Surgical Treatment of Acute Type A Aortic Dissection: In-Hospital Outcomes and Long-Term Follow-Up

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SUMMARY

Background
Acute type A aortic dissection (TA-AAD) is an extremely severe condition that requires emergency surgery. In spite of advances in surgical techniques, the procedure still carries great morbidity and mortality rates.

Objectives
To analyze in-hospital morbidity and mortality and long-term survival of a consecutive series of patients undergoing surgery for TA-AAD.

Material and Methods
We included 63 consecutive patients (71% were men) in four health care centers in Buenos Aires from July 1994 to May 2007. Eighty nine percent of patients completed follow-up. Mean age was 63±11.3 years. Aortic hemiarch was replaced in 15 patients and 5 patients received complete aortic replacement. Aortic valve replacement was performed in 12 patients.

Results
During hospitalization 19 patients (30.1%) died: one death occurred at the operation room, 7 patients died due to ischemic complications or multi organ failure, 3 patients died of neurological complications, 5 of cardiac complications, 1 of gastrointestinal bleeding and 2 deaths were a consequence of multiple complications. Twelve patients (32.4%) died during follow-up (8 cardiac deaths and 4 non cardiac deaths). Multivariate analysis detected that low cardiac output and cardiac bypass pump (CBP) duration were associated with greater in-hospital mortality rates, while age >70 years and lower CBP duration correlated with greater long-term mortality. Survival rates at 1, 3, 5 and 10 years were 89%, 79,5%, 73% and 58%, respectively.

Conclusions
Surgical results of TA-AAD in our environment are similar to those published in international series, confirming high in-hospital and long-term morbidity and mortality rates associated with this condition.

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Key words > Aorta - Thoracic Surgery - Dissection

Abbreviations >

CPB	Cardiopulmonary bypass	**PND**	Postoperative neurologic deficit
CABGS	Coronary artery bypass graft surgery	**DHCA**	Deep hypothermic circulatory arrest
TA-AAD	Type A acute aortic dissection	**LCOS**	Low cardiac output syndrome

BACKGROUND

Mortality rate of type A acute aortic dissection (TA-AAD) is 1% per hour by 24 hours after presentation, 29% by 48 hours, 44% by day 7, and 50% by 2 weeks. (1, 2) For this reason, urgent surgical intervention with the aim of resecting the region of intimal tear and replacement by a composite or interposition graft (if the aortic valves are intact or resuspendable) is still the best therapeutic strategy. In 20-30% of cases the intimal tear may extend to the aortic arch and, therefore, require an extended aortic replacement.

In spite of the advances in diagnostic (4, 15, 16) and surgical techniques (5-14), TA-AAD still carries great morbidity and mortality rates at short and long-term, with in-hospital mortality rates between 15%

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and 35%, and 5-year survival rates of 65% to 75%. (3, 17, 20)

The aim of this study is to analyze in-hospital morbidity and mortality and long-term survival of a consecutive series of patients undergoing surgery for TA-AAD, and to detect the variables associated with short-term and long-term outcomes.

MATERIAL AND METHODS

Patients Selection

We conducted a retrospective analysis of 63 patients included in a database, who underwent surgery due to TA-AAD in 4 health centers in Buenos Aires from July 1994 to May 2007. The information was included in an ad-hoc database; follow-up was performed by telephone contact with patients or their relatives, and with their family physicians.

Type A acute aortic dissection was defined as any non-traumatic dissection involving the ascending aorta, presenting within 14 days from symptom onset. (2, 18, 19)

The majority of patients (71.4%) were men. The mean age was 63 ± 11.3 years; 21 patients (33.3%) were older than age 70 at the moment of surgery. Table 1 shows that hypertension was the most prevalent cardiovascular risk factor (89%) and 36.5% of patients had diabetes.

Chest pain was the most frequent symptom at admission in 95% of cases and only 4 patients had clinical signs of shock. The diagnosis of TA-AAD was made by transesophageal echocardiography in 48.4% of cases and by computed tomography, magnetic resonance imaging and angiography in the remaining patients. Surgery was performed within 2 hours of hospitalization in 86.9% of patients.

