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Original Article

# Can Coronary Complexity Improve Risk Prediction in Transcatheter Aortic Valve Implantation? Insights from SYNTAX II Compared with Surgical Scores

**Remziye Doğan,[1] Selim Aydemir,[2] İbrahim Saraç,[3] Sidar Şiyar Aydın,[3] Mehmet Saygı,[1] Uğur Aksu,[4] Hüseyin Şenocak[3]**

[1]Department of Cardiology, Hisar Intercontinental Hospital, İstanbul, Türkiye
[2]Department of Cardiology, Erzurum City Hospital, University of Health Sciences, Erzurum, Türkiye
[3]Department of Cardiology, Atatürk University Faculty of Medicine, Erzurum, Türkiye
[4]Department of Cardiology, University of Health Sciences Faculty of Medicine, Afyonkarahisar, Türkiye

## Abstract

**Objective:** Aortic stenosis (AS) is one of the most common valvular heart diseases, and transcatheter aortic valve implantation (TAVI) has become an established treatment option for patients at high surgical risk. As TAVI is increasingly performed, there is a growing need for reliable risk stratification tools to predict peri- and post-procedural outcomes. This study compared the predictive value of the Syntax Score II (SS II), commonly used in coronary artery disease, with conventional surgical risk scores – EuroSCORE and the Society of Thoracic Surgeons (STS) score; in estimating in-hospital mortality after TAVI.

**Methods:** Seventy patients who underwent TAVI for severe AS between 2011 and 2018 at our center were included. Patients were classified according to in-hospital survival, and associations between risk scores and mortality were assessed.

**Results:** The mean age was 77.4±10.1 years, and 58.6% of the patients were male. Univariate analysis showed that STS, EuroSCORE, SS II, left ventricular systolic diameter, and mean aortic gradient were higher in the mortality group. Post-procedural complications did not differ significantly between survivors and non-survivors (stroke, p=0.22; acute renal failure, p=0.50; pacemaker implantation, p=0.49). Multivariable regression analysis identified EuroSCORE as an independent predictor of in-hospital mortality (p=0.05), whereas STS and SS II were not statistically significant.

**Conclusion:** Among the scores evaluated, EuroSCORE demonstrated superior predictive ability for in-hospital mortality following TAVI. Nonetheless, the findings highlight the need for novel, procedure-specific risk models tailored to TAVI populations.

**Keywords:** EuroSCORE; severe aortic stenosis; Society of Thoracic Surgeons; syntax score II; transcatheter aortic valve implantation.

# Koroner Kompleksite TAVI'de Risk Tahminini İyileştirebilir mi? SYNTAX II ile Cerrahi Skorlarının Karşılaştırılması

## Özet

**Amaç:** Aort darlığı en sık görülen kapak hastalıklarından biridir ve transkateter aort kapak implantasyonu (TAVI), cerrahi riski yüksek hastalarda yerleşik bir tedavi seçeneği haline gelmiştir. TAVI uygulamalarının artmasıyla birlikte, işlem sırasında ve sonrasında gelişebilecek komplikasyonları öngörebilecek güvenilir risk skorlama sistemlerine olan ihtiyaç giderek artmaktadır. Bu çalışmada, koroner arter hastalığında yaygın olarak kullanılan Syntax Skoru II (SS II) ile cerrahi risk skorları olan EuroSCORE ve Society of Thoracic Surgeons (STS) skorlarının, TAVI sonrası hastane içi mortaliteyi öngörmedeki değerleri karşılaştırıldı.

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**Address for Correspondence:**
Remziye Doğan

Department of Cardiology, Hisar Intercontinental Hospital, İstanbul, Türkiye

**E-mail:** remziye_2148@hotmail.com

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**Yöntem:** 2011–2018 yılları arasında merkezimizde ciddi aort darlığı nedeniyle TAVI uygulanan 70 hasta çalışmaya dahil edildi. Hastalar hastane içi sağkalım durumuna göre sınıflandırıldı ve risk skorları ile mortalite arasındaki ilişkiler incelendi.

