Elective Repair of Type IV Thoraco-abdominal Aortic Aneurysms; Experience of a Subcostal (Transabdominal) Approach*

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Objective: preoperative pulmonary function has been shown by univariate analysis to be an independent predictor of outcome following Crawford Type IV thoraco-abdominal aortic aneurysm repair. The aim of this study was to determine if outcome had been improved by the introduction of a subcostal approach for the elective repair of these aneurysms.

Methods: 39 patients studied (19 subcostal, 20 thoracolaparotomy) all operated on between 1993 and 1998 by a single surgeon using a standard technique. No significant difference in median age (69 years) or weight (64 kg vs. 69 kg) between the two groups.

Results: preoperative co-morbidities, pulmonary function and predictors of respiratory failure did not vary significantly between the two groups, despite a trend towards greater respiratory, cardiac and renal disease in the subcostal group. Preoperative median pulmonary function in both groups was 80% of that predicted for age, sex and height. The subcostal approach did not significantly reduce blood loss (3500 ml vs. 4500 ml) or anaesthetic time (255 min vs. 253 min). Overall 30 day mortality was 10.2%. The rate of re-operation was significantly higher in the subcostal group (21% vs. 0%, \( p = 0.05 \)). No differences were observed in intensive care unit stay, total hospital stay or respiratory complications, despite earlier extubation of the subcostal group (47% vs. 10% extubated at 12 h, \( p = 0.01 \)).

Conclusion: the introduction of a subcostal approach for type IV thoraco-abdominal aneurysm repair in selected “high risk” patients has been associated with an unacceptably high rate of complications requiring early re-operation. We feel that this relates to the problems inherent in the introduction of a new technique and reduced exposure in patients of inappropriate body habitus. The predicted benefit to pulmonary function is realised in shorter intubation times, but has not translated into earlier recovery or improved outcome. Operation duration and blood loss have not been significantly reduced. Based on these outcomes, we do not currently recommend the general adoption of this approach in all type IV repairs. We will continue to evaluate this approach in patients with poor pulmonary function and a suitable body habitus.

Key Words: Thoraco-abdominal aneurysm; Pulmonary function; Subcostal incision.

Introduction

Type IV thoraco-abdominal aortic aneurysms are those classified by Crawford et al. as extending from the level of the diaphragmatic hiatus to below the level of the visceral arteries. The repair of these aneurysms has traditionally been performed, as for other types, via a thoracolaparotomy incision to provide exposure of both the intrathoracic and intra-abdominal aorta. Retrospective outcome studies of the elective repair of type IV thoraco-abdominal aortic aneurysms show lower morbidity and mortality than that of other types. Univariate analysis of 73 type IV thoraco-abdominal aortic aneurysm repairs performed by three surgeons at this institution revealed, perhaps surprisingly, that preoperative respiratory impairment was the only significant independent predictor of postoperative morbidity and mortality. That surgical incisions reduce postoperative pulmonary function is well recognised. Johnson in 1975 showed a reduction in functional vital capacity (FVC) and one second forced expiratory volume (FEV₁) following thoracotomy of 75% and following subcostal incision of 53%. The possibility for improving postoperative pulmonary function led us to evaluate the adoption of the subcostal approach for the elective repair of type IV thoraco-abdominal aortic aneurysms.

Our chosen technique for the repair of type IV thoraco-abdominal aneurysms via a subcostal, transabdominal, approach has previously been described. This paper studies 19 selected type IV repairs performed via this subcostal approach and 20 repairs performed via a thoracolaparotomy approach during the same time period to evaluate if the predicted improvement in respiratory function has been realised and outcome improved.