Surgical technique

After median sternotomy, the patient was placed on cardiopulmonary bypass (CPB); arterial cannulation was performed via the following accesses: femoral artery (41.3%), right subclavian artery or right axillary artery (31.7%), aortic arch (12.7%), carotid artery (1.6%), or left ventricular apex (12.7%). Cannulation via the subclavian artery has been the access of choice since 1997. The extent of aortic replacement was decided considering the site of the intimal tear; every attempt was made to resect it. Deep hypothermic (16°) circulatory arrest (DHCA) was used for aortic arch replacement or distal open anastomosis. Brain protection was achieved via cerebral retrograde perfusion, and since 2004 antegrade cerebral perfusion is being used.

The intimal tear, or false lumen, reached the descending aorta or the abdominal aorta in 36 patients (57%). In 68% of patients, the intimal tear was limited to the ascending aorta, and this segment was replaced (Table 2). Fifteen patients required partial arch replacement and 5 total arch replacement. Aortic valve replacement was performed in 12 patients; 39 patients underwent aortic valve resuspension or aortic arch remodeling (Yacoub's resuspension technique was used in two patients), and 12 patients did not have any intervention in the aortic valve. In 7 patients undergoing aortic valve replacement a separate valve-graft was implanted, whereas 5 patients underwent valved conduit implant using the modified Bentall-DeBono procedure.

Eleven patients (17.5%) underwent coronary artery bypass graft surgery (CABGS).

Mean CPB time was 155.4 ± 47.5 minutes and DHCA was 38.8 ± 25.6 minutes (Table 2).

Table 1. Preoperative characteristics

Preoperative data, demographics and personal history (n = 63)	
Variables	
Age (years)*	63 ± 11.3
Men (%)	45 (71.4)
Symptoms > 24 hrs (%)	8 (13)
Pain	60 (95)
Syncope	4 (6.3)
Mesenteric/limb ischemia	13 (20.6)
Shock	4 (6.3)
Hypertension (%)	56 (89)
Diabetes	23 (36.5)
Previous coronary artery disease	9 (14)
Previous aortic disease	3 (4.8)
Previous cardiovascular surgery	6 (9.6)
Stroke	2 (3)
Marfan syndrome	2 (3)

* Mean ± standard deviation.

Table 2. Intraoperative characteristics (n = 63)

Variables	
Length of aortic dissection (%)	
Ascending aorta	12 (19)
Aortic arch	15 (23.8)
Descending aorta	15 (23.8)
Abdominal aorta	21 (33.4)
Length of aortic replacement (%)*	
Ascending aorta	43 (68.3)
Hemiarch	15 (23.8)
Ascending aorta + total arch	5 (7.9)
Contained hematoma	3 (5.3)
Pericardial effusion	29 (46.8)
Cardiopulmonary bypass time (min)	155.4 ± 47.5
Myocardial ischemic time (min)	97 ± 39.6
Deep hypothermic circulatory arrest (DHCA) (min)	38.8 ± 25.6
Minimal esophageal temperature (°C)	16.7 ± 2.9
Aortic valve (%)	
No surgical intervention	12 (19)
Replacement	12 (19)
Resuspension	39 (62)
Concomitant CABGS (%)	11 (17.5)
Any complication [n = 62] (%)†	47 (75.8)
Reoperation	6 (9.7)
Myocardial infarction	9 (14.5)
PND	12 (19.4)
LCOS	14 (22.6)
Infection	28 (45.2)
Renal failure	36 (58)

* Length of the aortic replacement according to the site of intimal tear.
† One patient died during surgery.
CABGS: Coronary artery bypass graft surgery. LCOS: Low cardiac output syndrome. PND: Postoperative neurologic deficit.volumen minuto. DNP: Déficit neurológico posoperatorio.

Definitions

Low cardiac output syndrome (LCOS): postoperative hemodynamic state requiring the use of inotropic agents or ventricular assist device to maintain an adequate cardiac index (> 2.2 L/min/m²); infection: the presence of any type of infection during the postoperative period; acute renal failure: increase in serum creatinine levels of at least 0.5 mg/dl or of more than 25% above basal values; postoperative neurologic deficit (PND): presence of new neurologic symptoms which may be transient or definitive, due to local or diffuse lesion.

Statistical Analysis

Continuous variables were expressed as mean ± standard deviation or range, and categorical variables as percentages. Univariate analysis was performed using chi square test and/or two-tailed Fisher test for categorical variables and Student's *t* test for continuous variables. A p value < 0.05 was considered statistically significant. A multivariate logistic regression analysis was performed thereafter to identify independent risk factors associated with in-hospital mortality and long-term mortality (variables with unadjusted p value < 0.5 were included). Preoperative variables were incorporated first; significant variables were retained in the model. Then, perioperative variables were added. The Kaplan-Meier method was used to calculate long-term survival. Survival percentages with their corresponding 95% confidence intervals in different periods are informed.

