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# Early Systolic Lengthening Is Associated with SYNTAX Score in Patients with Non-ST-Elevation Acute Coronary Syndrome


## ABSTRACT

**Background:** Early systolic lengthening is a echocardiographic strain parameter previously used to determine the lesion severity in patients with stable coronary artery disease. In the present study, we aimed to evaluate the relationship between early systolic lengthening and anatomic SYNTAX score in troponin (−) and (+) groups among patients with non-ST-elevation acute coronary syndrome (ACS).

**Methods:** A total of 95 patients diagnosed with non-ST-elevation ACS were included in the prospective, non-randomized, single-center study. The patients were categorized into 2 groups as troponin (+) and troponin (−). The patients were evaluated in terms of echocardiographic, clinical, and angiographic parameters.

**Results:** The baseline characteristics, including age (58 ± 13 vs. 60 ± 10 respectively, $P = .340$), a history of hypertension (67.1% vs. 64%, respectively, $P = .479$), diabetes (28.6% vs. 32%, respectively, $P = .467$), global longitudinal strain (−14.37 ± 5.11 vs. −16.42 ± 3.93, respectively, $P = .095$), left ventricular ejection fraction (58.71 ± 8.73 vs. 57.20 ± 8.70, respectively, $P = .263$), and *E/e'* (8.44 ± 2.13 vs. 8.33 ± 1.99, respectively, $P = .785$), were similar between troponin (+) and troponin (−) groups. Left ventricle end-systolic diameter (3.2 ± 0.78; 3.50 ± 0.74 vs. 3.2 ± 0.78, respectively, $P = .031$), left ventricle end-systolic volume (55.57 ± 32.17 vs. 38.28 ± 13.63, respectively, $P = .013$), left ventricle end-diastolic volume (115.31 ± 49.54 vs. 91.23 ± 20.57, respectively, $P = .042$), the rate of early systolic lengthening (65.7% vs. 28%, respectively, $P = .001$), the duration of early systolic lengthening (24.02 ± 31 ms vs. 15.56 ± 30.19 ms, respectively, $P = .009$), and the SYNTAX score (16 ± 11 vs. 10 ± 10, respectively, $P = .023$) were higher in the troponin (+) group. Furthermore, a significant correlation was found between early systolic lengthening and SYNTAX score ($r = 0.43$, $P < .001$).

**Conclusion:** The rate and duration of early systolic lengthening were higher in patients in the troponin (+) group. Early systolic lengthening is related to SYNTAX score in patients with non-ST-elevation ACS.


**Keywords:** Echocardiography, coronary artery disease, early systolic lengthening

## INTRODUCTION

Patients with acute coronary syndrome (ACS) are divided into 2 groups as ST-elevation ACS (STEMI) and non-ST-elevation ACS (NSTE-ACS). Non-ST-elevation ACS is categorized as non-ST-elevation myocardial infarction (NSTEMI) and unstable angina pectoris according to troponin value, which is the marker of myocardial necrosis.[1] Widespread vessel involvement may frequently be seen in NSTE-ACS patients. While noninvasive assessments like risk scores, electrocardiogram (ECG) findings, and traditional echocardiography are performed, these methods are not sufficient for the prediction of severity of the coronary lesions. Coronary artery stenosis may be detected with coronary angiography (CAG) in most cases.

The SYNTAX score is a scoring algorithm that is determined through angiography.[2] It was planned to evaluate the number, functional importance, location, and complexity of the lesions and their correlation with prospective data. A high SYNTAX score indicates difficulties, severe disease status, and a potential poor prognosis.





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Speckle tracking echocardiography (STE) enables the analysis of rotational mechanics of the heart (rotation, torsion, and untwisting), regional and global deformation properties, and their contribution to contractility.[3] Strain and strain rate, which are measured using STE, enable us to provide information about myocardial deformation. Early systolic lengthening (ESL) is a novel strain parameter and was defined as the time period in which the corresponding strain curve stayed positive from the onset of a Q-wave (or R-wave if Q was absent).[4] Studies indicate that ESL is predictive for ischemia. In normal myocardial systolic cycle, left ventricle (LV) pressure increases during LV isovolumetric contraction and shows shortening properties by producing active power. However, ischemic myocardium cannot produce an active power and may lead to passive ESL before shortening.[4,5] A correlation was found between ESL and post-STEMI infarct area.[6] Zahid et al[7] have indicated that ESL is useful for the prediction of myocardial damage in non-STEMI patients. Recent studies have shown that ESL provides prognostic information in patients from the general population and with myocardial infarction (MI).[8,9]

This study aims at investigation the relationship between ESL and SYNTAX scores calculated on CAG for determining severity of the coronary artery disease (CAD) in NSTE-ACS patients.

