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Value of preoperative D-dimer level as a prognostic indicator in patients with acute type A aortic dissection

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Abstract

Background: Quite severe Quick surgical repair is necessary to prevent death in cases of aortic dissection, a cardiovascular emergency.

Aim and objectives: We looked at the predictive value of preoperative D-dimer level for early postoperative death and bad outcomes in patients with acute type A aortic dissection.

Patients and methods: We enrolled fifteen (15) consecutive patients in this prospective observational cross-sectional study who had symptoms of acute aortic dissection (Stanford type A) & had emergency surgical repair. Participants took part in the study at the Cardiothoracic Surgery Department at Kasr Al-Aini Hospitals, Cairo University, from May 2021 to February 2022.

Results: Diseases characterized by renal, hepatic, pulmonary, or neurological dysfunction were associated with a markedly elevated D-dimer level when contrasted with healthy controls. There was a perfect match between the sensitivity and specificity of 5.35 mg/L of D-dimer for death prediction and 5.35 mg/L of placebo. Both the sensitivity and specificity for the prediction of renal failure were 100% at 4.55 mg/L and 6.10 mg/L, respectively.

Conclusion: Most hospitals and clinics should have D-dimer on hand. In patients undergoing surgical repair for type A aortic dissection, our study found that higher preopermer levels were linked to an increased incidence of postoperative mortality and adverse events. Patients whose D-dimer levels are consistently high should be closely always observed.

Key words: Acute type A aortic dissection,D-dimer, renal failure,neurological dysfunction.

Introduction

D-dimer may be easily obtained at most medical facilities. Higher preopermer levels were associated with an increased incidence of postoperative mortality &negative consequences in patients participating in surgical repair for type A aortic dissection, according to our study. Patients with high levels of D-dimer should be continuously monitored.Very bad Cardiovascular crises such as aortic dissections necessitate rapid surgical correction (1).

At each hour after symptoms begin, the untreated death rate ranges between one and two percent. A prompt and precise diagnosis is crucial for improving a patient's prognosis and preventing catastrophic outcomes. Low blood pressure, fainting, and intense chest pain are symptoms that people with acute aortic dissection may have. These symptoms can be similar to those of a heart attack or pulmonary embolism. The highest risk factors for a population are aortic aneurysm, advanced age, male gender, and a history of arterial hypertension. Aortic dissection can occur at a younger age in people with bicuspid aortic valves, inherited connective tissue disorders such Marfan, Loeys Dietz, or Ehlers Danlos syndrome, or both. Accurate identification of acute aortic dissection and monitoring of patients at high risk for aortic illness are both supported by image analysis. Despite being in their infancy, readily available blood tests have great promise for improving patient monitoring and diagnosis (2).

Although surgical techniques have improved over the years, many complications and even fatalities occur following surgery (3).Although D-dimer is a sensitive biomarker for the diagnosis of acute aortic dissection, its function in predicting mortality and early postoperative outcomes remains uncertain, and the pathophysiology of the condition is associated with coagulation and inflammatory response pathways (4-6).When crosslinked fibrin breaks down, the resulting substance is called D-dimer. Due to the constant low natural fibrin formation and breakdown in vivo, healthy humans maintain a minimum D-dimer level. Elevated D-dimer levels indicate ongoing activation of the hemostatic and thrombolytic system. Less than half a microgram per milliliter, or 500 nanograms per milliliter, is the typical concentration of D-dimer. (7).

Developing clinical predictors of the prognosis of patients with acute type A aortic dissection can lead to better perioperative care, more accurate assessments of early postoperative prognosis, optimized treatment strategies, fewer severe complications in the early postoperative period, and a lower incidence of patients with poor prognoses in the early postoperative period. On top of that, it helps with pre-op conversations with patients and their loved ones to be more precise and accurate, so everyone knows how serious the patient's condition is (8).

With a focus on early postoperative mortality and adverse events, this study aimed to examine the outcome rates of patients with acute type A aortic dissection and varied preoperative D-dimer levels.

Patients and methods

Fifteen (15) consecutive patients experiencing symptoms of acute aortic dissection (Stanford type A) who received emergency surgical repair were included in this prospective observational cross-sectional investigation. The research took place from May 2021 to February 2022 at the Cardiothoracic Surgery Department of Kasr Al-Aini Hospitals, Cairo University, with the blessing of the relevant ethical committee.

Contrast-enhanced computed tomography (CT) and echocardiography were used to diagnosis ATAAD, and a D-dimer test was measured upon admission. All patients were proven to be COVID-19 negative using either a fast antigen test or a PCR test because the study was conducted during the era of COVID-19.

