**Title:** Stanford Type A Aortic Dissection Mortality Prediction: Are Hematological Parameters an Overestimation Method?

**Short Title:** Hematological Markers in Type A Aortic Dissection

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**Conflict of interest:**

The authors declare no conflict of interest.

# ABSTRACT

# Objective: Acute Type A aortic dissection (TAAD) has a high mortality. Our aim was to predict early mortality in patients undergoing TAAD surgery and to investigate possible risk factors.

# Methods: 82 consecutive patients who were admitted to the emergency service and operated on were retrospectively analyzed. Risk factors for in-hospital death were investigated to develop a predictive model.

# Results: There was no difference between patients in terms of demographic data of the patients. In the mortality group, only preoperative creatinine levels were found to be higher (p <0.05). Factors affecting mortality were found as total circulatory arrest (TCA) and cross-clamp (X-clamp) times when intraoperative data were examined (p <0.05). ROC analysis was performed to determine the power to predict mortality and to determine the cut-off point. In ROC analysis to predict mortality, X-Clamp time> 71 minutes, 68.2% sensitivity and 66.1% specificity, TCA> 44.5 minutes, 72.7% sensitivity and 73.2% specificity were found. In the mortality group, these values ​​were found to be significantly higher than those who were discharged.

# Conclusion: Preoperative variables and intraoperative data should be added to models to estimate the mortality of patients undergoing surgical treatment in TAAD.

# Keywords: acute; aortic dissection; biomarker; mortality

# Introduction

Acute aortic dissection (AAD) is a life-threatening disease that requires rapid diagnosis and is seen in 0.3% of patients who present to the emergency department with chest pain 1,2. As a result of the tear between the intima and media layers of the aorta, restricted or progressing along the entire aorta, it may cause symptoms of all organ systems 3,4. Dissections starting from the ascending aorta are classified as Type A, and dissections starting from the distal of the left subclavian artery are classified as Type B. Repair of Type A AAD (TAAD) with emergency surgical intervention constitutes the current treatment protocol 5. The mortality rate of patients who have increased mortality within hours after diagnosis and who remain without treatment reaches 90% within a year. Despite satisfactory results of surgical treatment, it still has high morbidity and mortality rates of up to 40 % 6.

Mortality in AAD is caused by a systemic inflammatory reaction that starts with the dysfunction in multiple-organ perfusion secondary to the mechanical effect created by blood penetrating between the aortic layers 7. Various tests are used in the emergency room to evaluate systemic inflammation. However, many of these tests have long waiting times and high costs. Measurements of erythrocyte distribution width (RDW), thrombocyte/lymphocyte ratio (PLR), neutrophil/lymphocyte ratio (NLR), and mean platelet volume (MPV), which can be easily obtained from the whole blood sample taken from patients in the emergency room, can show inflammation quickly and at low cost 8. In addition, it has been reported that it can provide predictive information about the prognosis of cardiovascular diseases 9. Although early diagnosis has positive effects on survival, predictive biochemical parameters are needed for mortality.

Prediction of mortality with easily applicable tests in determining the risk of surgical interventions to be applied to patients may become more understandable for the patient and the surgeon. Our hypothesis in this study was to determine the efficacy of diagnostic hematological tests in predicting mortality in patients with TAAD.

# Materials and methods

## Study Population

A total of 82 consecutive patients who were diagnosed with acute TAAD in the emergency department from January 2010 to January 2018 and operated on urgently were retrospectively analyzed. After the study protocol was approved by Aydın Adnan Menderes University Non-Interventional Clinical Studies Ethics Committee (Ref: 53043469-050.04.04), the data were retrospectively prepared and recorded. Patients with known hematological diseases, cancer, immunological diseases, and infections were excluded from the study. Hematological and biochemical values of 78 patients included in the study at the time of admission to the emergency department were recorded. Operational data were obtained by examining the surgery reports in files that are stored in electronic media.

## Operative Technique

Deep hypothermic (180C) cardiopulmonary bypass was performed in all patients under general anesthesia via standard aortic, femoral, or axillary arterial cannulation and femoral or right atrial venous cannulation. Antegrade hypothermic and hyperkalemic blood cardioplegia was performed in all patients. When the deep hypothermic circulatory arrest was achieved, sodium pentothal was administered. The intimal tear area was found with aortotomy and was excised and made suitable for anastomosis. The anastomosis was conducted using the Dacron vascular graft instead of the removed ascending aorta. After the anastomoses were finished, the patient was started to be warmed, cardiopulmonary bypass was terminated and the patient was transferred to intensive care.

