitis, and one because of septic arthritis of the ankle. The remaining 3 amputations were performed on trauma patients; 2 of these amputations were done in an acute setting and the third was performed because of symptomatic nonunion of the femur.

One knee disarticulation, 55 transfemoral, 60 transtibial, and 4 Syme amputations constituted the case mix. The left side was affected in 57 cases, whereas 63 cases involved the right side.

20 patients lost their contralateral lower limbs during the follow-up period, in a total of 1648 limb-months. The sex distribution of these patients was almost equal: 9 men and 11 women. Seven patients had both of their lower limbs amputated in a single session. For these patients, the mean interval between the amputations of the 2 legs was 10 months (range, 0–48 months).

The survival curve of the remaining leg is shown in Fig. 1. After 2 years, 24% of the survivors had their remaining leg amputated.

Duration of stay

The mean duration of stay in the hospital providing surgical intervention was 26.5 days. Patients without complications stayed for a mean of 19.5 days; in contrast, patients with postoperative complications required a longer hospitalisation, of 36.0 days.

Complications

51 (43%) amputations led to complications within 30 days after the operation; 27 (23%) amputations were followed by wound infection. A total of 14 (12%) cases required revision amputation because the wound failed to heal as a result of poor circulation or ongoing uncontrollable infection. Syme amputation carried a significant complication rate: of the total 4 Syme amputations performed, 3 required revision.

The breakdown for the causes of postoperative complications is shown in Table 2. 14 patients developed more than one type of complication. The occurrence of postoperative complications did not relate to the mean post-internship working experience of the patients' attending surgeons. The attending surgeons had a mean of 8.3 and 6.9 years of experience for surgeries with and without complications, respectively ($p=0.26$).

Table 2
30-Day postoperative complications

Complication	Episodes No. (%)
Wound infection	27 (23)
Wound dehiscence	13 (11)
Cardiac event	20 (17)
Gastro-intestinal bleeding	7 (6)
Septicaemia, excluding pneumonia	10 (8)
Chest infection	7 (6)
Cerebral vascular accident	2 (2)

Table 3
Causes of mortality

Cause	30-day mortality	1-year mortality	Total
Acute myocardial infarction	11	5	**16**
Pneumonia	4	8	**12**
Septicaemia	3	8	**11**
Cerebral vascular accident	0	2	**2**
Cancer	0	1	**1**
Gastro-intestinal bleeding	0	1	**1**
Unknown	0	14	**14**

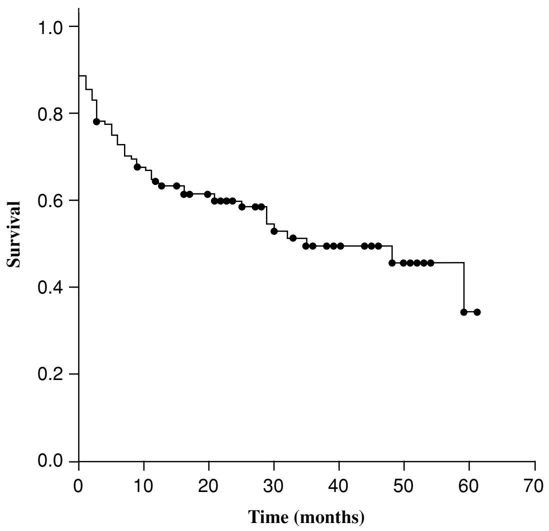

Figure 2 Kaplan-Meier survival curve for patient survival after lower limb amputation.

Mortality

The 30-day mortality rate was 15% (18 episodes). A total of 57 patients died during the follow-up period (representing 2462 person-months). Fatalities occurred at a mean interval of 9.3 months (range, 0–59 months). The survival curve is shown in Fig. 2. After one year, 63% of amputees survived. By the end of the fourth year, only 45% remained alive.

16 patients died because of a cardiac event, and 12 patients died of pneumonia. Septicaemia, excluding pneumonia, caused 11 deaths. Cerebrovascular accidents, cancer, and gastro-intestinal bleeding were uncommon causes of death and only contributed 4 cases in total. The remaining 14 patients died before arriving at the hospital and the postmortem examination was subsequently waived. Thus, their cause of death remained unknown (Table 3).

By using reverse stepwise regression analysis, we estimated that early (30-day) mortality was related to the presence of cardiac disease. Late mortality (at 1 year) could be predicted by poor preoperative walking ability, low Barthel score at 2 weeks before and 6 months after the operation, and not living at home at the sixth postoperative month (Table 4).

Rehabilitation outcome

Of 120 amputations, 67 (56%) cases lived in their homes before the operation, whereas only 37 (44%) of the 85 surviving cases could live with their families at the sixth month after surgery. Bilateral amputees had a much lower rate of returning home (20%) than unilateral amputees (49%). The level of amputation did not affect the likelihood of returning home after amputation.