**Bulgular:** Hastaların yaş ortalaması 77,4±10,1 yıl olup %58,6'sı erkekti. Tek değişkenli analizde, mortalite gelişen grupta STS, EuroSCORE, SS II, sol ventrikül sistolik çapı ve ortalama aort gradyanı daha yüksek bulundu. İşlem sonrası komplikasyonlar açısından gruplar arasında anlamlı fark saptanmadı (inme, p=0,22; akut böbrek yetmezliği, p=0,50; pacemaker implantasyonu, p=0,49). Çok değişkenli regresyon analizinde yalnızca EuroSCORE hastane içi mortalitenin bağımsız bir öngördürücüsü olarak belirlendi (p=0,05); STS ve SS II istatistiksel olarak anlamlı bulunmadı.

**Sonuç:** İncelenen skorlar arasında EuroSCORE, TAVI sonrası hastane içi mortaliteyi öngörmede daha yüksek prediktif değere sahiptir. Bununla birlikte, sonuçlarımız TAVI popülasyonuna özgü yeni risk modellerine duyulan ihtiyacı vurgulamaktadır.

**Anahtar sözcükler:** EuroSCORE; ileri aort darlığı; Society of Thoracic Surgeons; syntax Skoru II; transkateter aort kapak implantasyonu.

## Introduction

Aortic stenosis (AS) is a progressive valvular disease that typically involves a prolonged asymptomatic period, followed by rapid clinical decline once symptoms appear.[1] In the absence of definitive treatment, the prognosis is poor, with nearly half of symptomatic patients dying within 2 years.[2] For patients at low surgical risk and without major comorbidities such as chronic obstructive pulmonary disease, diabetes mellitus, cerebrovascular events, pulmonary hypertension, or peripheral arterial disease, surgical aortic valve replacement (AVR) remains the standard of care.[3] Nevertheless, approximately one-third of patients with severe AS are not suitable candidates for surgery due to clinical or anatomical limitations.[4–6] In such high-risk groups, transcatheter aortic valve implantation (TAVI) has emerged as a less invasive alternative, offering encouraging clinical outcomes.[5] Since its first use in Turkey in 2009, TAVI has been increasingly adopted and continues to evolve as an effective therapeutic option.[4]

AS frequently coexists with coronary artery disease (CAD) owing to shared risk factors such as advanced age, male sex, hypertension, dyslipidemia, diabetes, and chronic kidney disease.[7,8–15] Consequently, a considerable proportion of patients undergoing AVR or TAVI present with CAD. The presence of CAD increases procedural complexity and adversely affects long-term prognosis following surgical valve replacement.[8–10] However, the specific influence of CAD burden on outcomes in elderly patients undergoing TAVI remains debated.[11–16]

Accurate mortality prediction is crucial for planning cardiovascular interventions, and multiple risk stratification models have been proposed to address this need. Mortality, as an objective endpoint, enhances the reliability of these scoring systems.[17] While the EUROSCORE and the Society of Thoracic Surgeons (STS) score are frequently applied in TAVI candidates, it should be emphasized that both were originally created for conventional cardiac surgery and may not fully capture the procedural risks unique to TAVI.[18]

Given the lack of a risk model specifically tailored for TAVI, this study aimed to assess the prognostic performance of the SYNTAX II score in predicting perioperative and in-hospital mortality, and to compare its predictive accuracy with the more widely utilized EUROSCORE and STS scores.

## Materials and Methods

This retrospective, cross-sectional study enrolled 70 patients who underwent transfemoral TAVI for severe AS at Atatürk University Hospital, Erzurum, between 2011 and 2018. Medical records were reviewed to extract demographic data, comorbidities, previous interventions, clinical progress, and hospitalization details. Admission laboratory data, including creatinine and estimated glomerular filtration rate, were obtained from the hospital's information system. Patients lacking complete archival records, preoperative echocardiography, or coronary angiographic imaging were excluded.

