

Abdominal aortic aneurysm surgery: retroperitoneal or transperitoneal approach?

Abdominal aort anevrizmalarında cerrahi: Retroperitoneal veya transperitoneal yaklaşım

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Background: Mortality and morbidity of abdominal aortic aneurysm surgery have decreased significantly in time and transperitoneal approach still preserves its firm ground although retroperitoneal approach is known to serve with various advantages. In this study, two approaches were compared for elective and emergency cases.

Methods: Patients that underwent abdominal aortic aneurysm repair between January, 1994 and March, 2004 were reviewed and analyzed based on the elective/emergent nature of the surgery and the type of the incision. Pre- and perioperative data including hospital mortality and various morbidities were analyzed.

Results: Forty five patients were operated with retroperitoneal approach (RPA) among 155 patients and 35 patients had a ruptured aneurysm in 10 years period. Significantly shorter mechanical ventilation and nasogastric decompression periods, less need for intravenous fluid supplementation with shorter ICU stay were observed with the RPA ($p<0.001$). Need for allogenic blood transfusion was similar ($p>0.05$). Analysis of mortality and morbidity revealed bleeding as the major cause of mortality in the ruptured cases. A similar comparison between two groups, however, revealed no significant difference ($p>0.05$).

Conclusion: Retroperitoneal approach serves many advantages as rapid weaning from mechanical ventilation and shorter stay in intensive care unit in addition to rapid restoration of gastrointestinal physiology. It also provides adequate surgical exposure.

Key words: Abdominal aorta; aneurysm; retroperitoneal.

Amaç: Abdominal aort anevrizması cerrahisinde mortalite ve morbiditenin yıllar içinde azalmıştır ve retroperitoneal (RP) yaklaşımın birçok avantajına karşın transperitoneal (TP) yaklaşım hala tercih edilen bir yöntem olmaya devam etmektedir. Bu çalışmada her iki yaklaşım elektif ve acil olgular için karşılaştırıldı.

Çalışma planı: Ocak 1994 ile Mart 2004 tarihleri arasında acil veya elektif şartlarda abdominal aort anevrizma cerrahisi geçiren olgular saptanarak, cerrahi yaklaşımın ve insizyonun tipine göre hastane mortalitesi, değişik morbiditeler, ile ameliyat öncesi ve ameliyat sırasındaki bulgular karşılaştırıldı.

Bulgular: On senelik bu dönemde 35'inde rüptüre anevrizma bulunan 155 hastanın 45'i RP retroperitoneal yaklaşımla tedavi edildi. Retroperiton yaklaşımıyla ameliyat edilen grupta; mekanik ventilasyon süresi ($p<0.001$), nazogastrik sonda dekompresyonu ($p<0.001$), intravenöz sıvı ihtiyacı ve yoğun bakımda kalış süresinin ($p<0.001$) anlamlı olarak daha az olduğu görüldü. Kan transfüzyon ihtiyacı ise her iki cerrahi yaklaşım için benzerdi ($p>0.05$). Rüptüre olgularda mortaliteye yol açan belirgin nedenin kanama olduğu saptandı ancak iki cerrahi yaklaşımın karşılaştırılmasında benzer sonuçlar bulundu.

Sonuç: Retroperitoneal yaklaşım; daha az yoğun bakımda kalım ve mekanik ventilasyon gereksinimi, bağırsak fizyolojisinin daha erken sağlanması gibi avantajlara sahip olduğu gibi cerrahi açıdan yeterli görüş alanı da sağlamaktadır.

Anahtar sözcükler: Abdominal aorta; anevrizma; retroperitoneal.

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Since the report of Dubost et al.,^[1] surgical repair of the abdominal aortic aneurysms has evolved significantly. Creech and DeBakey^[2] further popularized endoaneurysmorrhaphy and intraluminal graft interposition and these techniques have become the standard approach since then. Within decades, mortality and morbidity have decreased significantly as more refined surgical and anesthetic skills evolved.^[3-5] Transperitoneal approach (TPA) to abdominal aortic aneurysms (AAA) still preserves its firm ground although an alternative and probably a less invasive retroperitoneally approach has long been known. Rob^[6] reported a series of 500 patients with anterolateral retroperitoneal approach (RPA) to abdominal aorta. He discussed on several advantages of such an incision over a conventional TPA. Lower incidence and shortened duration of ileus, shorter intensive care unit (ICU) and hospital stay, earlier oral intake and less patient discomfort and pain are among the possible advantages of the retroperitoneal approach in addition to better cosmetic results. Introduction of posterolateral RPA by Williams et al.^[7] provided an easier approach to more proximal aorta and its branches. Recent publications on this topic have emphasized RPA as a less invasive method^[8,11] and we present our results with TPA and RPA.

