Mortality in Abdominal Aortic Aneurysm Surgery – The Effect of Hospital Volume, Patient Mix and Surgeon’s Case Load

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Objective: Assessment of mortality in abdominal aortic aneurysm surgery.

Design: A 4-year cross sectional study based on a nationwide vascular registry: Finnvasc.

Material and Methods: A total of 17,465 vascular interventions included 929 elective repairs for abdominal aortic aneurysms (AAA), and 610 emergency cases with 454 ruptures. Fifty-three percent of the operations were done in university hospitals, 44% in central hospitals and 3% in district hospitals.

Results: The 30-day mortality rate for AAA repair was 5.1% in elective and 46% in ruptured cases. A clear dependence of operative mortality on surgeon’s experience in AAA surgery was observed, both regarding the surgeon’s total vascular case load (p<0.01) and the number of operated elective aneurysms (p<0.01), but not the number of operated ruptured aneurysms. However, no association was found between hospital volume and mortality in AAA surgery.

Conclusions: Vascular surgical experience clearly improves the results of elective aneurysm surgery.

Key Words: Abdominal aortic aneurysm; Centralisation; Hospital volume; Mortality; Surgical experience.

Introduction

The incidence of abdominal aortic aneurysm (AAA) is increasing. This increase may be associated with the rising median age of the population along with a rise in cigarette consumption. Despite increasing number of elective operations, the incidence of ruptured AAA is also on the increase. Because elective aortic repair is often performed on asymptomatic patients, it must carry a low mortality and morbidity. Over the past few years the need for quality assurance in vascular surgery has been emphasised, the ultimate purpose of quality assurance systems being to ensure a high quality of care with acceptable results. An acceptable level of care is hard to define except in terms of outcome, such as success or failure of treatment, and morbidity and mortality rates. Furthermore, all factors except death may be biased by the lack of an exact definition. Unfortunately, even mortality as an end point is influenced or confounded by a number of factors other than quality of care, such as the severity of the disease, the patient’s age and the coexistence of other diseases. In addition, the surgeon’s experience and case load, as well as hospital volume, may have impact on the outcome of these patients. Despite these factors, postoperative mortality rate qualifies as an acceptable measure of quality in AAA surgery.

The Vascular Section of the Scandinavian Surgical Society has recommended that standards for quality in AAA surgery for postoperative mortality in elective repair should be below 5–7% and less than 50–60% after rupture. These recommendations may easily be fulfilled by specialised vascular centres with concentrated experience and expertise, but there are no data available as to whether these recommendations can be fulfilled on a population basis. The aim of the present study was to analyse the mortality rates after AAA repair in the whole of Finland during the years 1991–94. The data was based on the Finnvasc registry. To assess the need for centralisation of AAA surgery, we sought to discover whether any association existed between mortality rates and hospital volume or the surgeon’s case load, and the effect of different case mix on mortality.

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Materials and Methods

Systematic collection of data of vascular procedures in a nationwide vascular registry, the Finnvasc registry, was initiated in the beginning of 1991 in Finland. This registry embraces a total of 5.1 million inhabitants, i.e. the whole population of Finland. The country is served by 16 central hospitals, with the six surgical departments of the five university hospitals of Helsinki, Kuopio, Oulu, Tampere and Turku serving as their referral centres. Four large district hospitals are also included in this registry. Three private hospitals and 18 small district hospitals with little provision for vascular surgery do not participate in the registry. The record forms of all vascular procedures, except varicose vein surgery, were filled in by the surgeon or the resident in charge of the patient and checked within the hospital by one vascular surgeon responsible for the collection of the data and the local register, called Minivasc. The recorded or printed paper forms were then mailed to the central registry at Tampere University Hospital. The names of the patients and surgeons were coded and unidentifiable to the authors.

During the first 4 years, 17465 vascular interventions were recorded. All but two of the hospitals performed elective aortic surgery. Emergency operations for AAA were done in 88% of the hospitals. The data included 929 elective abdominal aneurysm operations and 610 emergency cases with 454 ruptures. Fifty-three percent of the operations were done in university hospitals, 44% in central hospitals and 3% in district hospitals. In the 18 district hospitals not participating in the Finnvasc registry no aneurysm operations were done, and in the three private hospitals, on average five elective aneurysm operations per hospital were done annually according to a questionnaire. In the three large volume hospitals (>15 elective aneurysm operations per year) there were on average 13 surgeons per hospital performing elective aneurysm operations, instead of on average three surgeons per hospital in the rest of the hospitals.