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Methods

The results presented are those of a single surgeon performing elective type IV thoraco-abdominal aneurysm repairs between October 1993 and August 1998. All subcostal repairs performed during that period are presented (group I), with 20 thoracolaparotomy repairs in which all the necessary pulmonary data were available (group II). Patients were selected for a subcostal approach if they possessed a suitable body habitus and were perceived to be of greater perioperative risk due to pulmonary, cardiac or renal impairment. Thoracotomy was performed through the bed of the excised 6th rib with the incision continued as a midline laparotomy. Subcostal incision was performed following the costal margin from the tip of the left 12th rib to the lateral border of the right rectus sheath. Exposure of the intra-abdominal aorta was achieved transperitoneally by dissection from the left peritoneal reflection onto the left psoas muscle and left crus with en bloc medial rotation of the left kidney, spleen and splenic flexure of the colon. In the subcostal approach the distal thoracic aorta was exposed by trans-hiatal division of the left crus. The technique of aneurysm repair using a woven Dacron graft and an oblique proximal anastomosis with re-implantation of the left renal artery was identical for the two approaches. A single chest drain was sited in the left thorax in the thoracolaparotomy but not subcostal patients.

All patients underwent full preoperative assessment including chest radiograph, electrocardiogram, stress echocardiogram, spirometry, creatinine relogram, thoraco-abdominal CT scan and arteriogram. Intraoperatively all patients had invasive central venous and arterial pressure monitoring. All patients were transferred to the Intensive Care Unit postoperatively.

Statistical analysis

Results are presented as medians with 95% confidence intervals (CI). Continuous variables are analysed using the Mann–Whitney U- and Student’s t-tests. Discrete variables are analysed by Fisher’s exact test. Significance is determined as p<0.05. Computer analysis performed using InStat version 2.01 for Power Macintosh (GraphPad Software, 1994).

Results

The male to female ratio was significantly lower in group I (3:1) than group II (19:1) (p=0.044). No differences are observed between the two groups for age, group I 69 yrs (68–73) and group II 70 yrs (65–72) or weight, group I 69 kg (56–72) and group II 64 kg (62–75). The aneurysm aetiology was atherosclerosis in all cases with three cases, all in group II, being of inflammatory type. Two patients had undergone previous infraenal aortic aneurysm repair. Preoperative co-morbidities and normalised pulmonary function are shown in Table 1. The greater number of co-morbid conditions in group I did not reach statistical significance but was expected given the selection bias in allocating patients to this approach.

Intraoperative

Intraoperative details are given in Table 2. None of these measurements was significantly different between the two groups. Ten patients, five in each group, developed intraoperative lower limb ischaemia persisting after cross-clamp removal. Femoral embolectomies were performed successfully in half of these patients. In group I the following revascularisation procedures were performed: femoral to femoral crossover graft following ligation of an internal iliac artery aneurysm and unilateral jump grafts to the common femoral, superficial femoral and profunda femoris arteries. In group II one jump graft
to the profunda femoris artery was performed. One group I patient developed intraoperative colonic ischaemia necessitating superior mesenteric artery revascularisation and re-implantation of the inferior mesenteric artery. Three patients in group I and two patients in group II sustained splenic injuries. Splenectomy was performed in four of these patients. One group I patient with splenomegaly due to high factor VIII underwent elective splenectomy to improve surgical access.

**Complications**

The rate of reoperation in the subcostal group was 20%. No patient in group II underwent reoperation (20% vs. 0%, \( p = 0.047 \)). The indications for reoperation were haemorrhage from a lumbar artery in one patient and the proximal anastomosis in a second patient. The latter occurred in a patient with poor pulmonary function in whom a subcostal approach was used unadvisedly for an inappropriate aneurysm. The other two reoperations were evacuation of a splenic bed haematoma and a femoral embolus requiring embolectomy. The overall 30 day mortality (group I and group II) was 10.2%. The three deaths in group I resulted from disseminated intravascular coagulopathy, sepsis and subarachnoid haemorrhage. The subarachnoid haemorrhage occurred on day nine postoperatively in a normotensive patient with a normal clotting profile. The single death in a group II patient resulted from an acute cardiac event. Minor complications and outcome are shown in Table 3.

