Suprarenal Aortic Cross-Clamping in Elective Abdominal Aortic Aneurysm Surgery

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Introduction: *this retrospective study was undertaken to evaluate whether suprarenal aortic cross-clamping increased the perioperative mortality and morbidity as compared to infrarenal clamping, in order to create the rationale for a more extensive application of this apparently more traumatic manoeuvre.*

Materials and methods: *in a series of 734 elective aortic substitutions for abdominal aneurysm (AA), performed consecutively from January 1992 to June 1999, aortic cross-clamping was performed at a suprarenal level in 56 juxtarenal aneurysms, i.e. aneurysms extending to the lower edge of the renal arteries (8%, Group 1), and at an infrarenal level in 634 subrenal aneurysms (92%, Group 2). When analysing preoperative data, the diameter of aneurysms was larger in Group 1 than in Group 2 (p<0.005). No significant differences were found between the two groups as regards age, sex, postinfarction cardiomyopathy, chronic obstructive pulmonary disease, chronic renal insufficiency and ASA classification of operative risks.*

Results: *the average time of renal exclusion in the juxtarenal aneurysms was 20 min (range 12–35 min). There is no difference between the two groups as regards the time of aortic clamping (mean 50 vs. 60 min) or the need for homologous blood transfusion (7% vs. 11% of patients). Perioperative (30 days) mortality did not differ: 3.6% vs. 1.9% (n.s.); nor did the incidence of acute myocardial infarction (3.6% vs. 2.3%). Renal function deteriorated in 8 (14%) vs. 0 (0%) (p<0.001) and 1 patient (2%) required permanent dialysis, as compared to 0% in Group 2. The incidence of ischaemic colitis was also significantly higher in Group 1 (7%) than in Group 2 (2%, p<0.01).*

Conclusion: *this data shows that suprarenal clamping, which is necessary for the radical treatment of juxtarenal aortic aneurysms, can be performed with a low risk.*

Key Words: Abdominal aorta; Aneurysms; Aortic cross-clamping; Juxtarenal aneurysms; Renal artery; Pararenal aneurysms; Endovascular exclusion.

Introduction

Suprarenal aortic cross-clamping in aortic aneurysm surgery is used with varying frequency (from 2% to 20%),[1–14] according to the anatomy, pathology and the personal preferences of the surgeon. For aneurysms that are close to the origin of the renal arteries, some surgeons consider the suprarenal clamping mandatory to substitute the entire subrenal aorta, whereas in order to avoid the risks of this manoeuvre, others prefer clamping the infrarenal aorta and performing aorto-prosthesis anastomosis on an ectasic and fragile neck.[15–28]

The aim of this study was to evaluate whether suprarenal clamping, which allows the radical treatment of a juxtarenal aortic aneurysm, is as safe as infrarenal clamping.

Materials and Methods

Between January 1992 and June 1999, 734 patients underwent elective repair of abdominal juxta or infrarenal aortic aneurysm (AAA). In 56 of the 734 patients (7.6%), Group 1, the aneurysm was juxtarenal. In these cases suprarenal aortic cross-clamping was required. In 678 cases (92%), Group 2, the aneurysm was infrarenal. Group 1 and Group 2 did not differ significantly (Kruskal–Wallis Chi-squared test) with regard to sex, age or co-morbidity (Table 1).[29]

Preoperative assessment routinely included

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Table 1. Characters of patients and aortic aneurysms in 734 cases operated electively.

	Juxtarenal AAA 56 (7.6%)	Infrarenal AAA 678 (92.4%)	p	Total AAA 734 (100%)
Female	5 (9%)	42 (6%)	ns	47 (6%)
Male	51 (91%)	636 (94%)	ns	687 (94%)
Age				
Median	67 yrs	68 yrs		68 yrs
I.Q. range	62–72 yrs	64–73 yrs	ns	64–72 yrs
Range	48–82 yrs	42–89 yrs		42–89 yrs
COPD	18 (32%)	211 (35%)	ns	229 (31%)
CMP	16 (29%)	129 (19%)	ns	145 (20%)
CRI	4 (7%)	29 (4%)	ns	33 (5%)
ASA 1 & 2	11 (20%)	193 (28.5%)	ns	204 (28%)
ASA 3 & 4	45 (80%)	485 (71.5%)	ns	530 (72%)
Diameter				
Median	6 cm	5.4 cm		5.7 cm
I.Q. range	5–7 cm	4.5–6.3 cm	<0.005	4.8–6.3 cm
Range	4.2–11 cm	3.4–13 cm		4.2—13 cm