The software package Paradox 4.0 was used as the database program for the Finnvasc registry and SPSS for statistical analysis. The association between mortality and hospital volume, surgeon's aneurysm as well as total vascular case load was evaluated with regression analysis both in elective and ruptured cases. Possible curvilinear dependence was tested using 1/n as the explanatory variable, where n is the number of operations. The influence of risk factors on mortality of elective AAA surgery were analysed with logistic multiple regression analysis. These risk factors included age, coronary artery disease (CAD), chronic obstructive pulmonary disease (COPD), cerebrovascular disease (CVD), diabetes, renal dysfunction (RD), hypertension, smoking, previous vascular surgery and hyperlipidemia. The criteria for CAD were old myocardial infarction, typical angina pectoris or coronary artery bypass grafting. Hypertension was indicated by treatment with antihypertensive drugs or blood pressure >160/95, CVD by history of a transient ischaemic attack or a stroke, RD by creatinine serum levels constantly >150μmol/l or dialysis, and COPD by the recorded diagnosis. Statistical significance was assumed when p<0.05. Ninety percent confidence intervals (CI) were used as proposed in recent epidemiological literature.

Results

In elective AAA surgery the 30-day mortality rate was 5.1%, ranging from 0% to 15%. Seven (29%) of the 24 units performing aneurysm surgery showed an elective mortality rate above 7%. The 30-day mortality was 46% in ruptured AAA surgery, with a range from 0% to 80%. Acute, non-ruptured cases were not included in these rates, and mortality in this group was 13.5%, ranging from 0% to 33%.

A higher mortality was associated with the presence of CAD (odds ratio 3.0, 90% CI 1.7–5.2, p = 0.001) and RD (odds ratio 4.2, 90% CI 1.9–9.0, p = 0.002) as well as higher age (odds ratio 1.1, 90% CI 1.03–1.11, p = 0.001) in elective AAA surgery. Other potential risk factors, i.e. COPD, CVD, hyperlipidemia, smoking, hypertension, previous vascular surgery and diabetes, were not associated with higher mortality. In elective AAA operations a dependence of mortality rates on the surgeon's experience in AAA surgery was observed (p<0.01) (Fig. 1), and we also found a dependence of mortality rates on the surgeon's total vascular case load in elective AAA surgery (p<0.01) (Fig. 2). However, there was no influence of the surgeon's case load on mortality rates in ruptured AAA surgery (Fig. 3). Acute, non-ruptured cases were not separately analysed, because this group was too small for statistical analysis (156 cases).

There was no association between hospital volume and mortality in elective (Fig. 4) or ruptured AAA operations (Fig. 5). Also, no association was found between hospital volume and mortality when the three high volume hospitals (>15 elective cases or >10 ruptured cases per year) were compared with other hospitals both in elective and ruptured cases. Coronary artery disease (CAD) and renal dysfunction (RD) were observed in equal frequencies in the three large volume
AAA Mortality

Fig. 1. The association between surgeon's aneurysm case load and mortality in elective AAA surgery. (•) Surgeon, (—) regression curve ($p<0.01$) tested using $1/n$ as the explanatory variable, where $n$ is the number of operations.

Fig. 2. The association between surgeon's total vascular case load and mortality in elective AAA surgery. (•) Surgeon, (—) regression curve ($p<0.01$) tested using $1/n$ as the explanatory variable, where $n$ is the number of operations.

Fig. 3. Influence of surgeon's case load on mortality in ruptured AAA surgery. No statistical association was found. (•) Surgeon.

Fig. 4. Influence of hospital volume on mortality in elective AAA surgery. There was no statistical dependence. (•) Hospital.

Discussion

The quality of surgical practice is of an increasing concern, and the need for continuous audit is very important. Nationwide vascular registries are established in the Scandinavian countries to assess the standards of vascular surgery as well as to assist in scientific work, teaching, proper resource allocation and health care planning. Comparison of results based on the data of a vascular registry is not without problems. A crucial problem is the validity of the registry. Efforts have to be made to include all patients and all data on each patient. A high proportion of missing data will tend to make the comparison of results unreliable, as complications may be missed. Even with complete and validated data, comparison may still be tricky. Comparison between different surgeons and hospitals is made difficult by differences in patient presentation, differences in general health condition of the local population and the different practice to classify diseases. Differences exist in indications for therapy and patient material from place...
Fig. 5. Influence of hospital volume on mortality in ruptured AAA surgery. No statistical dependence was found. (○) Hospital.

to place. Units operating on a higher proportion of low-risk patients have achieved better performance figures than those operating on more high-risk patients. One important factor is the proportion of patients with an aneurysm, but who are excluded from operation. These numbers are seldom published, perhaps because they have not been reliably collected. In the present study no data were available on patients treated expectantly. Referral patterns may also influence results. This influence could not be assessed in this study, because the proportion of referred AAA patients per catchment area population is not known.