Preoperatively, 43 (36%) cases could walk independently; 14 (12%) cases were dependent ambulators as defined by their constant need of assistance when walking. In all, 63 (53%) cases were either bed-bound or chair-bound. Postoperatively, only 11 independent ambulators could remain so, and 24 independent ambulators were downgraded to dependent ambulators, or being chair- or bed-bound. The remaining 8 patients died during the observed 6-month period. Among the dependent ambulators, only one retained the ability to ambulate (with the help from other people), whereas the remainder either died or became chair- or bed-bound. None of the bilateral amputees could walk after their second operation. Unexpectedly, 2 unilateral amputees were upgraded from dependent to independent ambulator status after the operation. Predictors for being a functional ambulator are shown in Table 5.

A total of 36 legs were referred for prosthesis fitting; 25 functional and 11 cosmetic prostheses were issued. Amputees equipped with functional prosthesis on average wore them 4.9 hours each day (range, 0–16 hours). Eight amputees admitted that they seldom used the prosthesis for walking. The situation was

Table 4
Prognostic factors for mortality determined by reverse stepwise regression analysis

Prognostic factor	Survival	Deceased
Early (30-day)		
No. with heart disease (%)	20 (24)	10 (56)
Late (1-year)		
Mean Barthel score 2 weeks before operation (SD)	54.5 (38.1)	29.6 (36.6)
No. independently ambulatory before operation (%)	31 (41)	12 (27)
Mean Barthel score at the sixth postoperative month (SD)	47.4 (36.1)	13.0 (20.0)
No. living at home at the sixth postoperative month (%)	33 (44)	4 (9)

Table 5
Predictors of ability to walk independently after amputation

Predictor	Independent ambulator (n=13)	Dependent ambulator/bed-bound/chair-bound (n=72)
No. of men (%)	10 (77)	24 (33)
Mean age (SD) [years]	73.8 (6.1)	78.3 (7.2)
No. able to walk independently before operation (%)	11 (85)	25 (35)
Mean Barthel score 2 weeks before operation (SD)	83.6 (21.2)	43.2 (38.1)
Mean Barthel score 2 weeks after operation (SD)	59.4 (15.0)	23.9 (21.5)
Mean Barthel score 6 months after operation (SD)	85.3 (14.9)	35.1 (32.9)
No. of amputations of right leg (%)	10 (77)	33 (46)
No. of below-knee and Syme amputations (%)	12 (92)	37 (51)
No. with one remaining leg (%)	13 (100)	45 (63)

more significant for cosmetic prosthesis. Nine of the 11 patients with cosmetic prosthesis would not wear it in their daily life. Of the 2 daily users, both wore their prosthesis for less than 2 hours per day when going out with a wheelchair.

The preoperative mean Barthel score was 44.7. At the sixth postoperative month, the mean Barthel score of the surviving amputees decreased to 25.0. Amputation caused a significant decrease in the mean Barthel score to 29.3 (from 48.5) and 18.0 (from 38.4) among unilateral transtibial and transfemoral amputees, respectively. The mean Barthel score for surviving bilateral amputees was only 16.8.

DISCUSSION

The loss of a limb represents a detrimental situation that not only affects patients' social function, but also causes a significant psychological morbidity.[1,13] The increase in their dependence also implies a significant financial burden both for families and the health care system.[14]

From the literature, it is apparent that despite a great advance in medicine during the past 3 decades, little has been achieved to lessen the morbidity and mortality associated with amputation, as well as the likelihood of contralateral limb loss, and to improve the rehabilitation outcome.[6] However, more transtibial amputation was performed instead of transfemoral amputation.[9]

The incidence of major lower extremity amputation in Hong Kong is 4.8 in 100 000 per year.[15] In comparison, the incidence in the West was 17 to 43 in 100 000 per year in the 1990s.[9,16,17] Although disease patterns between Caucasian and Chinese populations might be different, the substantially lower incidence among the latter might underestimate the local incidence of limb-threatening ischaemia and infection. It is a common clinical scenario that patients refuse amputation even when the affected limb is posing an imminent threat to life. This observation could be accounted for by the Chinese culture that imprints, "one should die with an integral body."

In western society, amputation is 12.3 to 15.0 times as likely to happen in patients with diabetes mellitus as it is in non-diabetic counterparts.[9,17] The prevalence of diabetes in Hong Kong has been reported as 6.3% to 16.1%, depending on the sampling method used.[18,19] This range suggests that Chinese patients with diabetes have a 4 to 10 times increased risk of major lower-limb amputation—a considerably lower, but yet still significant, risk compared with western patients.