MATERIALS AND METHODS

Patients that underwent AAA repair at our Cardiovascular Surgery Center between January 1994 and March, 2004 were reviewed and analyzed based on the elective/emergent nature of the surgery and the type of the incision as either TPA or RPA. Hospital mortality depicted mortality within 30 days after surgery. Non-fatal complications were life-threatening complications without ending-up in death. Diagnosis was established with biplanar aortography, CAT scan or both. Retroperitoneal technique used has been depicted by other authors elsewhere.^[6,12]

RPA became popular in 2000 by the surgical team and thus 45 patients in RPA group were operated between 2000 and 2004. Among the postoperative complications, acute myocardial infarction was diagnosed

according to AHA/ACC criteria; acute renal failure was diagnosed with perioperative onset of oliguria/anuria and/or if previously normal serum creatinine exceeds 1.8 mg/dl. Neurological states were evaluated using NIH criteria. Colonic ischemia and peritonitis were diagnosed upon clinical examination and direct explorative laparotomy.

Statistical analysis. Statistical procedures were done by using SPSS 10.0 (SPSS Inc, Chicago, IL). Data are expressed as means \pm standard deviation. A P value of less than 0.05 was considered to indicate statistical significance. "Fischer's Exact test", "Levene's f-test", "Independent-Samples t-test" and "Mann Whitney U-test" were used for the statistical evaluation of data.

Patients were divided as elective and emergent or transperitoneal and retroperitoneal. Fisher's Exact test was used for comparison of mortality and non-fatal complications between groups based on the principle of comparison of independent groups. Patients operated with either TPA or RPA were compared for their postoperative variables depending on variance homogeneity of the each variable. Independent-Samples t-test was used for homogeneous variables following a variance homogeneity testing with Levene's t-test; for the non-homogeneous variables, Mann Whitney U-test was used as a non-parametric alternative.

RESULTS

Within this 10-year-period, 155 (126 male-81%, 29 female-19%) patients underwent either elective or emergent (due to rupture of the aneurysm) repair of the AAA with either midline transperitoneal or left retroperitoneal approach by the same operating surgeon. 35 of 155 patients (22.5%) were operated in an emergency setting with rupture into retroperitoneal space (24 patients), intraperitoneal space (8 patients), gastrointestinal tract (2 patients) and inferior vena cava (1 patient). Mean age of the patients was 67.04 \pm 9.14 years (range 45-85 years old). Distribution of preoperative patient characteristics in RPA and TPA groups were similar (Table 1).

Table 1. Preoperative characteristics of patients in Transperitoneal and retroperitoneal approach groups

	Transperitoneal approach (n)	Retroperitoneal approach (n)	p
Age (years \pm SD)	67.77 \pm 8.74	65.02 \pm 9.98	0.104*
Smoking	61	27	0.721**
Diabetes mellitus	32	16	0.449**
Cardiac disease	53	19	0.595**
Hypertension	81	30	0.434**
Chronic obstructive pulmonary disease	24	8	0.665**

P value less than 0.05 is accepted significant; *: Independent Samples t-test, **: Fisher's Exact test.

Table 2. Causes of perioperative mortality between groups

	Elective RPA/TPA n=120 (% in elective cases)		Ruptured RPA/TPA n=35 (% in ruptured cases)		Total n=155 (% in the whole)		p*
	n	%	n	%	n	%	
	Acute MI	1 - 1	4.7 - 4.7	0 - 2	0 - 9.5	4	
Acute renal failure	0 - 2	0 - 9.5	0 - 3	0 - 14.2	5	23.8	0.076
Colonic ischemia & peritonitis	0 - 1	0 - 4.7	0 - 2	0 - 9.5	3	14.2	0.128
Bleeding	0 - 0	0 - 0	0 - 9	0 - 42.8	9	4.3	<0.001
Mortality in the group	1 - 4	4.7 - 19	0 - 16	0 - 76.2	21	100	
Overall mortality in the series	5	2.5	16	45.7	21	13.5	<0.001

P value less than 0.05 indicates significance; *: Fisher's Exact test. TPA: Transperitoneal approach; RPA: Retroperitoneal approach.

Overall mortality was 13.5%; however, mortality in only elective cases was as low as 2.5%. For the sake of better analysis, two different methods were used for the assessment of mortality. In majority of the patients in the ruptured group, excessive bleeding was found to be the cause of death ($p < 0.001$); in the elective cases, however, acute myocardial infarction and acute renal failure were responsible for mortality (Table 2). Overall mortality was significantly higher in the emergent operation group than elective group possibly due to reasons mentioned elsewhere in the text ($p < 0.001$). From the point of surgical approach, only one patient died in the RPA group due to myocardial infarction. Patients in RPA and TPA groups were compared for causes of mortality and non-fatal complications and no significant difference was found. Only bleeding as the cause of expiration in the TPA group was near-significant ($p = 0.06$).