## Study groups

Study groups were divided according to the Stanford aortic dissection classification. Among the patients with TAAD, those with early postoperative mortality (within the first 30 days) were classified as Exitus, and the patients who were discharged were classified as Discharge. Regardless of hunger, preoperative blood samples taken in the emergency room were taken. Using Mindray BC 6800 (Mindray, China), full blood counts were collected, including total white blood cells, neutrophils, lymphocytes, and platelets. The ratio of thrombocytes (103 / uL) to lymphocytes (103 / uL) collected from blood samples was calculated as PLR, and the ratio of neutrophils (103 / uL) to lymphocytes (103 / uL) was calculated as NLR.

## Statistical analysis

For statistical analysis, the data were analyzed using the Statistical Package for the Social Sciences (SPSS) program (IBM SPSS Statistics for Windows, Version 18.0. Armonk, NY, USA). The study of normality was carried out using either the Kolmogorov-Smirnov or Shapiro-Wilk measures. Chi-square test was used for categorical variables and Mann Whitney u test was used for continuous variables. Receiver operating curve (ROC) analysis was performed to determine the factors that may affect mortality. The significance level was accepted as p <0.05 for all statistical evaluations.

# Results

The demographic data of the patients are shown in Table 1. No difference was observed between discharged patients and patients who died. When the data were examined in terms of preoperative blood values, there was no difference in blood parameters such as Hemoglobin (Hb), PLR, NLR, RDW, and MPV. Only preoperative creatinine levels were found to be higher in the mortality group (p <0.05) (Table 2).

The display of intraoperative data is given in Table 3. When these data are examined, the effect of cardiopulmonary bypass time on mortality has not been found. It was found that the factors affecting mortality were total circulatory arrest (TCA) and Cross clamp (X-clamp) times (p <0.05).

The receiver operating characteristics curve was used to determine the sensitivity and specificity of TCA and X-clamp time and the optimal cut-off value for predicting mortality (Figure 1). In ROC analysis, X-Clamp time >71 m. predicted mortality with 68.2% sensitivity and 66.1% specificity (AUC: 0.788, p<0.05), TCA >44.5 m. predicted mortality with 72.7% sensitivity and 73.2% specificity (AUC: 0.778, p<0.05). It was found that these times were significantly higher in the mortality group than those who were discharged.

# Discussion

TAAD is a vascular clinical pathology that occurs with high morbidity and mortality, and its incidence is increasing with prolongation of life span and prevalence of hypertension. Patients and doctors are still concerned about the high risk of surgery. Data that may answer these concerns of patients undergoing surgery are being investigated. Therefore, although many tests are evaluated for diagnostic purposes, no reliable parametric test predicting mortality has been found. The results we found in our study show that preoperative hematological markers do not predict mortality, but the effect of intraoperative variables on mortality is more important.

In previous studies, the efficacy of hematological markers, a simple and inexpensive method, predicting thrombosis, inflammation, and mortality was investigated. Most of the studies conducted to show mortality are related to Type B AAD 10. The time period from diagnosis to surgery in patients diagnosed with Type B AAD may allow such assessments. Due to the need for rapid evaluation of patients diagnosed with TAAD and the decision for surgery, this option can often be missed. There are a limited number of studies and case series regarding whether it has a predictive effect on mortality in TAAD.

Several recent studies have found an association between increased hematological inflammatory markers and mortality. However, when these studies are examined, it is seen that a limited number of patients and preoperative data are evaluated alone 11,12. Considering the preoperative inflammation and inflammation caused by intraoperative causes, it may not be sufficient to evaluate the factors that may affect mortality alone. In a study by Sbarouni et al., They could not find the mortality predictive effect of PLR and NLR in a patient group with TAAD 13. In another study stating that preoperative hematological markers have a predictive effect on mortality, Erdolu et al.14 they reported that CRP and NLR were predictors of mortality. However, the reason why it could not be determined in our study may be due to rupture of the aorta as a result of mechanical effects rather than preoperative inflammation and end organ damage.

One of the studies on TAAD in Mehta et al. study15, renal failure is among the factors associated with mortality. Similarly, in our study, although there was a relationship between preoperative creatinine value and mortality, the fact that this value was within normal limits indicates that these patients may have postoperative mortality due to renal failure, as can be predicted.

Many tests have been used to predict mortality. However, the reliability of these tests was limited due to a major surgical operation affecting mortality. It was stated that the factors affecting mortality were age, preoperative renal dysfunction and prolongation of CPB duration 16–18. In the international registry of acute aortic dissection (IRAD) study, Rampoldi et al.19, it was found that prolongation of intraoperative TCA duration was associated with mortality. In our study, it was found to be associated with prolonged X-clamp and TCA durations. Graft anastomosis time, which is one of the factors that may affect the prolongation of TCA, may be related to intact aortic tissue. In addition, in cases where the dissection line includes the aortic arch, mortality may increase in this patient group as the duration of the anastomosis may increase, resulting in longer X-clamp and TCA times.

