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Long-term Outcome Following Thrombembolectomy in the Upper Extremity

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Objectives. *To evaluate short- and long-term mortality and morbidity in patients that were treated for acute upper extremity ischemia.*
Design. *Single center retrospective study.*
Patients. *A consecutive series of 148 patients who were admitted with a diagnosis of acute ischemia of the upper extremity during an 11-year period.*
Methods. *All charts were reviewed retrospectively and 96% of all survivors participated in clinical follow-up.*
Results. *The median age was 78 years and 64% of patients were females. The 30-day mortality was 8% and the overall 5-year survival 37%. The observed mortality during the follow-up period was significantly higher than expected. Survival was not significantly different in patients who received anticoagulant drugs following discharge from the hospital. The duration of ischemia did not significantly influence long-term arm-function.*
Conclusions. *Acute embolic episodes in the upper extremity primarily occur in elderly and the peri-operative mortality is high. Mortality following discharge from the hospital remains significantly higher than that of the background population.*

Keywords: Upper extremity; Arterial occlusion; Embolectomy; Outcome.

Introduction

Acute arterial occlusions in the upper extremity are rare compared with the lower extremity.[1] It is almost always caused by an embolus and is best treated by embolectomy with a balloon catheter as soon as possible.[1] Numerous follow-up studies have been published regarding embolectomy in the lower extremity. Few reports have focused on the upper extremity[2–9] and most of these only present short-term outcome.[2–6] It is well known that most emboli in the upper extremity occur in elderly and peri-operative mortality is high following embolectomy.[1] However, it is not clear whether mortality following discharge from the hospital remains higher compared with the background population. These findings prompted us to initiate a clinical follow-up study to investigate both short- and long-term mortality and morbidity in patients who were treated for acute upper extremity ischemia.

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Material and Methods

'Karbase' is a national database which holds information on patients who have been treated at Danish departments of vascular surgery.[10] We used this database to identify patients who were admitted to our department with a diagnosis of acute ischemia of the upper extremity during an 11-year period (September 1991–December 2002). Arterial trauma, mainly from cardiac catheterization, was not included because we considered this an entirely different patient population.

All hospital records were retrieved and the following data recorded: (1) approximate time of symptom onset (established to the nearest hour before surgery), (2) medical history, (3) smoking habits, (4) medications, (5) findings at physical examination upon admission, (6) operative findings, (7) post-operative course and (8) medications at discharge from the hospital.

In those patients who died during the follow-up period (1991–2003) the various causes of death were established from the official death-certificates that were retrieved along with autopsy reports when

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available. Survival curves were estimated by the product limit method using the Kaplan–Meier procedure implemented in the SPSS 10.1 statistical software package. Survival was calculated from the time of surgery. The observed mortality during the follow-up period was compared with the expected mortality in a sex- and age-matched background population. Firstly, the number of years that sex- and age-matched patients would have lived through corresponding calendar years was calculated. Secondly, for each calendar-year, the number of accumulated patient-years were multiplied with the corresponding mortality rates, provided by the national service Danish Statistics (www.dst.dk) giving the expected mortality. Finally, the Score-test statistic $S=(O-E)^2/E$ was calculated. This statistic tests the probability of equal mortality between patients and the background population and follows a Chi-square distribution with one degree of freedom.[11] *P*-values less than 0.05 were considered statistically significant.

All survivors, except two patients who were amputated, were invited to participate in a clinical follow up. One patient refused to participate but the remaining ($n=68$) were examined by the same investigator with particular attention to pulse deficits, motor power, and diminished sensation. The arm-function was assessed by history and examination and recorded as normal, slightly decreased or severely decreased.