The STS and EUROSCORE values were calculated using validated web-based tools. SYNTAX I scores were assessed from coronary angiograms, and SYNTAX II scores were derived accordingly.

All patients underwent transfemoral TAVI using either the Edwards Sapien (Edwards Lifesciences, USA) or Medtronic CoreValve (Medtronic, USA) prostheses. Device selection and sizing were guided by operator judgment, anatomical suitability, echocardiographic findings, and contrast-enhanced cardiac computed tomography measurements of the aortic annulus and root.

Antithrombotic therapy included lifelong aspirin and 3–6 months of clopidogrel. In patients with indications for chronic anticoagulation, oral anticoagulants were administered either alone or in combination with antiplatelet therapy, as appropriate.

Routine echocardiographic evaluations were conducted pre-TAVI, intraoperatively, and during follow-up. The occurrence of post-TAVI and in-hospital paravalvular regurgitation was documented, with optimal views obtained from parasternal long- and short-axis, apical long-axis, and five-chamber windows.[18]

### Echocardiography

Transthoracic echocardiographic studies were performed using a Vivid™ 6 system with XDclear™ technology (GE, Norway) in the left lateral decubitus position. Imaging followed American Society of Echocardiography guidelines and included multiple standard views: parasternal long- and short-axis; apical long-axis, two-, four-, and five-chamber views.[19]

Each exam included M-mode, 2D, pulsed-wave, continuous-wave, and color Doppler imaging. The aortic valve was evaluated for leaflet mobility, thickness, and calcification. Transvalvular flow velocities were measured with CW Doppler to determine peak and mean gradients.

Severe AS was diagnosed based on the following criteria:

- Aortic valve area (AVA) <1.0 $cm^2$
- Mean gradient >40 mmHg
- Peak velocity >4.0 m/s.[19]

Due to missing AVA data, this parameter was excluded from statistical analysis. Gradients were measured from the apical five-chamber view using the modified Bernoulli equation (ΔP = 4 v2). Dobutamine stress echocardiography was conducted in selected cases with suspected low-flow, low-gradient AS and reduced left ventricular function, in accordance with ASE recommendations.

## Ethics Committee

The study protocol was approved by the institutional ethics committee on February 13, 2019 (Meeting No: 01, Decision No: 46), following evaluation of its rationale and methodology. Approval was granted with the condition that all study-related costs would be borne by the investigators. The study was conducted in accordance with the principles of the Declaration of Helsinki.

## Statistics Analysis

Continuous variables were presented as mean ± standard deviation, while categorical variables were expressed as frequencies and percentages. Student's t-test and Chi-square test were used for between-group comparisons of continuous and categorical variables, respectively.

Significant predictors identified in univariate analysis were included in Cox regression modeling to determine independent predictors of in-hospital mortality. All analyses were performed using IBM the Statistical Package for the Social Sciences Statistics version 25.0 (IBM Corp., Armonk, NY, USA). A $p<0.05$ was considered statistically significant.

## Results

Among the 70 patients evaluated, the mean age was 77.4±10.1 years, and 58.6% were male. Patients were divided into two groups: Group 1 (n=55), who were discharged alive, and Group 2 (n=15), who died during hospitalization. Table 1 outlines the baseline characteristics, which were comparable between the groups in terms of age, comorbidities, and prior cardiovascular history.

Table 2 summarizes echocardiographic findings. Group 1 demonstrated significantly higher maximum and mean aortic gradients (p=0.03 and p=0.002). Although Group 2 had a lower left ventricular ejection fraction (LVEF), the difference was not statistically significant. Group 2 exhibited slightly larger left ventricular systolic and diastolic dimensions (p=0.05 and p=0.23).

Most patients were treated with dual antiplatelet therapy, and there were no significant differences in antithrombotic regimens between groups (Table 3). Post-procedural complications such as stroke, temporary pacemaker use, and paravalvular regurgitation were similar (Table 4).

