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A comparison between hiatal and thoracic clamping for ruptured abdominal aortic aneurysms

Rüptüre abdominal aort anevrizmalarında hiatal ve torakal klemplemenin karşılaştırılması

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ABSTRACT

Background: This study aims to evaluate the effects of hiatal and thoracic clamping on postoperative morbidity and mortality in the management of ruptured abdominal aortic aneurysms.

Methods: This retrospective study included 47 patients (35 males, 12 females) who were performed open repair for ruptured abdominal aortic aneurysms in our clinic between March 2005 and June 2013. Thoracic and hiatal clamping were performed in 26 (19 males, 7 females; mean age 68.5±8.0 years) and 21 (16 males, 5 females; mean age 66.1±7.8 years) patients, respectively. Postoperative complications and mortality were evaluated between the two groups by univariate and multivariate statistical analyses.

Results: Overall mortality was 36.7% (n=18) and there was no significant difference between the two groups. Univariate analyses showed no significant difference between the two groups in terms of postoperative respiratory complications (p=0.59), renal failure (p=0.98), the use of cell saver (p=0.26), and intestinal ischemia (p=0.08). Duration of hospital stay was longer in thoracic clamping group (p=0.01). Age and clamp time (>30 minutes) significantly increased hospital mortality.

Conclusion: Hiatal and thoracic clamping were not superior to each other when postoperative complications were compared in patients for whom infrarenal clamping was not feasible. Both techniques can be applied safely by keeping the cross-clamp time as short as possible.

Keywords: Abdominal aortic aneurysm; aortic aneurysm; aortic rupture; surgical clamp.

ÖZ

Amaç: Bu çalışmada rüptüre abdominal aort anevrizmalarında hiatal ve torakal klemplemenin ameliyat sonrası morbidite ve mortalite üzerindeki etkileri incelendi.

Çalışma planı: Bu retrospektif çalışmaya kliniğimizde Mart 2005 - Haziran 2013 tarihleri arasında rüptüre abdominal aort anevrizmaları için açık tamir uygulanan 47 hasta (35 erkek, 12 kadın) dahil edildi. Torakal ve hiatal klempleme sırasıyla 26 (19 erkek, 7 kadın; ort. yaş 68.5±7.9) ve 21 (16 erkek, 5 kadın; ort. yaş 66.1±7.8) hastaya uygulandı. Ameliyat sonrası komplikasyonlar ve mortalite iki grup arasında tek değişkenli ve çok değişkenli analizlerle değerlendirildi.

Bulgular: Toplam mortalite %36.7 (n=18) idi ve iki grup arasında anlamlı farklılık yoktu. Tek değişkenli analizler ameliyat sonrası solunum komplikasyonları (p=0.59), renal yetmezlik (p=0.98), cell saver kullanımı (p=0.26) ve intestinal iskemi (p=0.08) açısından iki grup arasında anlamlı farklılık göstermedi. Hastanede kalış süresi torakal klempleme grubunda daha uzun idi (p=0.01). Yaş ve klemp zamanı (>30 dakika) hastane mortalitesini anlamlı olarak artırdı.

Sonuç: İnfrarenal klemplemenin uygun olmadığı hastalarda ameliyat sonrası komplikasyonlar karşılaştırıldığında hiatal ve torakal klempleme birbirinden üstün değildi. Klemp süresi mümkün olduğunca kısa tutularak her iki teknik güvenle uygulanabilir.

Anahtar sözcükler: Abdominal aortik anevrizma; aortik anevrizma; aortik rüptür; cerrahi klemp.

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Abdominal aortic aneurysms (AAAs) are one of the most common causes of mortality and morbidity in the male population, with an incidence rate of between 1.8% and 6.6% in males over the age of 60.[1,2] The operative mortality rate is 5% in elective cases and 50-60% in ruptured cases.[3] In 1952, Dubost et al.[4] performed the first successful AAA repair, but despite recent technological advances in AAA surgeries, the mortality for ruptured AAA (rAAA) surgery still ranges between 20 and 90%.[5] Nevertheless, there have been promising results associated with endovascular stenting procedures for the treatment of rAAAs.[6,7] Advanced age, chronic obstructive pulmonary disease (COPD), renal failure, and coronary artery disease (CAD) are the major risk factors that affect mortality and morbidity in patients with AAAs; hence, preoperative evaluation should be conducted with these risk factors in mind in order to reduce the mortality and morbidity rates after unruptured AAA surgery. On the other hand, in rAAA cases, the proximal clamping site (infrarenal, hiatal, or thoracic), duration of distal anastomosis, and use of a cell saver affect mortality and morbidity. In this study, we compared the results of hiatal and thoracic clamping to evaluate their effectiveness.