RESULTS

During hospitalization 19 patients (30.1%) died: one death occurred during the surgery, 7 patients died due to ischemic complications or multiorganic failure, 3 patients died of neurological complications, 5 of cardiac complications, 1 of gastrointestinal bleeding and 2 as a consequence of multiple complications.

A total of 75.8% of patients presented a complication during the postoperative period. The most frequent adverse events were renal failure (36 patients; 58%), infections (28 patients; 45%; none of them related to the surgical wound); LCOS (14 patients; 22.6%) and PND (12 patients; 19.4%).

Complete follow-up was achieved in 89% of the 44 patients (69.9%) discharged (median follow-up: 6.4 years: range 11 days to 11.7 years). Twelve patients (32.4%) died during long-term follow-up: (4 non cardiac deaths and 8 cardiac deaths, 4 of the latter were related with the aortic disease: 1 abdominal aorta rupture, 1 thoracic aorta rupture and 1 after the reoperation of the proximal aorta) (Figure 1).

Only 2 patients underwent reoperation of the proximal aorta. One of them died in the postoperative period.

Survival rates of patients discharged at 1, 3, 5 and 10 years were 89% (95% CI, 73-95), 79.5% (95% CI, 61-89), 72% (95% CI, 53-84)and 57.7% (95% CI, 36-74), respectively (Figure 2). In the entire group, survival at 1, 3, 5 and 10 years was 59.9% (95% CI, 45-71), 54% (95% CI, 39-65), 48.9% (95% CI, 34-61) and 38.8% (95% CI, 24-53), respectively.

Univariate analysis identified that the factors associated with in-hospital mortality were age, CBP time, the presence of LCOS and of any postoperative complication; concomitant CABGS showed a statistical trend. Multivariate analysis detected LCOS and prolonged CPB time as independent variables.

Short CPB time was associated with long-term mortality at univariate analysis, while age, long cerebral perfusion time and pericardial effusion presented a statistical trend. Multivariate analysis identified age 70 years and short CBP time as independent variables (Tables 3 and 4).

DISCUSSION

Acute type A aortic dissection (TA-AAD) is an extremely severe condition that requires emergency surgery. In the IRAD registry (International Registry of Acute Dissection), 72% of 464 patients had TA-AAD. In patients managed surgically, in-hospital mortality was 26% versus 58% among those not receiving surgery. (2)

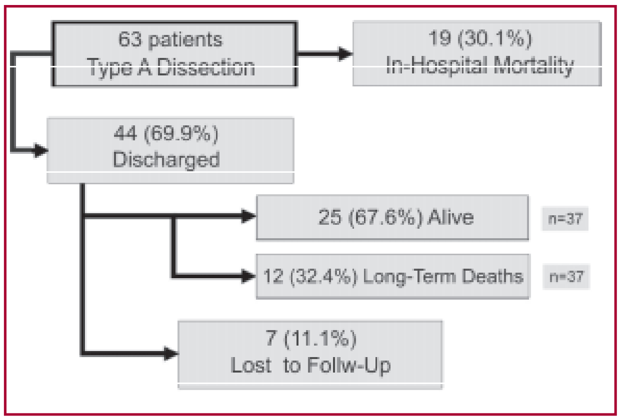

Fig. 1. Flow chart representing follow-up of patients, in-hospital mortality and long-term mortality.

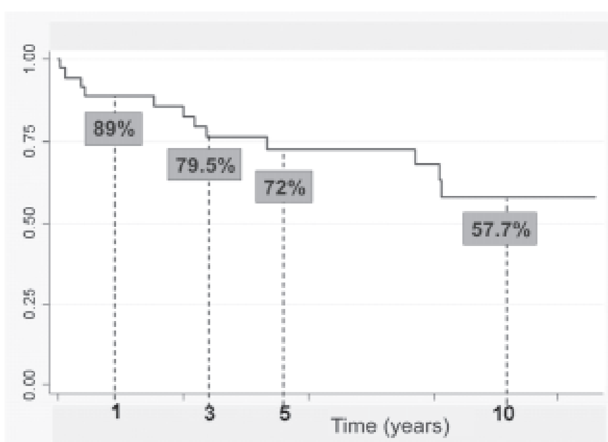

Fig. 2. Curva de sobrevida durante el seguimiento (Kaplan-Meier) de los pacientes dados de alta.