In multivariate analysis, EUROSCORE emerged as an independent predictor of in-hospital mortality (Table 5). Although SYNTAX I and II scores were numerically higher in non-survivors, differences were not statistically significant (p=0.70 and p=0.75). EUROSCORE was significantly elevated in Group 2 (p=0.036), while STS score showed a non-significant trend (p=0.46). Figures 1-3 illustrate the distributions of these scores.

**Table 1. Demographic characteristics**

| Variables | Group-1 | Group-2 (Death) | p |
|---|---|---|---|
| Age (year) | 77.3±10.1 | 77.9±10.4 | 0.87 |
| Sex (male, %) | 59.6 | 53.8 | 0.70 |
| EUROSCORE | 15.1±7.6 | 22.5±12.6 | 0.036 |
| STS SCORE | 15.9±6.5 | 16.5±5.7 | 0.46 |
| SYNTAX II SCORE | 40.9±11.6 | 41.9±8.9 | 0.75 |
| Chronic renal failure | 28.1 | 38.5 | 0.46 |
| HT (%) | 52.6 | 53.8 | 0.93 |
| DM (%) | 14 | 15.4 | 0.90 |
| History of ischemic event (%) | 1.8 | 7.7 | 0.25 |
| History of stroke (%) | 8.8 | 7.7 | 0.90 |
| PAH (%) | 28.1 | 25.4 | 0.34 |
| COPD (%) | 38.6 | 38.6 | 0.99 |
| Prior CABG (%) | 7.1 | 7.7 | 0.94 |
| Kreatin (mg/dL) | 1.1±0.7 | 1.3±1.2 | 0.76 |
| GFR (mL/min) | 73±29.4 | 69.7±25.2 | 0.93 |
| NYHA | | | |
| 1 | 5.4 | 0 | 0.32 |
| 2 | 64.3 | 53.8 | |
| 3 | 17.9 | 38.5 | |
| 4 | 12.5 | 7.7 | |
| Permanent AF (%) | 19.3 | 18.5 | 0.14 |
| Prior MI | 1.8 | 0 | 0.63 |
| PCI (%) | | | |
| LAD | 10.7 | 7.7 | 0.74 |
| CX | 3.6 | 7.7 | 0.51 |
| RCA | 0 | 0 | 0.95 |
| Prior valve surgery (%) | 3.5 | 7.7 | 0.50 |

HT: Hypertension; DM: Diabetes mellitus; PAH: Peripheral arterial disease; COPD: Chronic obstructive pulmonary disease, CABG: Coronary artery bypass graft; GFR: Glomerular filtration rate; NYHA: New York Heart Association; AF: Atrial fibrillation; MI: Myocardial infarction; PCI: Percutaneous coronary intervention; LAD: Left atrial diameter, CX: Circumflex, RCA: right coronary artery.

**Table 2. Echocardiographic characteristics**

| Variables | Group-1 | Group-2 (Death) | p |
|---|---|---|---|
| Maximal aortic gradient | 82.1±21.7 | 65.8±15.1 | 0.03 |
| Mean aortic gradient | 51.1±14.8 | 37.9±8.7 | 0.002 |
| LVEF | 48.3±10.1 | 44.5±10.3 | 0.19 |
| LVDd | 49.5±7.8 | 53.2±8.7 | 0.23 |
| LVSd | 33.9±9.9 | 41±9.9 | 0.05 |
| LAd | 43.2±6.3 | 45.9±5.7 | 0.17 |
| sPAP | 46.7±17.1 | 51±19.2 | 0.16 |

LVEF: Left ventricular ejection fraction; LVDd: Left venticular diastolic diameter; LVSd: Left ventricular systolic diameter; LAd: Left atrial diameter; sPAP: Systolic pulmonary arterial pressure.