Inclusion criteria: Severe form Anyone who has undergone surgery to fix an aortic dissection could take part.

Exclusion criteria: Patients with malignant tumors, chronic organ failure, evidence of deep vein thrombosis (DVT) or pulmonary embolism, combined procedures, and chronic type A aortic dissection.

Methods:

Preoperative evaluations were conducted on all patients: A thorough patient history, physical exam, diagnostic tests, and imaging procedures including an electrocardiogram (ECG) and echocardiography

Surgical Techniques:

Everyone who needed a median sternotomy had one done. In every instance where the femoral artery was cannulated, cardiopulmonary bypass (CPB) and venous return via the right atrium were employed. Building an open distal anastomosis, removing the major intimal rip, and replacing the ascending aorta were the basic tasks. The aortic valve's anatomy and function could be studied by cross clamping the ascending aorta in its distal half, close to the innominate artery. Next, any intimal tears were located by performing supracoronary transection after the aorta was opened longitudinally. Cold blood cardioplegia was administered selectively antegradely through the coronary ostia to induce cardiac arrest. To safeguard the brain, retrograde cerebral perfusion was employed when needed.

After evaluating the patient, a group of surgeons determined the best course of surgery. When the intimal rip in the ascending aorta was discovered during the operation, it was replaced. When the intimal rip was present or extended to the aortic arch, we examined it while the patient was under circulatory arrest at a core temperature of around 25ºC and either partially or entirely replaced it. Surgical treatment was administered to the aortic valve or root according to their pathology. The conventional approach to coronary reconstruction was the button-Bentall technique, which entailed fastening buttons to the outside of the graft. After the proximal repair, an open distal anastomosis was performed. The patient was placed under hypothermic circulatory arrest for one session while the arch was evaluated. The 3-0 or 4-0 monofilament sutures utilized to construct the proximal and distal anastomoses were reinforced with a pericardial band. An arterial catheter was inserted into the ascending graft and, in most cases, continued via the femoral artery to initiate antegrade reperfusion. All patients were subsequently weaned successfully from cardiopulmonary bypass.

Follow-up data:

Cardiac thoracic surgery results and survival rates were collected from Cairo University Hospitals. Re-exploration for bleeding, inotropic support, vital stability, presence of acidosis, duration of intubation and mechanical breathing, organ dysfunction, patient survival, and time and reason of death are all part of the follow-up data.

Statistical Analysis

For data coding and entry, an application named SPSS, developed and maintained by IBM Corp. in Armonk, New York, USA, at version 28, was used. To show quantitative data, we utilized standard deviation and mean, and to show categorical data, we used frequencies (case count) and relative frequencies (%). The unpaired t test was used to compare the groups. [88] We employed the Chi-square (2) test for the purpose of comparing the groupings. When the anticipated frequency was less than 5, a more exact test was used. To find the optimal D-dimer cutoff value for adverse outcome identification, an area under the curve analysis was used to construct a receiver operating characteristic (ROC) curve. For statistical purposes, a p-value less than 0.05 was deemed significant.

Results

Table1: Study population demographics

Variable	**Value**

Age(year) (Mean±SD)		51.92±10.33(29.00-68.00)
Sex Count(%)	**Male**	18(72%)
	Female	7(28%)

With ages ranging from 29 to 68, the average age of the participants in this study was 51.92±10.33 years. Males made up eighteen (72%) of the patients.**(Table 1)**

Table2: Relationbetweenmortalityandsurgicaldataofstudy population

		Mortality		**P value**
		Yes	**No**	
		Count(%)	**Count(%)**	
Circulatory arrest	**Yes**	9(56.3%)	7(43.8%)	0.208
	No	2(22.2%)	7(77.8%)	
Operative procedure	**Valve sparing (TironeDavid)**	5(55.6%)	4(44.4%)	0.478
	Supracronary	2(25.0%)	6(75.0%)	
	Bentalloperation	4(50.0%)	4(50.0%)	
Re-exploration for Postoperative bleeding	**Yes**	7(77.8%)	2(22.2%)	**0.017***
	No	4(25.0%)	12(75.0%)	
Extubation	**Extubated**	0(0.0%)	14(100.0%)	**<0.001***
	Notextubated	11(100.0%)	0(0.0%)	
Inotropic support	**Yes**	11(50.0%)	11(50.0%)	0.230
	No	0(0.0%)	3(100.0%)	
Deep hypothermia	**Yes**	11(52.4%)	10(47.6%)	0.105
	No	0(0.0%)	4(100.0%)	