Table 3. Univariate analysis of in-hospital and long-term mortality

Categorical variables		IHM n dead / total N° (%)	p	LTM n dead / total N° (%)	p
Age > 70 years	Yes	11/21 (52.4%)		5/9 (55.5%)	
	No	8/42 (19%)	**0.01**	7/28 (25%)	**0.10**
Men		12/45 (26.7%)		7/28 (25%)	
Women		7/18 (39%)	ns	5/9 (55.5%)	ns
Hypertension	Yes	18/56 (32%)		10/32 (31%)	
	No	1/7 (14.3%)	ns	2/5 (40%)	ns
Diabetes	Yes	8/23 (34.8%)		5/11 (45.5%)	
	No	11/40 (27.5%)	ns	7/26 (27%)	ns
Visceral or limb ischemia	Yes	6/13 (46%)		2/6 (33%)	
	No	13/50 (26%)	ns	10/31 (32%)	ns
Pericardial effusion	Yes	9/29 (31%)		8/16 (50%)	
	No	9/33 (27%)	ns	4/21 (19%)	**0.07**
CABGS	Yes	6/11 (54.5%)		1/2 (50%)	
	No	13/52 (25%)	**0.07**	11/35 (31%)	ns
Aortic valve replacement	Yes	4/12 (33%)		3/6 (50%)	
	No	15/51 (29.4%)	ns	9/31 (29%)	ns
Aortic valve resuspension	Yes	8/39 (20.5%)		8/26 (30.7%)	
	No	11/24 (45.8%)	**0.04**	4/11 (36.3%)	ns
Preoperative shock	Yes	2/4 (50%)		1/2 (50%)	
	No	17/59 (29%)	ns	1/35 (31%)	ns
Postoperative complication	Yes	17/47 (36%)		9/26 (34.6%)	
	No	1/15 (7%)	**0.04**	3/11 (27%)	ns
Low cardiac output	Yes	10/14 (71%)		2/4 (50%)	
	No	8/48 (17%)	**< 0.001**	10/33 (30%)	ns
PND	Yes	4/12 (33.3%)		1/7 (14%)	
	No	14/36 (28%)	ns	11/19 (37%)	ns
Continuous variables‡		**IHM**	**p**	**LTM**	**p**
CPB time (min)	dead	181.6 ± 13.5		120.4 ± 29	
	alive	145 ± 6	**0,015**	158 ± 42	**0.009**
Circulatory arrest time (min)	dead	34.4 ± 3		45 ± 4	
	alive	40.4 ± 4	ns	41 ± 7	ns
Cerebral perfusion (min)	dead	33.9 ± 4		42.6 ± 12	
	alive	36 ± 3	ns	36.4 ± 28	**0.06**

‡ Expressed as mean ± standard deviation. CABGS: Coronary artery bypass graft surgery. CPB: Cardiopulmonary bypass. IHM: In-hospital mortality. LTM: Long-term mortality. PND: Postoperative neurologic deficit.

Table 4. Multivariate analysis of in-hospital and long-term mortality

IHM variables	Odds ratio	p	95% CI
Cardiopulmonary bypass time (min)	1.03 ± 0.01	0.021	1.005 a 1.06
Low cardiac output syndrome	8.8 ± 8	0.022	1.40 a 56.8
LTM variables	**Odds ratio**	**p**	**95% CI**
Cardiopulmonary bypass time	0.96 ± 0.01	0.038	0.92 a 0.99
Age > 70 years	25.7 ± 16	0.021	1.64 a 404

IHM: In-hospital mortality. LTM: Long-term mortality.

Despite improved diagnostic and therapeutic techniques and postoperative management, different groups have reported morbidity and mortality rates that vary from 15% to 35%. (3, 17, 20) In our experience, in-hospital mortality was 30.1%, similar to the one reported by the IRAD.

Among the preoperative predictive factors for mortality, most series have identified age, hypotension/shock/cardiac tamponade, previous heart disease or cardiovascular surgery, renal, mesenteric or myocardial ischemia, and migrating pain. Perioperative predictive factors include extended surgery (replacement of the ascending aorta, aortic ach and descending aorta versus ascending aorta and hemiarch replacement), hematoma, acute renal failure and neurologic deficit. (2, 17-20, 35)

In our series, although the age > 70 years was associated with in-hospital mortality (52.4% versus 19%; $p = 0.01$), CPB time and LCOS in the postoperative were the only variables independently related.

