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Time-trends in Vascular Access Surgery in Sweden 1987–2006

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Abstract *Objective:* To study time-trends in vascular access surgery.
Design: Prospectively registered data.
Material and methods: The Swedish vascular registry (Swedvasc) was searched for haemodialysis access operations (HAO) 1987–2006.
Results: 12,342 open and endovascular operations were identified. Eighty-five percent of HAO 2004–2006 were reported to the registry. The median age of patients having their first HAO increased from 56 to 68 during the first decade ($p < 0.0001$), then remained stable. The frequency of diabetes increased from 12% in 1987 to 32% in 2006 ($p < 0.0001$). The percentage of first HAO of total workload decreased from 76% to 48%. The percentage of first HAO performed as vein fistulas remained unchanged. The number of patients recorded for ten or more previous HAO increased over time. Percutaneous angioplasties increased during the last decade.

Of 4706 patients operated on with primary radiocephalic AV-fistulas, 2933 (62%) were operated only once. Analysis of 3739 subsequent operations in 1773 patients disclosed that at the tenth operation vein was still used in 54%. With an increasing number of operations, arterial inflow shifted towards a more proximal position.
Conclusions: Over time, the patients undergoing HAO became older and more often diabetic, reoperations increased. Despite these circumstances, vascular surgeons perform AV-fistulas without grafts in most patients.

Introduction

Haemodialysis access operations (HAO) have always been a slightly problematic area of the Swedvasc registry from

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the start in 1987. It was decided early on to restrict the follow-up in these operations to one month owing to the great number of reoperations. Moreover, patency alone is not necessarily a meaningful endpoint in this field since an access that is patent but not usable for haemodialysis is a failure. The general design of the registry makes it suitable for the study of outcome of individual vascular operations but it was not primarily designed to follow chronic patients who will undergo a series of operations. However, the unique personal identity code (PIN) of each Swedish citizen, that is also registered in the Swedvasc, makes it perfectly possible to identify each patient and the series of vascular surgical procedures performed on that very patient. The PIN facilitates reporting and follow-up, that is sometimes difficult if patients are operated on at larger hospitals but receive their haemodialysis treatment at smaller dialysis centres, or at home.

A review of time-trends of vascular access surgery during the first ten years of the registry has been published.[1] The aim of this study was to identify the continuing demographic changes in Swedish vascular access surgery patients and to identify time-trends in surgical decision-making over the studied 20-year period, with special emphasis on decision-making for secondary and subsequent HAO.

Materials and Methods

The analysis is based on 12,342 open and endovascular operations for haemodialysis access registered 1987–2006 in Swedvasc. Neither surgical insertions of permanent dialysis catheters, nor of peritoneal dialysis catheters, have been registered.

Primary operation was defined as the first HAO registered for a patient, all subsequent HAO were denoted reoperations.

From 1987 the number of Swedish vascular surgery departments reporting to Swedvasc gradually increased and from 1994 all reported. The number of access operations reported to Swedish Hospital Discharge Registry (SHDR, used for reimbursements) 2004–2006 was extracted and compared to the number reported to Swedvasc for validation purposes.

In a sub-group analysis 4706 patients operated on with a primary radiocephalic Brescia fistula were studied over time to analyse time-trends in surgical decision-making regarding secondary and subsequent HAO. Survival in this group was monitored by cross-matching with the Swedish Population registry. Thus, survival is not reported by the surgeons performing the HAO, but data is retrieved from the Population registry, and added to the Swedvasc Registry every week.

Individual patient survival was calculated from the patient's first registered procedure until the end of follow-up or until the date of death, which, according to law, is always recorded by the National Population Registry within three weeks. The Kaplan–Meier method was used and survival distributions were compared by the Mantel–Cox log rank test. The version 15 of the SPSS statistical package was used for all calculations (χ^2 for trend and ANOVA).

Results

Validation

The Swedvasc registry for 2004–2006 contained 85% of the HAO reported to the SHDR from departments of nephrology, vascular and general surgery. Four transplantation units performing HAO, not participating in the Swedvasc, were excluded from this comparison.