AAA: abdominal aortic aneurysm; COPD: chronic obstructive pulmonary disease; CMP: cardiomyopathy; CRI: chronic renal insufficiency; ASA: operative risk in according to American Society of Anesthesiologists.[29]
(I.Q.: interquartile; p calculated with Kruskal–Wallis Chi-squared test).

ecography and aortography or CT-scan. The final determination of the proximal extension of the lesion and, more importantly, of the relation with the renal arteries was, however, intraoperative.

A comparison of the aneurysm diameter in the two groups shows that the size of the Group 1 aneurysms was larger (median AP diameter 6, IQR 5–7 cm) than Group 2 (median 5.4 cm, IQR 4.5–6.3) (p<0.005).

All but four patients[10] were operated on via the transperitoneal approach. In the juxtarenal aneurysms, access to the suprarenal aorta was gained by mobilising (51/56, 91%) or dividing (5/56, 9%) the left renal vein, which was reconstructed end-to-end in four cases.

Patients were routinely heparinised (3500–5000 I.U.). Suprarenal clamping was performed with pharmacological protection of cardiac function by means of vasodilators to decrease afterload during aortic occlusion, and protection of renal function by selectively using Dopamine furosemide and mannitol.

The renal exclusion time was minimised as far as possible, performing endoaneurismectomy and suture of the patent lumber arteries under infrarenal clamping, wherever possible, on an ectasic but clampable aorta, before moving the clamping proximal to the renal arteries, just for the time required to perform the aorto-prosthetic anastomosis.

In juxtarenal aneurysms, once proximal anastomosis had been completed, the aortic clamp was moved distal to the anastomosis to restore flow in the renal arteries, while the distal reconstruction on the aorta or the iliac or femoral arteries was being performed.

Results

The average total time of aortic clamping was 59 (range 25–85) min with no significant differences between Groups 1 and 2. In Group 1 juxtarenal aneurysms, the average time for exclusion of one renal artery (22 cases) or both (the remaining 34) was 20 min (range of 12–35 min).

Perioperative bleeding was the same in both juxtarenal AA and infrarenal AA (Table 2). No blood transfusions were required in 50%, autotransfusion was enough to substitute blood loss in 39% and only 11% required homologous blood (Table 2).

In the 734 AAA elective procedures overall operative mortality (within postoperative day 30) was 15 cases (2.0%), with no significant difference between the two groups (Table 2).

No spinal cord ischaemia with paresis or paraplegia of the lower limbs was observed.

The overall incidence of acute myocardial infarction was 17 cases/734 AAA (2%), with a 47% death rate and no significant difference between the two groups (Table 2).

A significant postoperative rise in serum creatinine level (a creatinine level rise >0.5 mg/dl in comparison with the admission level) occurred in 8/56 (14%) of patients in Group 1, in all but one case treated successfully in the first few postoperative days merely by means of a careful fluid therapy and continuing dopamine infusion at subpressor doses. Only one (2%) patient out of 56 juxtarenal aneurysms required per-

Table 2. Mortality and morbidity in suprarenal and infrarenal aortic cross-clamping.

	Suprarenal aortic cross-clamping (56 juxtarenal AAA)	Infrarenal aortic cross-clamping (678 infrarenal AAA)	*p*
Mortality	2 (3.6%)	13 (1.9%)	ns
Perioperative blood transfusion			
None	30 (53%)	336 (50%)	ns
Autotransfusion	22 (39%)	266 (39%)	ns
+ homologous transfusion	4 (7%)	76 (11%)	ns
Spinal cord ischaemia	0	0	
Acute myocardial infarction	2 (4%) with 1 death (50%)	15 (2%) with 7 deaths (47%)	ns
Dialysis	1 (2%)	0	<0.01
Ischaemic colitis	4 (7%)	11 (2%)	<0.01

Rate of mortality, blood transfusions, spinal cord ischaemia, acute myocardial infarction, dialysis and ischaemic colitis in 734 abdominal aortic aneurysms (AAA) operated electively, with comparison between juxtarenal AAA and infrarenal AAA (*p* calculated with Chi-squared test).