Table 3. Postoperative course.

<table>
<thead>
<tr>
<th>Complication</th>
<th>Group I</th>
<th>Group II</th>
</tr>
</thead>
<tbody>
<tr>
<td>ITU stay (days)</td>
<td>3.5</td>
<td>2.5</td>
</tr>
<tr>
<td>Ward stay (days)</td>
<td>10</td>
<td>12</td>
</tr>
<tr>
<td>Respiratory failure¹</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Temporary haemofiltration</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Pulmonary embolus</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Left ventricular failure</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Transient ischaemic attack</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Pneumothorax</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>“Trash” foot</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Paraplegia</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

¹ Greater than 48 h of postoperative ventilation.

**Respiratory function**

Despite the greater number of patients with respiratory symptoms in group I, no significant differences were observed in preoperative pulmonary function or Money et al.’s predictors of respiratory failure following thoraco-abdominal aneurysm repair between the two groups, Table 4.³ Three group I patients were extubated immediately post operation. All group II patients were ventilated. Median intubation time was 11 h (8–24) for group I and 20 h (17–29) for group II. The difference is highly significant if the four patients...
who underwent reoperation are excluded from analysis (7.5 h vs. 20 h, *p* = 0.004). Twelve hours post operation 47% of group I and 10% of group II had been extubated (*p* = 0.014). The only difference observed between the two groups in arterial pO$_2$, arterial pCO$_2$ or oxygen saturation (data not presented) was immediately on arrival in the intensive care unit. Group I patients were administered a higher FiO$_2$, 58%, than group II patients, 45% (*p* = 0.031).

## Discussion

The series presented is of 19 consecutive elective type IV thoraco-abdominal repairs performed by a single surgeon via a subcostal incision, in high risk patients. The comparison group are patients operated on by the same surgeon in the same time period using the traditional thoracolaparotomy approach and otherwise similar technique. Comparisons between the two groups must be made with caution. The subcostal group were selected particularly on the basis of increased perioperative risk from thoracotomy. There was also female preponderance in the subcostal group.

The subcostal approach, despite a shorter incision and the avoidance of rib excision, did not significantly reduce operation time or blood loss. The subcostal approach was, however, associated with a significantly higher rate of perioperative complications requiring reoperation. Operative exposure may be less good with a subcostal than thoracolaparotomy incision. We had only been aware of this as a problem in obese or “barrel-chested” patients. The series presented suggests that difficulties can occur at the proximal anastomosis if the aortic wall is friable, since access to the thoracic aorta is limited. We also feel that the complication involving the proximal anastomosis may have resulted from the learning curve of a new technique.

The 16% 30 day mortality in the subcostal group probably represents the increased risk of a selected population with greater pulmonary, cardiac and renal disease. One death did follow from a complication requiring reoperation. Two deaths occurred in patients with impaired preoperative renal function who required hemofiltration in the postoperative period. Univariate analysis of all 39 patients revealed impaired preoperative renal function, defined as a preoperative creatinine greater than normal for age, to be an independent predictor of postoperative mortality (*p* = 0.05).

The rates of 30 day mortality, paraplegia and long-term dialysis compare to those reported elsewhere following elective type IV thoraco-abdominal aortic aneurysm repair. The predicted improvement in outcome due to improved postoperative respiratory function was not fulfilled, despite early extubation. This may, in part, be due to the low overall rate of respiratory complications.

Comparison of the subcostal approach with thoracolaparotomy for the elective repair of all type IV thoraco-abdominal aneurysms would require a randomised trial. Based on these early results, we feel that this would be inappropriate, as a higher rate of complications has been shown from the subcostal approach. The theoretical advantages have not translated into improved outcome. We will continue to evaluate the use of this approach, using more sensitive measures of postoperative pulmonary function, in patients considered to have a high operative risk for thoracolaparotomy.

## References


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