Surgical technique

Once a diagnosis of acute arterial obstruction of the upper extremity was made all patients underwent immediate surgical exploration under local anaesthesia. An S-shaped incision was made in the antecubital fossa for easy identification of the brachial, radial and ulnar artery. A transverse incision in the brachial artery was used and a balloon catheter was introduced for selective thrombo-embolectomy in each of the three vessels. If the surgeon was not satisfied with the arterial run-off intra-arterial thrombolysis was performed. Before 1999 we used up to three bolus injections of Streptokinase (25.000 units each) but after 1999 we have used Actilysis (5–10 mg). If the surgeon suspected thrombosis because of local arteriosclerosis as the main cause of acute ischemia the artery was reconstructed with a vein patch. None of our patients received heparin pre-operatively but all received low molecular weight heparin post-operatively (40 mg enoxaparin daily for 5 days).

Results

We identified a total of 148 consecutive patients who were admitted to our department with a diagnosis of acute ischemia of the upper extremity. The median age of our patients was 78 years (range 27–93) and 94 patients were females (64%). The diagnosis of acute arterial occlusion in the upper extremity was made solely on the patient history and a physical examination in 130 patients (88%). In the remaining 18 patients additional angiography was used in 17 and one underwent ultrasound examination. The duration of ischemia before surgery (from 147 available patient charts) was less than 12 h in 72 patients (49%), between 12–24 h in 37 (25%), and more than 24 h in 38 patients (26%). All patients presented with unilateral coldness of the upper extremity without radial pulse and at least one of the following: restpain (52%), paresthesia (30%) or some degrees of paralysis (26%). The site of the lesion was in the right upper extremity in 90 patients (61%). Nine patients suffered from diabetes and 23 had a history of cerebral stroke. An embolus originating from the heart was assumed to be the reason for ischemia in 90 cases (61%), i.e. 75 patients (51%) suffered from atrial fibrillation, nine patients (6%) had valvular heart disease and six patients (4%) had isolated ischemic heart disease. Local thrombosis in the brachial artery was identified in four patients (3%) one of whom also had a subclavian artery aneurysm diagnosed at angiography. In the remaining 54 patients (37%) the etiology was unknown.

At the time of diagnosis 49 patients (33%) received acetylisalicylic acid and eight patients (5%) were on coumarins. Smoking habits were available from 108 patient charts (73%): Of these 60 patients were non-smokers (56%), 38 were smokers (35%), and 10 were previous smokers (9%).

A review of the patient charts did not allow us to determine the exact anatomic site of the occlusion but at the operation a thrombo-embolus was recovered in all patients. Surgery consisted of simple embolectomy with a balloon catheter in 138 patients (93%). In addition five patients underwent embolectomy and local reconstruction of the brachial artery and another five patients received intra-operative intra-arterial Streptokinase/Actilyse. The pulse was restored in the radial artery in 133 patients (90%) and the in ulnar artery in 85 patients (57%). According to the surgical note a satisfactory result was achieved in 134 cases (91%). Seven patients underwent re-embolectomy during the hospital stay. Five of these had a successful outcome but amputation was necessary in two. At the time of discharge from the hospital 74 patients (50%) were treated with acetylicsalicylic acid, 40 patients

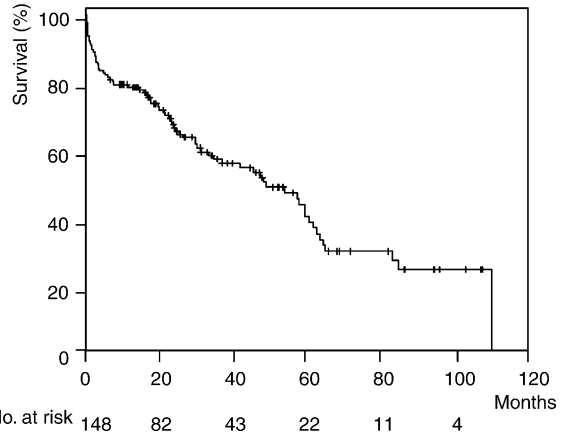

Fig. 1. Kaplan–Meyer survival curve of all patients who were admitted with acute ischemia of the upper extremity.