Despite these pitfalls, it is appealing to use raw mortality and morbidity rates to compare surgeons and institutions. The relationship between procedure volume and mortality rate has important implications for enhancing the quality of surgical health care. If hospitals or surgeons differ significantly in the outcomes of surgery as a function of volume, an increased tendency to centralise patients toward high-volume centres should lead to lower operative mortality.

The results after elective vascular surgery should be better, as far as mortality is concerned, in centres with a larger volume of vascular operations, and better in vascular units than in non-vascular units. There are many possible reasons for this, including better patient selection for surgery, experiences in surgical and anaesthesiological techniques, better knowledge of postoperative and intensive care and larger resources for them, and wider experience to detect and treat complications. Central units also have better possibilities to ensure the optimal treatment of complex aneurysms.

Amundsen and colleagues found in their study that there was a lower mortality in hospitals doing more than 10 AAA operations annually than in those doing less. The association between hospital volume and mortality shown by others was not confirmed by our study. There might have been some low volume surgeons in high volume hospitals, which might have confused the results. Furthermore, it seems probable that patients with, for example, juxtarenal aneurysm are treated in high volume hospitals which cannot be confirmed by available Finnvasc data. Under-reporting was not likely to affect the present results. A ninety-nine percent agreement in the number of aneurysm repairs between hospital records and the Finnvasc data has been previously observed.

Another controversial point is the influence of the individual surgeon’s case load on the results. Hertzer et al. found that members of the Cleveland Vascular Society operating on more than 25 elective aneurysms a year had substantially better results with a mortality of 2.9% than those dealing with 10–25 operations per year and ending up with a mortality of 15.9%. Also, in the present study an association between the surgeon’s case load in elective AAA surgery and mortality was found. The association was even better when assessing the surgeon’s total vascular case load and mortality in elective AAA surgery. Thus, there seems to be little doubt that those regularly engaged in arterial grafting have fewer deaths than surgeons performing occasional vascular reconstructions. This means that attention should be paid to AAA operations made by inexperienced surgeons, and these operations should occur under the supervision of a surgeon experienced in vascular surgery.

Because mortality rates are affected by different patient mix, a comparison based on raw mortality rates of individual surgeons and institutions may always be biased; therefore, some form of risk-adjusted analysis is necessary to make the comparison more meaningful. One approach is to develop a scoring system for all important factors, thereby allowing comparison of patient materials with different constitutions of risk factors. In recent years attempts have been made to develop such a scoring system in surgery to assess morbidity and mortality. Copeland et al. has described a scoring system for surgical audit (POSSUM, a physiological and operative severity score for the enumeration of mortality and morbidity). The first attempts to define the elements of a specific vascular scoring system have also been recently published. This kind of scoring system would be more exact than our method in distinguishing patients with different risk factors.

There is a need for further investigation on the
influence of a different case mix on mortality in AAA surgery with the help of a scoring system. Also, a need exists for further analysis of the differences in mortality rates between operations done by inexperienced surgeons with or without supervision. The Finnvasc registry has recently increased the items for the surgeon’s personal code from one to two, which will facilitate a more accurate analysis of the influence of the surgeon’s experience on mortality rates.

In the present study more than two-thirds of the Finnish centres showed mortality rates in AAA surgery within the standards recommended by the Committee for Vascular Surgery within Scandinavian Surgical Society. The present study illustrates the need for audit in vascular surgery in order to improve the quality to an acceptable level in all hospitals. Based on this study, surgical experience clearly improves the results of elective AAA surgery. Therefore, results of AAA surgery could be improved by centralising the AAA surgery to few centres and ensuring that surgeons in these centres are sufficiently busy to maintain their experience.

Acknowledgements

We are grateful to Karin and Einar Stroehm Foundation and Finnish Society of Angiology for financial support, to Ms Anita Mikkelä, RN, for administrative assistance, and Mr Jukka Ollgren, M.Sc., for performing the statistical analysis.

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References


Accepted 2 April 1997