Demographic changes

During the first and second decades 3352 vs. 8990 operations were registered, an increase which mainly reflects the inclusion of more vascular centres in the registry. The number of operations has been virtually constant around 900 per annum during the last ten years, equal to one HAO per 10,000 person years. This is, however, an underestimation, since four transplantation units performing some HAO do not participate in the Registry, and the vascular surgical units only report 85% of their procedures. We estimate the true incidence of HAO to be in the interval 1.3–1.5/10,000 person years. The male/female ratio of the patients was 63%/37%. This gender distribution is equal to that reported from the Swedish Nephrology Registry.[2]

The median age of patients and the presence of diabetes was studied at the time when the first vascular access operation was reported to the registry. The age increased during the first decade ($p < 0.0001$), during the second decade age remained unchanged, Fig. 1. The frequency of diabetes increased over the entire 20-year period ($p < 0.0001$), a trend that was even more pronounced during the later years, Fig. 2.

Operations

The proportion of primary HAO performed, of the entire workload, decreased with time, from 76% of registered operations in 1987 to 48% in 2006, $p = 0.00027$, Fig. 3.

In 81.3% of the primary, and in 71.2% of the secondary operations, vein fistulas were constructed, Fig. 4. The percentage of vein fistulas dropped during the middle of the 20-year period and increased again during the end of the period. In graft fistulas the material was almost exclusively ePTFE.

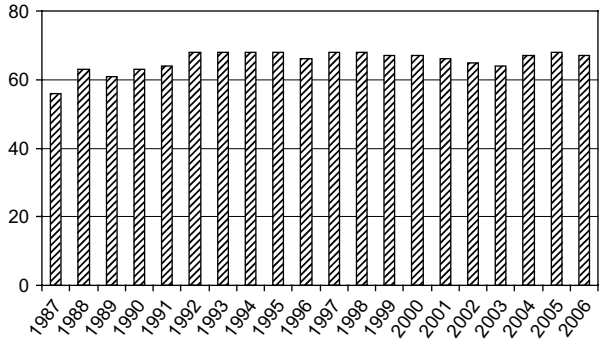

Figure 1 Median age at the time of the primary operation, per procedural year.

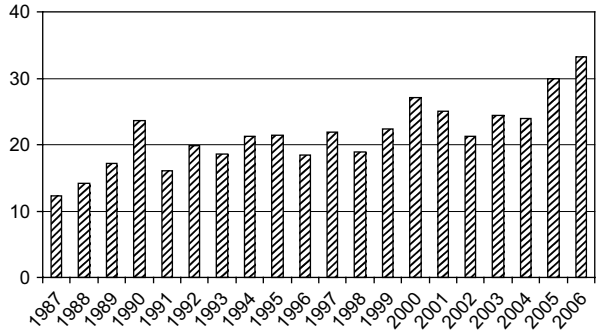

Figure 2 Percentage of diabetes among patients undergoing a primary operation, per procedural year.

In 1993 the first patients were registered as having their tenth vascular access operation since the registry started in 1987, and the annual number of patients of this category has been steadily increasing as shown in Fig. 5.

Percutaneous angioplasties were very infrequent reoperations during the first decade but have increased considerably during the last decade, from 3% in 1997 to 17% of the total number of HAO in 2006.

Primary radiocephalic fistulas

In 4706 patients a radiocephalic fistula was reported as the primary HAO to the Registry, 3709 of these operations had been done after 1994, with a follow-up of at least one year. Sixty-nine percent of the patients were male and 80% of the fistulas were left-sided. 2933 patients (62%) had no recorded reoperation, the remaining 1773 had undergone a total of 3739 reoperations (range 1—26 reoperations). The use of autogenous vein declined with increasing number of reoperations from 73% at the first reoperation to 60% at the fifth as depicted in Fig. 6, but still at the 10th reoperation was an autogenous vein used more frequently than a synthetic graft (54%).

With an increasing number of reoperations the use of inflow artery shifted, by the second reoperation on the left side and the third reoperation on the right side the brachial artery was used more frequently than the radial artery.

Survival was decreased among patients with diabetes, compared to non-diabetic patients ($p = 0.00034$). Fifty percent of the diabetic patients were alive after 3.2 years compared to 4.5 years for the non-diabetic patients, Fig. 7.