## METHODS

The study population is composed of a total of 138 patients who were admitted to the emergency department with complaints lasting for less than 3 days and planned to undergo CAG due to NSTE-ACS after exclusion criterias were applied. A total 95 patients were included in the study. Risk assessment was done according to Grace and thrombolysis in MI (TIMI) risk scoring.[10,11] Clinical risk scores were evaluated based on the risk scores defined in the ECS guidelines. Diagnosis of NSTE-ACS and CAG plan were done according to the guidelines.[1]

The patients were categorized into 2 groups as troponin (+) (n = 70, 73.7%), and troponin (−) (n = 25, 26.3%) (cutoff values <20 and ≥20, respectively) as shown in the consort diagram (Figure 1). All patients were evaluated with echocardiography before CAG.

The patients aged 18 years and below, whose EF was <40%, with heart rate >100 bpm, who had a history of percutaneous coronary intervention, with MI or coronary artery bypass graft (CABG), with atrial fibrillation, with left bundle branch block (LBBB), with stroke, with peripheral artery disease, with more severe than mild valvular diseases, with congenital heart disease, with malignity, with chronic renal or hepatic failure, with chronic infection, and women who were pregnant or lactating were excluded from the study. Study protocol was approved by the Local Ethics Committee.

### Echocardiography

All patients were examined immediately before angiography (on average 2.1 ± 0.6 days after the initial admittance for NSTE-ACS). Echocardiography was performed with Vivid 7 dimension machines (General Electrics, Horten, Norway) and 2.5 MHz electronic transducer in left supine position. The head is elevated at 60-90 degrees. All images were recorded to workstation for future calculations. Echocardiography records were obtained from standard apical 4-chamber, 3-chamber, 2-chamber, para-sternal long-axis, and parasternal short-axis images. Echocardiography assessment was done in accordance with American Echocardiography Association guidelines.[12] Inflow records were obtained with pulse wave Doppler. Diastolic E and A wave velocities were extracted from these records. Apical 4-chamber, 3-chamber, 2-chamber, para-sternal short axis images were obtained with tissue Doppler images. Tissue velocity imaging mode was selected during apical 4-chamber imaging, pulse wave Doppler was put at sample volume lateral and septal mitral ring level and lateral tricuspid ring level, and tissue Doppler image records were obtained. Myocardial peak systolic mitrale, early diastolic e′, and late diastolic *a*′ velocities were measured. All images were analyzed blinded to clinical data. Left ventricular volume and EF were measured by Teicholtz and the Simpson biplane method using manual tracing of end-systolic and end-diastolic endocardial borders of apical 4-chamber and 2-chamber views. Strain (longitudinal, circumferential, radial global strain, twist, anti-twist velocity, postsystolic shortening, and ESL parameters) and strain rate were detected with 2-dimensional STE. Frame rate was 70 ± 12 frames per second. For each segment, peak systolic longitudinal strain (PSLS) (which represents the maximum segmental systolic shortening) and duration of ESL (DESL) were recorded. Global longitudinal strain (GLS) values were calculated by averaging all segmental PSLS values for all myocardial layers. The DESL in all 16 segments were averaged to obtain an average DESL value per patient. The DESL was measured as the time from the onset of the Q-wave (or R-wave if Q was absent) in the QRS complex on the ECG to the time of peak positive systolic strain (Figures 2 and 3). The echocardiographic evaluation was determined by 2 independent, 5-year-experienced echocardiographer cardiologist, intraclass correlation (ICC) method was used to determine reliablity of echocardiographic evaluation and interobserver reliablity analysis was 0.96 and intraobserver reliablity analysis was 0.92.

### Coronary Angiography and Anatomic SYNTAX Score

The patients underwent CAG within the first 48 hours after admission. Patient data were analyzed by 2 experienced invasive cardiologists who were blinded to patient data.

## HIGHLIGHTS

- Early systolic lengthening (ESL) is a new strain parameter previously used to determine the lesion severity in patients with stable coronary artery disease.
- Early systolic lengthening is associated with a higher SYNTAX score in patients with non-ST-elevation acute coronary syndrome (NSTE-ACS). Therefore ESL development and prolonged duration of ESL may be associated with high risk and poor prognosis in patients with NSTE-ACS.