PATIENTS AND METHODS

In this study, we retrospectively analyzed the data of 47 patients (35 males, 12 females) who had surgery for rAAAs between March 2005 and June 2013 and compared the outcomes of 26 who underwent thoracic clamping (19 males, 7 females; mean age 68.5±8.0) and 21 who underwent hiatal clamping (16 males, 5 females mean age 66.1±7.8) (Table 1). All patients who underwent infrarenal clamping were excluded.

All patients were operated on in the supine position at a 30 degree angle facing right. We performed a median laparotomy and explored the aorta via a transperitoneal approach. We then performed the hiatal clamping by exploring the omentum minus in hemodynamically stable cases with aortic aneurysms that were unsuitable for infrarenal clamping. For the patients with hypotension, shock, and cardiac arrest and for those who had previously undergone abdominal surgery, we performed a left anterolateral thoracotomy and cross-clamped the descending aorta just above the diaphragm. In addition, we used tubular or Y-aortic bifurcation grafts made of either Dacron or polytetrafluoroethylene (PTFE). In 39 patients, the Medtronic, SEQUESTRA 1000 model Cell Saver® autotransfusion system (Medtronic, Texas, USA) was utilized after taking into account factors such as preoperative blood loss, the patient's blood group, and the availability of this autotransfusion system.

Next, the respiratory, renal, intestinal, and cardiac complications were compared along with the need for re-exploration, in hospital mortality, the use of autotransfusion, the need for blood transfusion, and hospital stay duration between the thoracic and hiatal clamping groups.

Statistical methods

Statistical analyses were performed using the SPSS version 15.0 for Windows software program (SPSS Inc., Chicago, IL, USA). The variables were investigated using both visual (histograms and probability plots) and analytical methods (Kolmogorov-Smirnov and Shapiro-Wilk tests) to determinate whether or not they were normally distributed. Descriptive analyses were presented using mean ± standard deviation (SD) for normally distributed variables and frequency tables for categorical variables. In addition, the descriptive analyses were presented using medians and inter-quartile ranges (IQRs) for the non-normally distributed and ordinal variables. The normally distributed variables were compared using Student's t-test, and the non-normally distributed variables were compared using the Mann-Whitney U test. Furthermore, the categorical variables were compared using a chi-square or Fisher's exact test, and the overall mortality results were analyzed via multivariant logistic regression. A p value of less than 0.05 was considered to be statistically significant for these comparisons. The independent predictors were analyzed by employing univariant logistic regression to assess the cause of overall mortality, and any variants with a value of $p<0.20$ (age, gender, respiratory failure, intestinal ischemia, acute renal failure, relapse, clamp duration, and hospital stay duration) were analyzed using Spearman's correlation test and the Akaike information criterion (AIC). The variants that met the appropriate criteria were then selected (age, clamp duration, and acute renal failure) and were included in the new model, which was analyzed via multivariant regression. The goodness of fit of the new model was assessed using the Hosmer-Lemeshow test.

RESULTS

The preoperative demographic data showed no statistically significant differences between the thoracic and hiatal clamping groups with respect to factors such as age, gender, CAD, COPD, hypertension (HT),

Table 1. Preoperative variables

Preoperative	Hiatal group (n=21)			Thoracic group (n=26)			
	n	%	Mean±SD	n	%	Mean±SD	*p*
Age (years)			66.1±7.8			68.5±8.0	0.29
Male	16	76.2		19	73.1		0.80
Coronary artery disease	8	38.1		13	50		0.41
Chronic obstructive pulmonary disease	5	23.8		8	30.8		0.59
Hypertension	11	52.4		15	57.7		0.71
Diabetes mellitus	3	14.3		5	19.2		0.65
Smokers	8	38.1		12	46.2		0.57
Hypovolemic shock	3	14.3		4	15.4		0.91

SD: Standard deviation.

diabetes mellitus (DM), and shock (Table 1). Eighteen of the patients (36.7%) did not survive, but there were no statistically significant differences in the mortality rates between the two groups.

There were also no statistically significant differences in the operative parameters such as the need for transfusion, the use of tubular or Y-aortic bifurcation grafts, clamp duration, the amount of blood collected by the autotransfusion system, and intestinal ischemia (Table 2).

Moreover, a postoperative evaluation of the data revealed no statistically significant differences with regard to respiratory failure, acute renal failure, or re-exploration. However, the hospital stay duration was longer in the thoracic clamping group ($p<0.01$) (Table 2).

Furthermore, we also assessed the clamp duration and age as a predictor of overall mortality (Table 3).