(27%) received coumarin and five patients (3%) received both.

The 30-day mortality was 9% (14 patients). Four patients died from cardiovascular failure, four from respiratory failure, three suffered a stroke, two had a major gastrointestinal bleeding episode and one died from tumour cachexia. During the follow-up period 77 patients (52%) died. The survival curve for all patients is shown in Fig. 1. The overall 2-year survival was 64%, 3-year survival was 54% and 5-year survival was 37%. We found no significant difference in survival between patients who did or did not receive any of the two methods of anticoagulation following discharge: Log-rank = 0.27 ($p = 0.61$). Likewise, there was no significant difference in survival when acetylisalicylic acid or coumarins were analysed separately. Finally, we did not discover any significant difference in survival between patients who did or did not have a palpable radial pulse post-operatively: logrank = 0.07 ($p = 0.79$).

Sixty-eight survivors participated in a follow-up examination after a median follow-up time of 29 months (range 7–108). At follow-up the radial pulse was palpable in 63 patients (93%) and the ulnar pulse was palpable in 37 patients (54%). Fifty-seven patients had a normal arm-function (84%). Nine patients (13%) had a slightly decreased arm-function and two patients (3%) a severely decreased arm-function. The relationship between arm-function and duration of ischemia is shown in Table 1. There was no significant statistical difference between the three time intervals: Chi-square = 3.9 ($p = 0.42$). Similarly, there was no statistically significant relationship between the arm-function and presence of neurological deficits before operation: Chi-square = 4.22 ($p = 0.12$). One patient underwent amputation of his second and fourth finger post-operatively. Another patient had a post-operative ischemic contracture of three fingers even though his arm was revascularized before 12 h. Both patients had a palpable radial pulse at follow-up

The 63 patients who died after 30 days were used for comparison of the long-term observed and expected mortality. The number of accumulated patient years in a sex- and age-matched background population multiplied with the corresponding death rates resulted in an expected mortality of 23 patients. Thus, $S = (O - E)^2/E = 76.7$ ($p < 0.001$) indicating a significantly higher observed mortality. The best estimate of increased mortality in our patients is $O/E = 2.8$.[11]

Discussion

Numerous studies of acute arterial occlusion in the lower extremity have been carried out but long-term follow-up studies are limited in the upper extremities. In an excellent review of the literature Eyers and Earnshaw found that acute arm ischemia accounts for a mean of 17% (7–32%) of cases of acute ischemia of the limbs.[1] Our study confirms that acute upper extremity ischemia due to emboli is rare accounting for 1% of all admissions or 7% of all acute admissions to our department during the study period.

Most studies attribute the cause of embolism to associated cardiac conditions but often they cannot be confirmed pathologically.[1] The majority use the following criteria for embolism: sudden clinical presentation, absence of peripheral arteriosclerosis and removal of discrete 'clot' at operation. Our study demonstrates that the diagnosis is relatively easy based on patient history and clinical findings alone in 88%. Arteriography was rarely needed in agreement with most previous reports.

Table 1. The relationship between arm-function and duration of ischemia (147 available patient charts)

	Armfunction			Total
	Normal armfunction	Slightly decreased armfunction	Severely decreased armfunction	
Less than 12 h	33 (87%)	4 (11%)	1 (2%)	38
12–24 h	13 (93%)	1 (7%)		14
More than 24 h	11 (69%)	4 (25%)	1 (6%)	16
Total	57 (84%)	9 (13%)	2 (3%)	68