Table 6
Crude death rate of general population, Hong Kong, 1999

Age (years)	Crude death rate (per 1000 per year)
50–54	2.91
55–59	5.32
60–64	8.82
65–69	14.21
70–74	24.06
75–79	39.00
80–84	61.06
≥85	102.06

In this study, amputation had no sex predilection. Consistent with other studies, our study found that women were older than men at the time of their operation.[6] This age difference may reflect a later onset or better control of arteriosclerosis or diabetes.[6]

Lower-limb amputation carries an increased likelihood of losing the contralateral limb. Nearly one quarter of survivors may lose their remaining legs within 2 years. In the first year, the incidence of contralateral limb loss according to our study was 14%, which is comparable to the incidence reported in other studies (12% to 33%).[6,9,20,21]

Multiple co-morbidities and high ASA score highlight the frailty of this special group of surgical patients. The most common postoperative complication was wound infection, affecting up to 23% of amputees; 12% of amputees were forced to undergo revision amputation. These findings are consistent with those of other studies, which show a 19% wound complication rate and a re-amputation rate of 5% to 22%.[6,9]

The duration of hospitalisation depends on clinical logistics, as well as support of the rehabilitation unit. Hospital stay also obviously correlates with the presence of a complication, which, however, is not associated with the experience of the attending surgeons. Our findings imply that the patient's condition is a major determinant of hospitalisation and treatment outcome.

The perioperative mortality has remained similar during the past 3 decades.[2,6,9] Most studies have reported the perioperative mortality to be in excess of 10%, with a cumulative mortality of approximately 50% in the third year after surgery.[2,6,9,20,21] Our findings are consistent with the results of these studies.

The crude death rate in Hong Kong was 4.97 per 1000 people per year in 1999.[22] However, it was age-specific and increased exponentially from age 50 years onwards (Table 6). Given that more than half of these amputees were older than 75 years, the death rate returned to that of age-matched individuals in the general population one year after surgery.

Elderly amputees are known to experience extra problems in locomotion and achieving independence.[23] Concomitant chronic illness, frail physical condition, concurrent disability arising from a cerebrovascular accident, parkinsonism, poor vision, and reduced learning capacity all pose hurdles that these amputees need to get over before they can regain their independence both in ambulation and self-care.

Social dependence can be reflected by the Barthel score.[10] However, in our case series, the mean score of survivors could not truly reflect the patients' impact, because, firstly, the operation selected fitter and more independent patients as potential survivors. Secondly, the distribution of Barthel score was skewed. Theoretically, patients who score a zero preoperatively can no longer use this scoring system to measure their dependency. Although the Barthel score is recommended as the gold standard for measuring rehabilitation outcome, it has been criticised that it was not developed specifically for amputees and that its 'ceiling effect' impairs its sensitivity.[23] Despite its shortcomings, the Barthel system gave us an unequivocal impression that amputation significantly downgraded the social function of these already compromised patients. A handful of transtibial amputees showed a gain in Barthel score after surgery. However, we failed to identify any prognostic factor predicting this favourable outcome. We were uncertain whether the removal of the affected limbs or the aggressive rehabilitation enhanced the potential of these patients.

Only 44% of patients could return to their homes 6 months postoperatively. Bilateral amputees had a much lower rate of returning home in contrast to unilateral cases. This finding reiterated the great impact of the surgery on the patient as a whole.

In the western literature the return-to-home rate was as high as 93%.[9] Compared with findings from the West, the impact of amputation on institutionalising amputees was more significant. The crowded environment of multi-storey buildings in Hong Kong reduces the feasibility of home modification. Families of small size and long working hours mean that these patients are probably lacking care. The amount of government support has also contributed to the lack of attendance on these patients.[9]

Only 13 of 85 (15%) surviving amputees could walk independently; 59% of surviving patients were rendered bed- or chair-bound 6 months after the operation. Similar results were reported by a study in Singapore in 2000.[6] That study claimed that up to 72%

of amputees are not able to walk about in their community. Other studies have stated that the proportion of successful prosthetic users is as high as 96%. However, the samples studied are not comparable and, most of the time, they were positively selected.[9] In agreement with other articles,[6,8,9,24] this study identified a list of self-explanatory predictors for an independent walker after amputation.

We reported the prosthesis usage rate as 18% and 68% for cosmetic and functional prosthesis, respectively. In the western literature, the rate of regular use of a prosthesis is about 40% to 70%.[9,13,14,25,26] One study reported an exceptionally high prosthetic use rate, claiming up to 96% of amputees were community ambulators after the establishment of a multidisciplinary amputee rehabilitation programme. However, regardless of selection bias, that figure remains to be a target rather than the benchmark.[9]

It is frustrating to know that amputees has not benefited from advances in medicine. Although a dedicated multidisciplinary rehabilitation team with experienced personnel remains indispensable, bringing improvement to all amputees is still an unrealistic goal. Measures to prevent amputation or amputating at a more distal site, and individualising rehabilitation goals early after the operation might be the panacea of the present situation.

CONCLUSION

Successful rehabilitation and long-term survival remain uncommon for elderly amputees. Aggressive limb salvage and amputating at a more distal level may improve the outcome. When amputation is performed to save lives and prevent suffering, individualised speedy rehabilitation and resource mobilisation should be the goal of the dedicated multidisciplinary team.

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