DISCUSSION

Abdominal aortic aneurysm is the most common aortic pathology. In spite of technological advances in the diagnosis and treatment of this condition, the mortality rates for rAAA are still high, with overall rates, including those cases that could not reach hospital care, ranging from 77-94%.[8] Currently, early diagnosis and treatment is crucial for AAAs, and the easiest and most consistent diagnostic test is computed tomography (CT),[9] which determines the clamping site during the preoperative period. Thoracic or hiatal clamping is a commonly used technique in cases not suitable for infrarenal clamping or in cases with unstable hemodynamics. While suprarenal cross-clamping increases the risk of visceral organ injury, it does allow for the management of hypotension and helps patients recover from shock by increasing their blood pressure, thereby making it possible to perform the bypass procedure.[10,11] In 1974, Mattox et al.[12]

Table 2. Operative and postoperative variables

Preoperative	Hiatal group (n=21)			Thoracic group (n=26)			
	n	%	Mean±SD	n	%	Mean±SD	*p*
Blood (units)			4.6±1.4			4.7±1.5	0.67
Plasma (units)			3.4±0.7			3.7±1.3	0.69
Clamp time (minutes)			25.3±5.1			26.8±4.6	0.42
Hospitalization (days)			11.0±3.2			12.2±2.3	0.01
Y-graft	14	66.7		16	61.5		0.71
Tube-graft	7	33.3		10	38.5		0.71
Cell-saver	16	76.2		23	88.5		0.26
Intestinal ischemia	1	4.8		6	23.1		0.08
Shortness of breath	5	23.8		8	30.8		0.59
Acute renal failure	4	19		5	19.2		0.98
Re-laparatomy	2	9.5		6	23.1		0.21
Hospital mortality	7	33.3		11	42.3		0.52

SD: Standard deviation.

Table 3. Preoperative and intraoperative variables affecting mortality

Causes of mortality	Relative risk	95% Confidence interval	*p*
Age (>70 years)	1.141	1.021-1.275	0.020
Clamp duration (>30 min.)	1.224	1.027-1.458	0.024

performed proximal clamping at the thoracic aorta for the first time. This method is used to stop blood loss in patients who are in shock in order to save time for volume replacement. In a study composed of 123 cases, Coselli et al.[13] suggested that thoracic and hiatal clamping for rAAAs be performed with distal anastomosis because this technique leaves the aortic wall intact without an intimal flap, calcification, or debris. In addition, this type of anastomosis is easily visualized, allowing for it to be performed safely.

Research has been conducted on multiple factors that affect mortality and morbidity in surgery for rAAAs. In a study made up of 229 rAAA cases, Marković et al.[14] determined that high mortality was related to preoperative hypotension, shock, renal failure, hemorrhage, the excessive need for transfusion, and the use of aortobifemoral grafts. In our study, we found no relationship between mortality and the clamp site; however, age and clamp duration did have a significant effect (Table 2). Sasaki et al.[15] reported that when suprarenal clamping lasts longer than 30 minutes, it significantly increases the risk of postoperative renal failure. Thus, renal protection should be performed to avoid this complication. In our study, there were no significant differences between the clamp duration in the two groups, and we also observed that a clamp duration of longer than 30 minutes increased the mortality rate (Table 2). Severe hypotension, hypovolemic shock, and previous abdominal surgery are factors which may complicate hiatal exploration; therefore, thoracic clamping can be performed in those cases. Additionally, some studies have observed that thoracic clamping may cause respiratory and intestinal complications.[10,16] In their study of 102 cases, Islamoglu et al.[17] found that mortality, the need for a blood transfusion, and respiratory and intestinal complications were significantly higher when thoracic clamping was performed rather than hiatal clamping. However, we observed no significant differences between the hiatal and thoracic clamping groups in our study, except that the hospital stay duration was significantly longer in the thoracic clamping group (p=0.01). In another study by Islamoglu at al.[18] that involved 61 rAAA cases, 32 of the patients did not survive, and four of these deaths (8%) occurred in the hiatal and infrarenal clamping groups. They also determined that preoperative unstable hemodynamics, prolonged clamp duration, and postoperative renal failure were related to the increased mortality in their study. Additionally, they reported that postoperative respiratory complications, the need for a blood transfusion, and hospital stay duration were significantly higher in the hiatal clamping group than in the infrarenal clamping group. Moreover, Fedakar et al.[19] determined that the in hospital mortality rate for patients with rAAAs was 52%, but in our study, this rate was only 36.7%.

Conclusion

Our study results showed that there were no differences between the hiatal and thoracic clamping techniques or the complications associated with these procedures. The only difference was that the hospital stay duration was longer in the thoracic clamping group. In addition, as expected, we found that age and prolonged clamp duration were factors that affected morbidity and mortality in both groups. Therefore, our findings indicate that both the hiatal and thoracic clamping techniques can be used safely when the clamping duration is less than 30 minutes in emergent rAAA cases in which infrarenal clamping is not feasible.

Declaration of conflicting interests

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