**Table 3. Antiplatelet therapy protocols**

| Variables | Group-1 | Group-2 (Death) | p |
|---|---|---|---|
| SAPT | 55.4 | 69.2 | 0.70 |
| Asetilsalisilik asit | 91.2 | 92.3 | 0.28 |
| Klopidogrel | 93 | 100 | 0.96 |
| DAPT | 87.3 | 92.3 | 0.46 |
| SAPT+OAT | 4.96 | 6.15 | 0.15 |
| DAPT+OAT | 0 | 0 | 0.93 |

SAPT: Single antiplatelet therapy; DAPT: Dual antiplatelet therapy; OAT: Oral anticoagulant therapy.

**Table 4. Perioperative complications**

| Variables | Group-1 | Group-2 (Death) | p |
|---|---|---|---|
| Post-operative stroke | 3.2 | 0 | 0.22 |
| Acute renal failure | 3.5 | 7.7 | 0.50 |
| Pacemaker implantation | 3.5 | 0 | 0.49 |
| Paravalvular regurgitation -mild | 17.6 | 18.2 | 0.96 |
| Paravalvular regurgitation -moderate | 7.8 | 12.3 | 0.067 |
| Paravalvular regurgitation-severe | 0 | 0 | 0.94 |
| Length of hospital stay (day) | 28.5±18 | 32.7±17 | 0.26 |
| 4-Year mortality (%) | 21.7±17.6 | 20.8±13.8 | 0.74 |

## Representative Case

A male patient, D.A.O., aged 85 years, with a history of peripheral artery disease and prior hemorrhagic stroke, presented with severe symptomatic AS. His baseline evaluation revealed a mean/peak aortic valve gradient of 50/70 mmHg and a left ventricular ejection fraction of 50%. Risk assessment showed a EuroSCORE of 14, an STS score of 8, and a SYNTAX II score of 27. The patient was in New York Heart Association functional Class II at admission.

**Table 5. Mortality rates**

| Variables | p | Multivariable p |
|---|---|---|
| EUROSCORE | 0.036 | 0.05 |
| Mean aortic gradient | 0.002 | 0.23 |
| LVSd | 0.05 | 0.12 |

LVSd: Left ventricular systolic diameter.

He underwent transfemoral TAVI and was discharged on single antiplatelet therapy. Early post-procedural course was complicated by acute renal failure. Despite initial stabilization, the patient died 3 months later due to a chronic subdural hematoma. This case illustrates the complexity of risk assessment in elderly TAVI candidates with multiple comorbidities and highlights how EuroSCORE may better capture overall risk compared with STS or SYNTAX II in such settings.

## Discussion

In this study, we evaluated the predictive performance of three risk models – EUROSCORE, STS, and SYNTAX II – in patients undergoing TAVI. Among them, the EUROSCORE was the only score that independently predicted in-hospital mortality. In contrast, neither STS nor SYNTAX II showed significant associations with mortality in our population.

Our findings are consistent with those of Geissler et al.,[20] who reported EUROSCORE as the most reliable among six surgical risk models for predicting mortality. Although EUROSCORE was initially designed for conventional cardiac surgery,[21,22] its simplicity and inclusion of valve procedures make it applicable to TAVI patients as well. In our high-risk elderly cohort, EUROSCORE provided meaningful insight into perioperative risk.

The STS score, originally based on isolated coronary artery bypass graft cases,[23] did not predict mortality in our study. De-