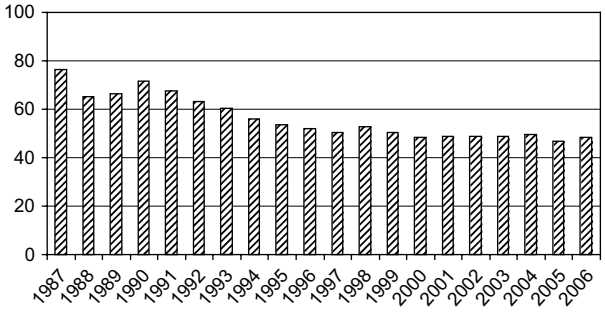

Figure 3 Percentage of primary access operations, per procedural year.

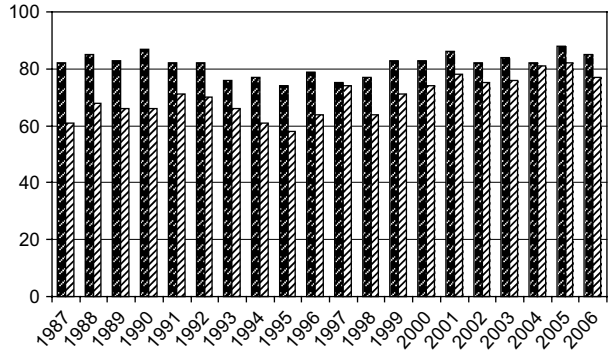

Figure 4 Percentage of vein fistulas at primary (dark shaded) and secondary (light shaded) operations, per procedural year. Redo procedures such as thrombectomy, PTA and thrombolysis were excluded from this analysis.

The difference in survival was restricted to the first three years after the first HAO, with diverging survival curves. The long-term survival between three and ten years was identical, however, with parallel curves, Fig. 7.

Discussion

The reporting of access surgery in Swedvasc is less complete than other types of vascular surgery. The number of HAO in Swedvasc was only 85 percent of the number reported to the SHDR, but there may be some overestimation in the latter figures due to operations being reported twice, both by nephrology departments and by vascular surgeons. The major reason for the discrepancy is probably poor reporting by some busy vascular centres and by the three centres involved in developing a new specific access registry (vide infra). The four transplantation centres in Sweden perform HAO without reporting to the registry although their number of annual HAO is much smaller than that performed by vascular surgeons. In any case the number of HAO is low in relation to the number of patients treated by chronic haemodialysis in Sweden, which by the end of 2006 amounted to 2775 patients.[3] Unfortunately a large proportion of these are treated by indwelling central dialysis catheters. According to statistics from the Swedish Nephrology Association no less than 33 percent of the Swedish haemodialysis patients were being dialysed using catheters by the end of 2006.[3] This may also

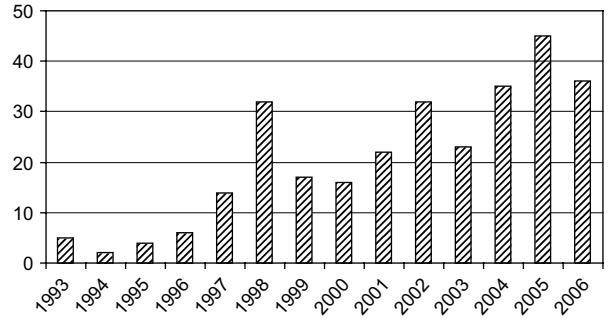

Figure 5 Number of patients reoperated on ten times or more, per procedural year.

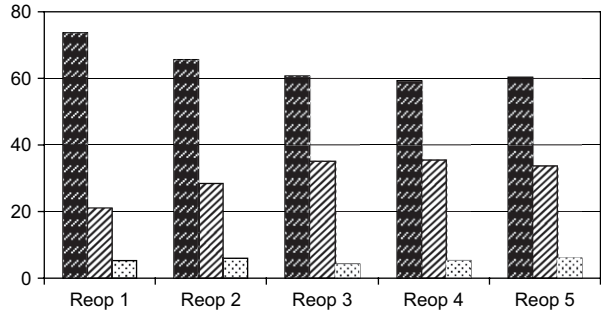

Figure 6 Percentage of AV-fistulas reoperated with the use of vein (black), synthetic graft (dark shaded) or other techniques (light shaded) at reoperation 1—5 after primary radiocephalic AV-fistulas in 4706 patients.

contribute to the number of operations reported being small in relation to the number of haemodialysis patients and the well-known need for frequent revisions of AV-accesses.