## Limitations

The data used in this study, which was planned as a retrospective cohort study, have limitations. The time that passes due to the distance of the patients from our center may have an impact on mortality. It will be useful to evaluate the results under these conditions. Causes such as late diagnosis, tamponade due to aortic rupture, and multipleorgan failure, which are among the data of preoperative conditions that may affect mortality, could not be presented in our study.

# Conclusion

TAAD continues to be an emergency cardiovascular pathology with high mortality and challenging treatment. Although studies have been carried out for years to predict mortality, and an effective option has not yet been put into use. There is a need for studies involving larger patient groups in which the mortality of patients undergoing surgery is evaluated in addition to preoperative variables, perioperative surgical, and hematologic variables.

# Data Availability Statement

Raw data were generated at [SPSS 25]. Derived data supporting the findings of this study are available from the corresponding author on request.

# Disclosure statement

The authors declare no conflict of interest.

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**Table1.** Demographic characteristics of patients

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Discharge | | Exitus | | p value |
|  |  |  |  |  |  |
| Age (Mean ± SD) | 59,28±11,39 |  | 57,13±17,19 |  | 0,276# |
| BMI (Mean ± SD) | 28,08± 4,6 |  | 28,36±4,38 |  | 0,803# |
| EF (Mean ± SD) | 49,66±10,08 |  | 51±9,46 |  | 0,536# |
| Female (n) | 10 |  | 6 |  | 0,365\* |
| Male (n) | 46 |  | 16 |  | 0.264\* |
| HT (n) | 32 |  | 14 |  | 0,600 |
| DM (n) | 25 |  | 12 |  | 0,431 |
| COPD (n) | 9 |  | 3 |  | 0,546\* |
| DL (n) | 15 |  | 5 |  | 0,712 |
| Family History (n) | 2 |  | 0 |  | 0,513\* |
| Smoking (n) | 28 |  | 10 |  | 0,718 |

BMI: Body mass index, EF: Ejection fraction, HT: Hypertension, DM: Diabetes Mellitus, COPD: Chronic Obstructive pulmonary disease, DL: Dyslipidaemia. \*Chi-square, #Mann Whitney-U test.

**Table 2.** Characteristics of blood values of patients

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Discharge | | Exitus | | p value\* |
|  |  |  |  |  |  |
| Hemoglobin | 13,20±1,61 |  | 13,63±1,48 |  | 0,257 |
| Htc | 39,44±4,27 |  | 40,81±4,17 |  | 0,196 |
| Neutrophils | 6,13±4,48 |  | 5,85±1,84 |  | 0,564 |
| Lymphocytes | 2,06±0,89 |  | 2,14±0,86 |  | 0,586 |
| Platelets | 278,28±88,53 |  | 288,45±66,85 |  | 0,328 |
| MPV | 9,73±7,64 |  | 8,51±1,02 |  | 0,515 |
| PDW | 53,31±7,11 |  | 49,20±9,98 |  | 0,084 |
| RDW | 16,44±14,67 |  | 13,94±1,16 |  | 0,153 |
| BUN | 38,55±19,52 |  | 36,72±12,24 |  | 0,894 |
| Creatinine | 0,82±0,20 |  | 0,97±0,34 |  | **0,041** |
| PLR | 163,30±92,21 |  | 158,18±81,45 |  | 0,903 |
| NLR | 3,49±3,30 |  | 3,19±1,81 |  | 0,798 |

Htc: Hematocrit, MPV: Mean platelet volume, PDW: Platelet distribution width, RDW: Red blood cell distribution width, BUN: Blood urea nitrogen, PLR: Platelet to lymphocyte ratio, NLR: Neutrophil to lymphocyte ratio. \*Mann Whitney-U test

**Table 3.** Operative characteristics of patients

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Discharge | | Exitus | | p value\* |
|  |  |  |  |  |  |
| X-Clamp (m, Mean ± SD) | 65,53 | ± 17,57 | 84,68 | ± 25,02 | **0,00** |
| TCA (m, Mean ± SD) | 39,76 | ± 9,78 | 50,63 | ± 10,34 | **0,00** |
| CPB (m, Mean ± SD) | 132,73 | ± 29,13 | 144,40 | ± 38,24 | 0,23 |

X-Clamp: Cross clamp time, TCA: Total circulatory arrest time, CPB: Cardiopulmonary bypass time (minute), \*Mann Whitney-U test.

**Figure 1.** Receiver operating curve characteristics of intraoperative variables to predict mortality in the study groups.