In our study, extended replacement of the aortic arch was not identified as an independent risk factor associated with in-hospital mortality. In their series of 124 surgeries, Ehrlich et al. (17) described that the site of the intimal tear did not correlate with the outcomes; however, they detected differences in mortality rates according to the extension of the aortic replacement: 43% when the resection included the descending aorta versus 14% when only the ascending aorta or the hemiarch were replaced. Nevertheless, we found that longer CPB time was an independent predictor. This might be attributed to the fact that complex surgical techniques are needed to repair proximal lesions or complicated intimal tears of the distal aorta, rather than to total replacement of the arch, to the presence of adhesions due to previous surgery, difficult hemostasis during surgery or need of concomitant surgery.

In fact, surgical therapies including CABGS had greater in-hospital mortality (54.5% versus 25%; $p = 0.07$), and this variable was an independent predictor of mortality during hospitalization in the studies by Kazui and Rampoldi (21, 29).

Postoperative complications have been associated with greater in-hospital mortality. Griepp et al. (5) found that the presence of a single complication in 71 out of 121 patients (58.6%) was associated with higher mortality (21% versus 2%; $p = 0.002$). In our series, 75% of patients had at least one postoperative complication, and mortality was greater among these patients (36% versus 7%; $p = 0.04$); LCOS was an independent predictor (71% versus 17%; $p < 0.001$) of mortality with almost a 9-fold increase in the risk compared to patients who were hemodynamically stable.

Postoperative neurologic deficits have been associated with increased morbidity and mortality. (20) The incidence of PND in the published literature ranges from 10% to 20%, with a value of 19.4% in our series. (17, 22, 23) Hagl et al. (24) suggest that focal PND are due to embolic events and therefore, they would not be related to the type of brain protection. Conversely, transient PND (such as psychomotor agitation, delusion, etc.) which is associated with brain protection, and lower long-term mortality, are less frequent with antegrade cerebral perfusion (20). We used cerebral retrograde perfusion from 1994 to 2004, and we have been using antegrade cerebral perfusion since 2004. However, we have not seen any significant differences in the incidence of neurologic events or in mortality since then due to the small number of interventions performed.

The small sample size might also explain the absence of the other predictors mentioned in international registries.

The wide variability in in-hospital mortality reported in the different series (15% -35%) might be attributed to heterogeneity among the study populations. In our study, we found that mortality was 30.1% in an elder population with a high prevalence of diabetes compared to the majority of series that reported lower mortality. In our population, the mean age was 63 ± 11years, and 36.5% had diabetes, while patients included in the series of Griepp et al. (5) had a mean age of 59 ± 14 years and only 4.8% were diabetics; mortality in this group was 15.3%. Lai et al. (25) and Martín et al. (20) reported mortality rates similar to Griepp; mean age was 56 ± 15 and 59 years, respectively; 7% of patients were diabetics. In contrast, the first 464 patients of the IRAD had a mean age of 61.2 ± 14 years and mortality of 26% (2); these findings are similar to our series. In the study by Rampoldi et al., (29) mean age was 59 ± 13.5 years in survivals versus 62.9 ± 14.3 years in patients who died ($p < 0,01$).

A recent review of the IRAD categorized 550 patients and reported that 32% were older than 70 years with a global mortality of 27%. Fewer elderly patients were managed surgically than younger patients (64% vs. 86%, $p < 0.0001$). In-hospital mortality was higher among older patients (38% vs. 23%, $p = 0.003$). (26) However, mortality was greater in patients managed surgically (52.5% vs. 38%). Among 319 patients in a study by Piccardo et al. (27), 23 patients were aged 80 years or older (7%). In this subgroup of patients in-hospital mortality was 61% and survival was 39% ± 10% and 33% ± 10% after 1 and 5 years, respectively.

In our series, LCOS was more frequent in patients older than 70 years (45% versus 12%; $p = 0.008$). Surgery should not be contraindicated in this subgroup of patients; however, candidates with less comorbidities and risk of perioperative complications should be carefully selected. A less aggressive approach should increase the outcomes of surgically managed patients. Hata et al. (28) randomized 42 octogenarians undergoing emergency surgery for TA-AAD in two groups: classic surgery with deep hypothermic circulatory arrest and selective cerebral perfusion versus less invasive quick replacement. The latter technique consists on circulatory arrest with a rectal temperature of 28°C. As soon as the distal anastomosis is completed, rapid rewarming is initiated. The duration of CPB was shorter and in-hospital mortality was lower with the less invasive quick replacement.