Despite the fact that this registry is not complete regarding access surgery, report rates were stable over time, and the time-trends in surgical decision-making can be analyzed with confidence. Access surgery for haemodialysis in Sweden is performed on older patients today than twenty years ago. The trend towards operating on ever older patients was most pronounced during the first decade, and then levelled off. Consequently, increasing technical problems are likely to be encountered due to more advanced arteriosclerosis and poorer vein quality. Furthermore, diabetes is becoming increasingly common, the proportion of diabetics increased through the entire 20 years studied from 12% in 1987 to 33% in 2006, an observation in accordance with the Swedish Nephrology Registry.[2] This will increase the need for reoperations since diabetes has been shown to increase the failure rate in previous studies.[4,5]

During the studied period the use of vein fistulas varied between 74 and 87 percent in primary and 58 and 82 percent in secondary operations (Fig. 4). The use of synthetic grafts was always higher in secondary than in primary operations, as could be expected. There is a slow drop in the use of vein

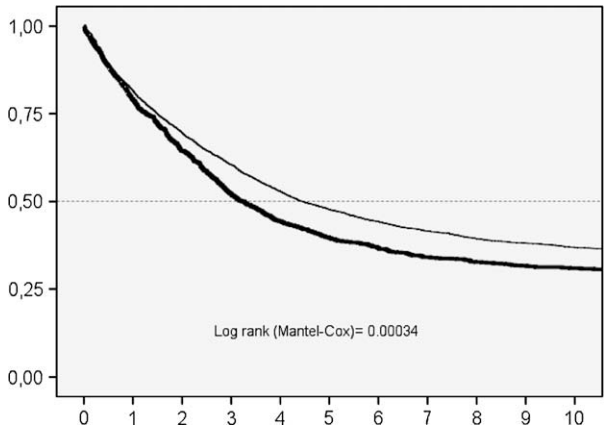

Figure 7 Influence of diabetes on the survival of 4706 patients operated on with primary radiocephalic AV-fistulas. Diabetics (heavy line), non-diabetics (thin line).

fistulas from 1990 to 1995, followed by an increase in the next decade, which probably reflects increasing knowledge of the superiority of vein fistulas as pointed out in the DOQI guidelines that were published first in 1997.[6]

Balloon angioplasty (PTA) of malfunctioning accesses has become a frequent procedure only during the last decade. This method has caught on much slower in this area than in other types of vascular surgery, the reason may be the short duration of improvement after PTA, as well as the fact that patch angioplasty of these stenoses usually is easily accomplished.

Follow-up of the patients with primary radiocephalic fistulas showed that 62% had no recorded reoperation. Although the percentage of reoperations using autogenous vein slowly declined with the increasing number of reoperations, it is evident that great efforts were made to use vein, illustrated by the finding that even at the 10th reoperation an autogenous vein was still used more frequently than a synthetic graft. With an increasing number of reoperations arterial inflow shifted towards a more proximal position, as could be expected.

Survival can be monitored exactly and infinitely, thanks to the Swedish unique identity code, and the cross-matching with the Population registry. Survival was decreased among patients with diabetes during the first three years after the primary HAO, but interestingly there was no difference in long-term survival after three years. We have no explanation for this observation which merits further investigation.

The fact that the Swedvasc registry was not well designed for HAO has prompted the development of a new specific vascular access registry, which is now being launched in the three centres where it was developed, and later will probably have a national coverage. This registry follows the patient and all types of accesses are being recorded which will give valuable information on the use of indwelling catheters, peritoneal dialysis, as well as HAO so that registration of which type of access that is being used will be more complete. Haemodialysis nurses run the registry which will improve follow-up, reduce the workload of the vascular surgeons, as well as most likely make registration more complete.

In conclusion, it appears that more and more of these operations are performed as redo operations on older patients who are more often diabetic. The percentage of primary operations decreased from 76% to 48% during the study period. Access surgery in Sweden is increasingly directed towards patching, mending and ballooning already existing AV-fistulas, which may also reflect the increasing age and the poorer general vascular status of this patient group. This is in accordance with the findings of the DOPPS II study.[7] Another factor that has increased the redo procedures is the routine of flow-measurements, that has become standard in most Swedish dialysis units in later years, identifying the stenoses before the access thromboses.

Conflict of Interest

None of the authors have had any financial relationships that could influence this study. We have received no financial support or grant for this work.

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