CPBtime(hour)Mean±SD	4.54±0.62	4.04±0.55	**0.043***
Crossclamptime(hour)Mean±SD	3.85±0.49	3.60±0.55	0.240
Circulatoryarresttime(minute) Mean±SD	21.00±4.06	19.57±2.51	0.429
Timeofextubation(hours) Mean±SD	-	19.21±18.12	-----

Patients who underwent re-exploration due to postoperative bleeding had a much greater mortality rate compared to those who did not experience postoperative bleeding (p=0.017*). Patients who were extubated had a far lower mortality rate than those who had failed weaning. A substantially longer duration of cardiopulmonary bypass was observed in patients who did not survive compared to those who did (4.54±0.62 vs 4.04±0.55 hrs., p=0.043*). Subject to the variables, no statistically significant correlation was found between mortality and the following: operating room technique, deep hypothermia administration, inotropic support requirements, cardiac arrest occurrence, cross clamp duration, cardiac arrest duration, or extubation duration. **(Table 2)**

Table3: RelationbetweenD-dimerlevelandoutcomeofpatients.

		D-dimer(mg/L)	**P value**
		Mean±SD	
Renalfailure	**Yes**	7.85±1.58	**<0.001***
	No	3.39±0.42	
Liverfailure	**Yes**	7.62±2.12	**0.032***
	No	5.11±2.41	
Respiratoryfailure	**Yes**	8.55±0.92	**0.042***
	No	5.46±2.50	
Neurologicaldysfunction	**Yes**	8.29±1.24	**<0.001***
	No	4.49±2.04	

We regarded a p-value less than 0.05 to be significant., mg/L: Milligrams per litre, SD: standard deviation.

The levels of D-dimer were found to be significantly higher in patients who had renal failure (7.85±1.58 vs 3.39±0.42 mg/L, p< 0.001*), liver failure (7.62±2.12 vs 5.11±2.41 mg/L, p= 00.032*), respiratory failure (8.55±0.92 vs 5.46±2.50 mg/L, p= 00.042*), as well as neurological dysfunction (8.29±1.24 vs 4.49±2.04 mg/L, p< 0.001*) (Table 3).

Table 4: Examining D-dimer's function in type A aortic dissection patients' multivariate logistic regression-based renal failure prediction.

Area Under the Curve	**P value**	**Confidence Interval95%**		**Cutoff**	**Specificity%**	**Sensitivity%**
		Lower Bound	**Upper Bound**			
1.000	**<0.001***	1.000	1.000	4.55	100	100

We regarded a p-value less than 0.05 to be significant.

There was a significant correlation between D-dimer readings upon admission and renal failure, with an area under the curve of 1.000 (95% CI 1.000-1.000, P<0.001*). With a sensitivity of 100% and a specificity of 100%, the best cutoff value of D-dimer to predict renal failure was determined to be 4.55mg/L **(Table 4)**.

Table5: Examining the potential of D-dimer as a predictor of liver failure in individuals with type A aortic dissection with multivariate logistic regression analysis.

Area Under the Curve	**P value**	**Confidence Interval 95%**		**Cutoff**	**Specificity%**	**Sensitivity%**
		Lower Bound	**Upper Bound**			
0.798	**0.001***	0.616	0.981	4.55	100	63.2

Significant was determined by a p-value less than 0.05.

The relationship between admission D-dimer values and liver failure was determined to have an area under the ROC curve of 0.798 (95% CI 0.616-0.981, P=0.001*). The optimal D-dimer cutoff value for predicting liver failure was 4.55mg/L, which had a sensitivity of 100% and a specificity of 63.2%. **(Table 5)**

Table6: Investigating the role of D-dimer in type A aortic dissection patients' prognoses for mortality via multivariate logistic regression.

Area Under the Curve	**P value**	**Confidence Interval 95%**		**Cutoff**	**Specificity%**	**Sensitivity%**
		Lower Bound	**Upper Bound**			
0.974	**<0.001***	0.917	1.031	5.35	100	92.9

Significant was determined by a p-value less than 0.05.

A significant correlation of 0.974 (95% CI 0.917-1.031, P<0.001*) was seen between D-dimer readings on admission and mortality in the receiver operating characteristic (ROC) curve. The optimal D-dimer cutoff value for mortality prediction was found to be 5.35mg/L, with a sensitivity of 100% and a specificity of 92.9%. **(Table 6)**

Table7: Finding D-dimer's predictive value for neurological dysfunction in individuals with type A aortic dissection by multivariate logistic regression analysis.

Area Under the Curve	**P value**	**Confidence Interval 95%**		**Cutoff**	**Specificity%**	**Sensitivity%**
		Lower Bound	**Upper Bound**			
0.904	**<0.001***	0.780	1.029	6.10	100	82.4

We regarded a p-value less than 0.05 to be significant.