In our study, 5-year survival after discharge was 72%, similar to the one reported by other studies (65% to 84%). (17, 20, 22, 29, 30) Age > 70 years and short CPB time were identified as predictors of long-term mortality. Although a radical surgery of the proximal or distal aorta with resection of the intimal tear requires longer CP time with greater perioperative mortality rate, long-term mortality is lower due to reduced reoperation rate and long-term complications. The Department of Cardiovascular Surgery, at the Stanford University School of Medicine, reported reoperation rates of 30% in patients undergoing replacement of the ascending aorta without arch repair. (31)Total replacement of the aortic arch was associated with reduced distal reoperation (32) and did not seem to be related with increased operative risk. (33) Yet, in a series of 70 patients undergoing aortic arch replacement, 5-year survival was inversely related with the perioperative risk (85% versus 72%). (34)

According to what has been previously commented, one might assume that extended surgeries require higher CBP times for a better repair of the proximal aorta, in an attempt to preserve the aortic valve, and of the distal aorta in order to resect the intimal tear. However, these procedures, which are more likely to present periopertative complications with higher in-hospital mortality, might improve long-term outcomes probably due to a reduced incidence of complications in the proximal and distal aorta.

In patients older and with more comorbidities, a less aggressive approach should be considered to achieve a shorter CPB time. The risk of extended surgeries overcomes the potential benefit, emphazising the need of an adequate stratification of patients in order to decide the most suitable technique in each patient.

Study Limitations

Our study is observational and retrospective. The number of patients is small due to the low incidence of this disease and thus limits the statistical power of the findings. As the surgical technique has been modified in the last years, the different periods are not completely comparable.

CONCLUSIONS

Surgical results of TA-AAD in our environment are similar to those published in international series, confirming high in-hospital and long-term morbidity and mortality rates associated with this condition

Postoperative complications are frequent, especially acute renal failure, infections and LCOS; the latter is an independent predictor of in-hospital mortality.

Extended surgeries with long CBP times are associated with greater in-hospital mortality but reduced long-term mortality. Data from ongoing multicenter and prospective studies will contribute to know the best surgical strategy and the relation between the type and extension of the surgery with long-term outcomes.

RESUMEN

Cirugía en la disección aórtica aguda tipo A: resultados hospitalarios y seguimiento alejado

Introducción
La disección aguda de la aorta tipo A (DAA-A) es una emergencia que requiere cirugía inmediata, debido al mal pronóstico de su evolución natural. A pesar del avance en las técnicas quirúrgicas, el procedimiento aún tiene una morbimortalidad elevada.

Objetivos
Analizar la morbimortalidad hospitalaria y la sobrevida alejada de una serie consecutiva de pacientes operados por DAA-A.

Material y métodos
Se incluyeron 63 pacientes consecutivos (el 71,4% eran hombres) en cuatro centros asistenciales de Buenos Aires desde julio de 1994 a mayo de 2007. El seguimiento se realizó en el 89% de los pacientes. La edad promedio fue de 63 ± 11,3 años. En 15 pacientes, el reemplazo se extendió hasta el hemiarco y en 5 se reemplazó el arco completo. La válvula aórtica se reemplazó en 12 pacientes.

Resultados
Durante la estadía hospitalaria fallecieron 19 pacientes (30,1%): un caso durante la cirugía, 7 por complicaciones isquémicas o falla multiorgánica, 3 por complicaciones neurológicas, 5 por complicaciones cardíacas, 1 por hemorragia digestiva y 2 pacientes a consecuencia de múltiples complicaciones. Durante el seguimiento fallecieron 12 pacientes (32,4%): 8 casos de causa cardiovascular y 4 de causa no cardíaca. El análisis multivariado detectó que las variables asociadas con mayor mortalidad hospitalaria fueron el bajo volumen minuto y el tiempo de circulación extracorpórea (CEC) prolongado, en tanto que las asociadas con mayor mortalidad alejada fueron la edad > 70 años y un tiempo menor de CEC. La sobrevida a 1, 3, 5 y 10 años fue del 89%, 79,5%, 73% y 58%, respectivamente.

Conclusiones
Los resultados del tratamiento quirúrgico de la DAA-A en nuestro medio pueden asimilarse a los obtenidos en series internacionales, lo que a su vez confirma la elevada morbimortalidad hospitalaria y alejada de esta entidad.

Palabras clave > Aorta - Cirugía torácica - Disección

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