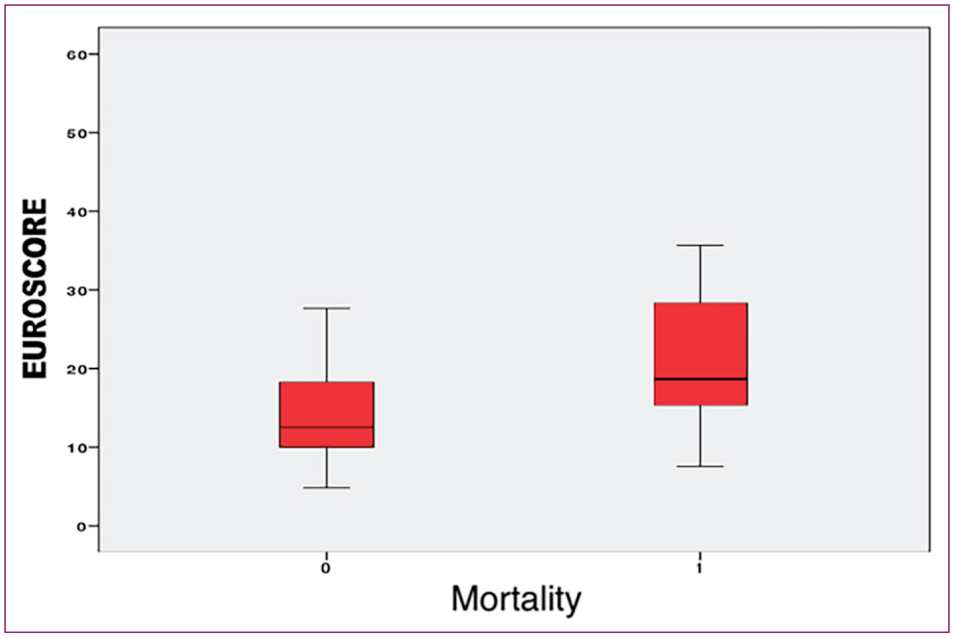


**Figure 1.** The relationship between EUROSCORE and mortality.

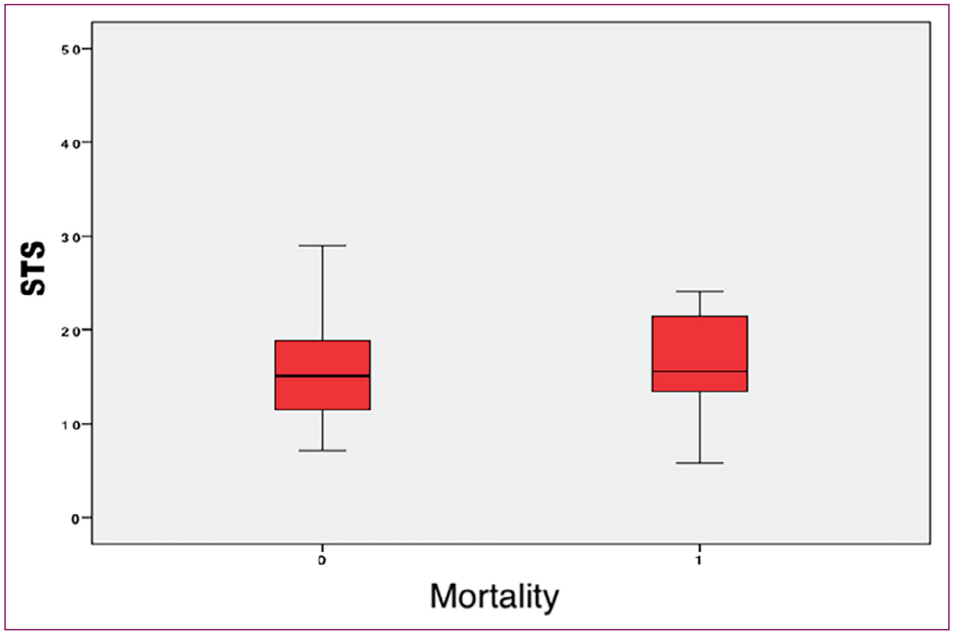


**Figure 2.** The relationship between the Society of Thoracic Surgeons and mortality.

STS: Society of Thoracic Surgeons.