Throughout the literature it is generally agreed that prompt operative intervention is the single most important determinant of a successful outcome. In a study of patients with arterial embolization Abbott found that patients whose treatment began less than 12 h after onset had a higher limb salvage and a lower mortality when compared with patients whose treatment began after more than 12 h.[12] Similarly, in patients who suffered from arterial embolization in general, mainly in the lower extremity, Elliot found that within the range of 8 h to 7 days the effect of delayed treatment had a linear relationship to severity of ischemic changes and unfavourable results.[13] In contrast, some reports claim that the duration of the symptoms before embolectomy in general does not have a significant effect on the mortality,[14,15] and one study which focused on the upper extremity reported that late embolectomy was successful.[7] In our department we always operate on patients acutely to minimise the duration of ischemia and, thus, the risk of compromised arm function. Nevertheless 26% of our patients were treated more than 24 h after the onset of symptoms and, at least among the survivors, the time interval between symptom onset and revascularization did not significantly influence the long-term result as measured by arm-function. Only two of the surviving patients suffered from severely reduced arm-function. One was revascularized before 12 h and the other after 24 h. Thus, we believe that the time interval *per se* is not a contraindication for surgery and we only consider the extremity out of therapeutic reach if the patient presents with a rigid limb indicating irreversible ischemia. Such limbs were not encountered in the upper extremity during the study period. It may be argued that analysis of the length of ischaemia and arm function does not take into account the severity of ischaemia. Thus, patients who presented after 24 h may have had less severe arm ischaemia than those who presented earlier because of the pain. However, one would expect that patients with severe ischaemia presented with neurological deficits and our study fail to detect any statistically significant difference in arm function between patients who did or did not have neurological deficits before surgery.

Acute embolic episodes in the upper extremity predominantly occur in the elderly.[1] The median age of our patients was 78 years. It is well known that early mortality is high in these patients and that older patients have a higher mortality.[15–17] Despite a seemingly small surgical procedure under local anaesthesia the 30-day mortality in our study was 9%. Previous studies in the upper extremity have reported a 30-day mortality up to 19% following embolectomy.[5] As demonstrated in Table 2 the most common causes of death in our patients were cardiovascular or cerebrovascular events.[1] In addition to the high peri-operative mortality our results demonstrate that patients continue to have a higher mortality compared with the background population following discharge from the hospital. The observed mortality was 2.8 times higher than expected. While several papers on arterial embolization in general, predominately in the lower extremity, have demonstrated an increased long-term mortality,[13,18] it appears that this is the first study focussing on the upper extremity which demonstrates an increased long-term mortality.

Table 2. The cause of death in the 77 patients who died during the follow-up period

	N
Cardiovascular	25 (32)
Cerebrovascular	17 (22%)
Respiratory	10 (13%)
Gastrointestinal bleeding	3 (4%)
Ruptured AAA	2 (3%)
Malignancy	6 (8%)
Intestinal ischemia	2 (3%)
Renal insufficiency	1 (1%)
Pulmonary emboli	1 (1%)
Suicide	1 (1%)
Unknown	9 (12%)
Total	77 (100%)

The peri- and post-operative mortality of patients undergoing embolectomy in general may be reduced by anticoagulant treatment [13,16,19] and it appears that the long-term functional results may also be improved by anticoagulants.[13,16] Only 50, 27 and 3% of our patients were discharged with acetylisalicylic acid, coumarins, or both, respectively, a practice we have changed. In the last 2 years all patients were discharged with acetylisalicylic acid and those who suffered from atrial fibrillation also received coumarins. Nevertheless, our results fail to demonstrate any significant difference in survival between patients who did or did not receive anticoagulants. This finding contrasts with results from another report which focused on the upper extremity.[19] We have no obvious explanation for it. Theoretically, it could be a consequence of low compliance in patients who received anticoagulants but we believe this is unlikely.

Failure to restore the radial pulse has been regarded as a strong indicator of poor outcome.[20] Our results fail to confirm this finding as there was no significant difference in survival between patients who did or did not have the radial pulse restored at the operation. One possible explanation may be found in a literature review which states that occlusion of a major artery in the upper extremity is better tolerated than it is in the

lower limb, possibly because the potential for the development of a collateral circulation is better, but also because the bulk and work rate of the muscles of the arm are considerably less than those of the leg.[5]

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