As a predictor of neurological impairment, D-dimer values on admission were found to be linked with a ROC curve area of 0.904 (95% CI 0.780-1.029, P<0.001*). When using 6.10 mg/L as a cutoff for neurological dysfunction prediction, the sensitivity level was 100% and the specificity level was 82.4%. **(Table 7)**

Discussion

This investigation included individuals whose ages varied from 29 to 68, with an average age of 51.92±10.33 years. A total of eighteen cases, or 72 percent, were male.

The mortality rate was significantly greater for individuals who had to have re-exploration due to postoperative bleeding (p=0.017*) compared to those who did not experience any bleeding after surgery. People whose weaning attempts failed also had a far higher mortality rate than those who were extubated. The cardiopulmonary bypass time was significantly greater for patients who did not survive (4.54±0.62 vs 4.04±0.55 hrs., p=0.043*) in comparison to those who did. Surgical procedure type, deep hypothermia use, inotropic support requirements, occurrence of circulatory arrest, time of cross clamp, time of circulatory arrest, and time of extubation were not significantly correlated with mortality.

It is in line with our results that patients who did not make it through DeBakey type I aortic dissection repair surgery were more likely to have tracheostomy, acute renal damage, and postoperative dialysis, as reported by Wang et al. (9).

Rethoracotomy to stop bleeding was identified as a distinct risk factor for death in a research by Martens et al. (10) that included 199 patients who had full aortic arch repairs.

The results of this investigation showed that D-dimer levels were considerably greater in people with renal failure compared to those without the condition (p< 0.001*). Both the sensitivity and specificity for the prediction of renal failure were found to be 100% at a D-dimer threshold value of 4.55 mg/L.

We found that D-dimer is a significant predictor of postoperative dialysis need for patients with Stanford A aortic dissection, which is in line with the findings of Han et al. (11). One indicator of potential renal failure following surgery is D-dimer. Patients with Stanford A aortic dissection can be predicted to be at risk of dialysis following surgery with a sensitivity of 91.7% and a specificity of 54.2% using a cut-off of 3 mg/L. We assessed the predictive value of D-dimer for postoperative renal failure using ROC analysis, and the results demonstrated an area under the curve (AUC) of 0.741 (95% CI, 0.642-0.840; P <0.001).

The current study found that individuals with liver failure had a higher D-dimer level than those without liver failure (p= 00.032*). The results demonstrated that a D-dimer cutoff of 4.55 mg/L was highly predictive of liver failure, with a sensitivity of 100% and specificity of 63.2%.

After analyzing 347 patients who underwent arch replacement and FET following acute type A aortic dissection, Liu et al. (12) came to similar conclusions. The D-dimer level was identified as an individual risk factor for postoperative complications.

Patients with neurological impairment had significantly different levels of D-dimer compared to those without ($p < 0.001$*). In the scenario of neurological impairment, the area under the curve for the ROC curve that evaluated D-dimer readings at admission was 0.904 (95% CI 0.780-1.029, $P<0.001$*). The D-dimer limit for neurological impairment prediction was 6.10 mg/L, which showed a sensitivity of 100% and specificity of 82.4%.

Our findings are consistent with those of Itagaki et al. (13) who also identified a greater rate of new postoperative onset stroke in groups with D-dimer >8.3 mg/L compared to groups with D-dimer ≤8.3 mg/L, although the differences between the two groups did not achieve statistical significance.

The levels of D-dimer were substantially greater in individuals who did not survive compared to those who did ($p < 0.001$*). A 0.974 (95% CI 0.917-1.031, $P<0.001$*) area under the receiver operating characteristic (ROC) curve was found between D-dimer levels on admission and death. Finding a D-dimer cutoff value of 5.35 mg/L achieved a sensitivity of 100% and a specificity of 92.9% in predicting death.

According to the research conducted by Wang et al., (9), the D-dimer level upon admission can be used as a standalone indicator of 30-day mortality. Results showed that a specificity of 43.1% and a sensitivity of 79.7% for predicting 30-day death were achieved with D-dimer readings of 3.91 mg/L.

Using multivariate analysis, the study conducted by Itagaki et al. (13) demonstrated that D-dimer levels greater than 8.3 mg/L were predictive of intrahospital death. Wen et al. (14) discovered that when D-dimer was equal to or greater than 4.43 mg/L, it had a 100% sensitivity in predicting in-hospital death, and when it was equal to or greater than 8.37 mg/L, it had a 100% specificity.

Conclusion

The availability of D-dimer is not an issue in routine medical practice. Our study suggests that patients with high preoperative D-dimer levels should be actively monitored for adverse events and postoperative mortality after surgical repair of type A aortic dissection.

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