For non-fatal complications, one patient in this group necessitated longer than one-day stay in ICU due to pulmonary failure. This patient had a rapidly growing AAA and low pulmonary functional capacity due to chronic obstructive pulmonary disease (COPD). Table

3 shows non-fatal complications seen in the patients. Retroperitoneal group showed significantly shorter periods of mechanical ventilation, ICU and hospital stay as well as less need for intravenous fluids. Significantly longer time was required for restoration of normal bowel motility in the TPA group represented by a longer duration with nasogastric decompression (Table 4). Need for allogeneic blood transfusion was similar for either group although TPA group included emergency cases with rupture. TPA and RPA patients were compared for the causes of mortality and morbidity separately and no significant results were found (Tables 2, 3, 5 and 6). It must be noted, however, bleeding as the cause of mortality was near-significance for TPA and RPA groups, which is attributable to the fact that the majority of the patients operated in an emergency setting expired due to uncontrollable bleeding.

DISCUSSION

With refinement of surgical and anesthetic techniques, mortality and morbidity of AAA have been significantly reduced and the surgeons have continued to search a

Table 3. Non-fatal complications

	Elective (n=120)				Ruptured (n=35)				Total (n=155)		p*
	RPA		TPA		RPA		TPA		n	%	
	n	%	n	%	n	%	n	%			
Cardiac	0	0	3	2.5	0	0	1	1.4	4	2.5	0.999
Pulmonary failure	1	0.8	1	0.8	0	0	2	2.8	4	2.5	0.220
Acute renal failure	1	0.8	1	0.8	0	0	2	2.8	4	2.5	0.220
Paraplegia/paraparesia	0	0	1	0.8	0	0	1	2.8	2	1.3	0.402
Colonic ischemia	0	0	0	0	0	0	1	2.8	1	0.6	0.226
Peripheral ischemia	1	1	1	1	0	0	0	0	2	1.3	0.999
Total	3	-	7	-	0	-	7	-	17	-	0.066

P value less than 0.05 indicates significance; *: Fisher's Exact test. TPA: Transperitoneal approach; RPA: Retroperitoneal approach.

Table 4. Comparison of several variables in Retroperitoneal and Transperitoneal approach patients

	Transperitoneal approach	Retroperitoneal approach	p (2-sided)
Mechanical ventilation (hours)	15.2±3.8	10.1±2.3	<0.001*
NG decompression (hours)	40.6±10.7	9.1±2.2	<0.001**
ICU stay (hours)	29.5±14.8	18.6±1.9	<0.001**
Hospital stay (days)	7.5±1.4	6.0±1.2	<0.001*
IV fluid replacement (ml)	5767.3±1766.4	1922.2±413.9	<0.001**
Allogenic transfusion (units)	1.3±1.4	0.9±0.4	0.401**
Cross-clamp time (minutes)	32.4±6.0	27±3.9	<0.001**

P value less than 0.05 is accepted significant; *: Independent Samples t-test; **: Mann Whitney U-test. ICU: Intensive care unit.

more physiological, less invasive techniques causing less discomfort for the patient. RPA popularized in recent years is deemed to transform into a minimal invasive RPA and laparoscopic surgery has already begun to cover AAA surgery. Endovascular approach is another alternative in AAA. Besides above-mentioned modalities requiring skilled technicians and delicate tools, cost-effectiveness has become more of concern. Centers have turned to less procedural costs and more successful results; thus, an open procedure with rapid recovery of the patient and short ICU/hospital stay is usually the choice of surgeon. RPA gains importance in this regard being less invasive and as shown in the results of our study it enables quicker gastrointestinal recovery with shorter dismissal.^[13-16] RPA may also be preferable in the presence of repeat abdominal surgery, inflammatory aneurysms, suprarenal aneurysms, obesity and horse-shoe kidney.^[12,17,18] This technique is on the other hand may serve difficulties in the presence of right iliac artery aneurysm or the close neighborhood of the right renal artery.