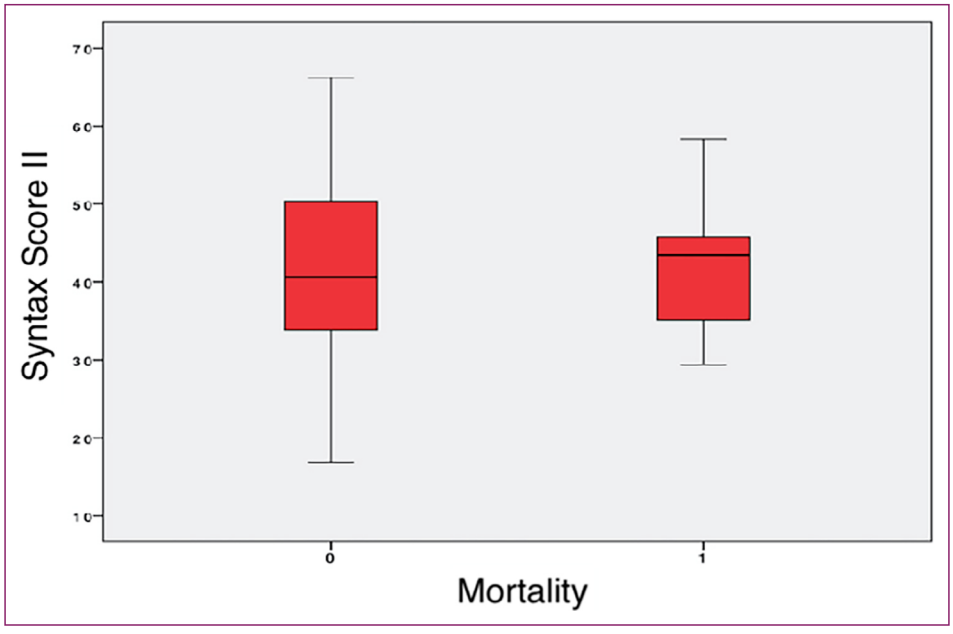


**Figure 3.** The relationship between Syntax Score II and mortality.

spite its use in TAVI evaluations and validation in other surgical contexts,[24–26] its lack of procedural and anatomical variables may limit its utility in this setting. Unlike our results, Hemman et al.[27] reported STS as predictive after TAVI. Differences in patient characteristics and sample size between the two studies may explain this inconsistency.

SYNTAX II, which combines coronary anatomy with clinical variables, has been shown to predict long-term outcomes in CAD patients.[28] In a study by Ryan et al.,[29] SYNTAX II was an independent predictor of mortality and major cardiac events after TAVI. However, in our study, SYNTAX II did not differentiate between survivors and non-survivors. This could be due to the low prevalence and severity of CAD in our population, as well as low SYNTAX II scores in those with CAD.

Overall, both STS and SYNTAX II were developed outside the context of TAVI. Their limited performance here supports the need for scoring systems specifically designed for this population. While SYNTAX II offers a broader clinical picture by combining anatomical and demographic factors,[30] its value may be reduced in elderly patients with high comorbidity but minimal coronary disease.

To the best of our knowledge, few studies have directly compared these three scores in the same TAVI cohort. Our results suggest

that EUROSCORE may currently be the most practical tool for predicting in-hospital mortality in this setting. However, future prospective studies with larger and more diverse populations are necessary to develop more accurate, TAVI-specific risk models.

### Study Limitations

This study has several limitations, including its retrospective design, single-center nature, and limited sample size. Missing data on echocardiographic parameters and short in-hospital follow-up further restrict generalizability. Larger, prospective, multicenter studies are needed to validate these findings.

## Conclusion

In this cohort of TAVI patients, the EUROSCORE demonstrated superior performance in predicting in-hospital mortality compared to the STS and SYNTAX II scores. While originally developed for surgical risk assessment, EUROSCORE may remain a practical tool in transcatheter settings. Future studies should aim to establish risk models specifically tailored to the TAVI population to enhance outcome prediction and guide clinical decision-making.

#### Disclosures

**Ethics Committee Approval:** The study was approved by the Atatürk University Faculty of Medicine Ethics Committee (no: 46, date: 13/02/2019).

**Informed Consent:** Informed consent was obtained from all participants.

**Conflict of Interest Statement:** The authors have no conflicts of interest to declare.

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