Table 3. Review of literature on suprarenal aortic cross-clamping in elective surgery for abdominal aortic aneurysms.

	Number of cases	Perioperative mortality (%)	Transient renal failure (%)	Permanent dialysis (%)	Spinal cord ischaemia (%)
Crawford, 1986[1]	101	7.9	16	7.9	/
Qvafordt, 1986[2]	77	1.2	23	2.5	0
Stoney, 1989[3]	30	3.3	/	/	/
Shepard, 1991[4]	35	0	/	0	0
Etienne, 1991[5]	43	11.6	9.3	0	0
Poulias, 1992[6]	38	5.2	24	10.4	0
Breckwoldt, 1992[7]	23	2.6	28	2/5	0
Allen, 1993[8]	65	1.5	/	0	1.5
Nypaver, 1993[9]	53	3.8	23	3.7	0
Lacroix, 1994[10]	25	0	/	0	0
Schneider, 1997[11]	23	0	0	0	0
Faggioli, 1998[12]	42	7.1	2.4	0	0
Hines, 1998[13]	24	25	/	4.1	/
Jessie, 1999[14]	257	5.8	40.5	4.3	/
Present series 2000	56	3.6	14	2	0

/: not defined.

manent dialysis. This patient was one of four who preoperatively had CRI. In Group 2 we observed no cases of postoperative worsening of renal function, not even in the 29/678 patients showing preoperative CRI.

The rate of ischaemic colitis was significantly higher (*p*<0.01) in Group 1 (7%, with 1 death) than in Group 2 (2%, with no deaths).

Discussion

We believe suprarenal aortic cross-clamping should be used more frequently, because infrarenal cross-clamping does not allow a radical treatment of juxtarenal aneurysms and is associated with a high risk of intraoperative bleeding, early anastomotic failure

and false aneurysm, and supra-anastomotic aneurysm.[19,23–28]

Furthermore, as endovascular exclusion of the AAA becomes more widespread, open surgery will mainly be limited to juxta and suprarenal aneurysms, and to early and late re-interventions following failure of endovascular treatment that requires suprarenal clamping.[14,30]

However, it is commonly thought that suprarenal clamping exposes the patient to greater risks, as it involves more complex surgical manoeuvres, wider dissections, the temporary exclusion of the kidneys from blood circulation, and greater haemodynamic consequences.[2,5–7,9] This is not our experience (Table 3).

No differences were seen in terms of mortality, cardiac complications, length of surgery, aortic clamp time, haemodynamic instability or the requirement for

blood transfusion. We feel the haemodynamic impact of surgery can be limited by favouring submesenteric clamping (as we do) instead of supracoeliac clamping, which is frequently used by other surgeons.[1,7,11,13] In our experience, out of the most severe and potentially fatal complications, only ischaemic colitis was shown to have a significantly higher incidence in suprarenal clamping. This may be because the suprarenal clamp deforms the ostium of the superior mesenteric artery. The clamp may also cause emboli.[5,7,9,14–18] It is important, therefore, to check the superior mesenteric artery flow use retractors correctly and to consider reimplanting the inferior mesenteric artery, especially when hypogastric arteries are occluded or excluded.

Only patients who already have chronic renal failure seemed to be at risk in the case of suprarenal clamping, and, in such patients it may precipitate. Worsening of renal function was not observed in 678 infrarenal aneurysms. When section of the left renal vein is considered necessary for better control of the suprarenal aorta, reconstruction of the vein after completion of aortic reconstruction is simple, safe and not mandatory,[16] but advisable, for the formerly reported risk of insufficient drainage of back blood from the left kidney connected to the ligature of that vein.[16]

In conclusion, our experience suggests that suprarenal clamping for juxtarenal aneurysm repair is a well tolerated procedure and involves few risks.

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