In the modern era of elective AAA surgery, mortality has decreased below 5%; it was 2.5% in our study. Overall mortality was, however, higher principally due to high mortality rate of ruptured cases which constituted 22.5% of our series. It must be noted that most comparative studies regarding the surgical approach have excluded emergent ruptured aneurysm repair. Several centers reported mortality of 35-50% in ruptured AAA repair.^[19,20] We found 45.7% mortality in this latter group. Acute myocardial infarction has been cited as the most common cause for mortality in AAA repair. In our series, acute myocardial infarction constituted 19% of 21 fatal cases. Impact of acute MI on mortality was more significant on elective cases (9.4% of all deaths). In our series, excessive bleeding was responsible for most of the mortality in the ruptured cases (42.8% of all mortality). This, in part, may be due to hemodynamic instability and rapidly deteriorating states of bleeding patient. Among the non-fatal complications seen in 2.5% of the patients, only one patient had a non-fatal

infarction; arrhythmias and cardiac ischemia were among the other non-fatal cardiac complications. Acute renal failure has been responsible for 3-12% of mortality in AAA surgery. In our study, acute renal failure seen was held responsible in 23.8% of the 21 fatal cases. This may be in part due to the fact that 22.5% of the series is constituted of ruptured cases with 45.7% overall mortality. Gastrointestinal complications and bowel ischemia are particular interest to the surgeon due to anatomical relationships. Colonic ischemia has been reported to occur in 0.2-10% of the patients;^[19] in our series, 4 patients such a dismal complication with 3 of them succumbed to death. In accordance with the classical data, 3 of 4 patients with colonic ischemia were operated in emergency settings with rupture.

Anomalous origin of Adamkiewch artery and/or perioperative hypotension have been blamed for para-

Table 5. Comparison of TPA and RPA groups for non-fatal complications

	RPA	TPA	p*
Cardiac	0	4	0.324
Pulmonary	1	3	0.999
Renal	1	3	0.999
Paraplegia/paraparesia	0	2	0.999
Colonic ischemia	0	1	0.999
Peripheral ischemia	1	1	0.498

P value less than 0.05 indicates significance; *: Fisher's Exact test. TPA: Transperitoneal approach; RPA: Retroperitoneal approach.

Table 6. Comparison of RPA and TPA groups for causes of mortality

	RPA (n)	TPA (n)	p
Acute MI	1	3	0.999
Acute renal failure	0	5	0.322
Colonic ischemia	0	3	0.557
Bleeding	0	9	0.060

P value less than 0.05 indicates significance. TPA: Transperitoneal approach; RPA: Retroperitoneal approach.

plegia and spinal chord ischemia which are notably rare post-AAA repair. We found one case with paraplegia and another case with paraparesia indicative of spinal chord ischemia. Both cases were noted to have had severe hypotensive episodes perioperatively. It is noteworthy that the cross clamp times in the RPA group were significantly shorter than in the TPA group. This was attributed to the fact that TPA group included ruptured cases with friable tissues. This, somewhat, contradicts the similar need for allogeneic blood transfusion in either group depicted on Table 4 (1.3 ± 1.4 vs. 0.9 ± 0.4 units; $p=0.401$).

As mentioned before, cost-effectiveness is a major drive for hospital management in our era. Besides various aforementioned advantages that RPA serves for the surgeons and the patients, it may well serve for significant financial savings. Ballard et al.^[21] indicated a mean cost difference of \$5,527 between TPA and RPA. Although an endovascular approach is as attractive causing significantly less hospital stay and possibly no ICU stay at all, this modality is still applied to selected cases in many centers and the potential complications that necessitate continuous surveillance and presence of limited long-term data raise doubts about its applicability in every day practice.^[22] Financial burden of endovascular versus open retroperitoneal AAA repair has also been assessed by some authors. Endovascular procedures were found to be more expensive with a mean difference of \$11,662 in comparison to RPA in selected cases.^[23] It was also noted that neither quality of life nor perioperative complication rate was significantly different for endovascular approach than TPA despite its minimal invasiveness.

This study aims to summarize a single-operating surgeon experience with either surgical strategy over a period of 10 years. Results of the current review show beneficial effects of RPA, but randomized studies with long-term results are required to establish solid data. It must be reminded that the review comprises the authors' experience with RPA. Inclusion of all infrarenal AAA's after 2000 in the RPA group may be an eliminating factor for patient-selection bias. Significantly quicker restoration of bowel motility and shorter ICU and hospital stay in spite of initial stages of learning curve support the idea that RPA should be preferred when applicable. Inclusion of more detailed data as the actual need for analgesia in ICU and the perioperative hematocrit drop would have made the review more comprehensive and would have enabled us to comment more on the impact of various factors on the postoperative outcome.

Retroperitoneal approach to abdominal aortic aneurysms is a reliable technique for repair. It causes

less fluid-electrolyte imbalance with rapid restoration of gastrointestinal physiology. It causes less discomfort to patients with reduced need for analgesia. Rapid weaning from mechanical ventilation and less hemodynamic instability due to less blood loss are benefits for patients with co-morbid states. Shorter ICU and hospital stay may substantially reduce costs for the patient, hospital and the health insurance system.

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