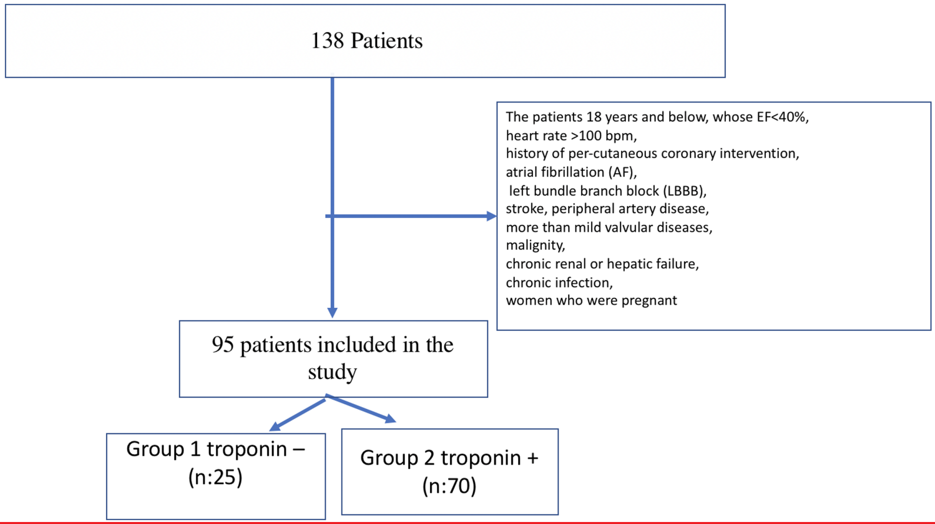


**Figure 1. Consort diagram of study. AF, atrial fibrillation; EF, ejection fraction.**

The number of involved vessels and SYNTAX score were calculated. Diseased vessel was defined as the presence of a lesion, which leads to more than 50% narrowing in each coronary artery and main branches. The SYNTAX score is a pure anatomic score and is estimated through scoring 11 parameters, of which 2 are about anatomic structure, 8 are the parameters evaluated for each lesion, and 1 is about diffuse involvement, which integrated the number of lesions, the location, bifurcation, total occlusions, thrombus, calcification, and small vessels. Each factor is represented as a score according to SYNTAX study (2). Lesion is defined as >1.5 mm and lesion ratio is ≥50%.

## Statistical Analysis

Calculations were done with Statistical Package for the Social Sciences Statistics 15 software (IBM, Armonk, NY, USA). The distribution of continuous variables was assessed with normality test like Shapiro–Wilk test and visual histogram.

The chi-square test was used for between-group comparison of categorical variables and expressed as numbers (n) and percentages (%). Continuous variables were compared with 2 sample *t*-test and the Mann–Whitney *U*-test, the test selected according to distribution of variables. Continuous

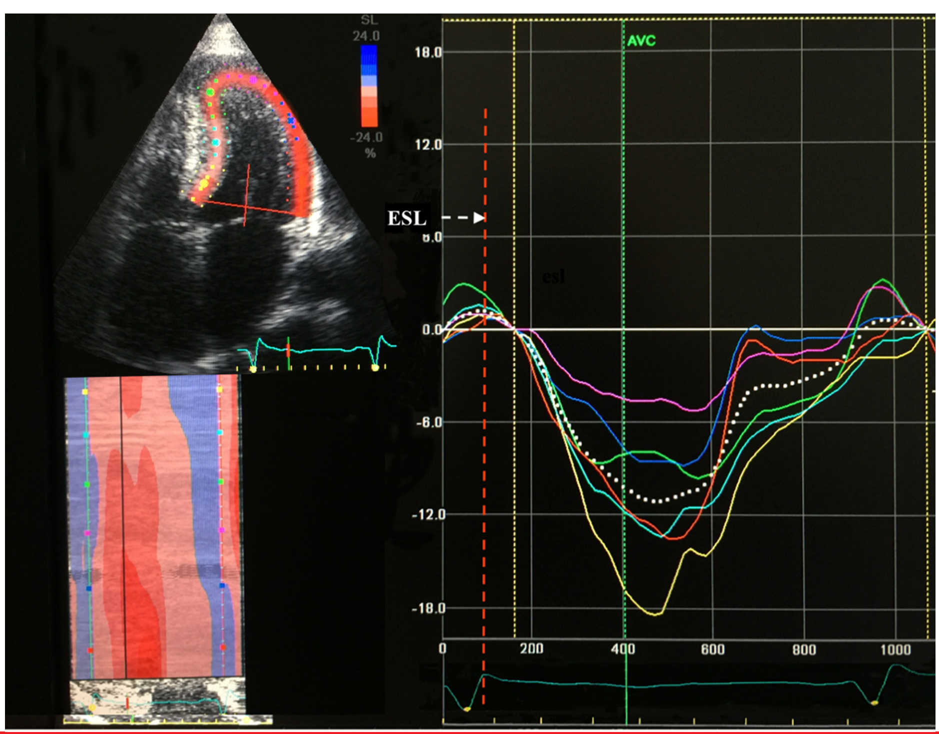


**Figure 2. Echocardiographic image of early systolic lengthening measurement. AVC, atrioventricular canal; ESL, early systolic lengthening.**

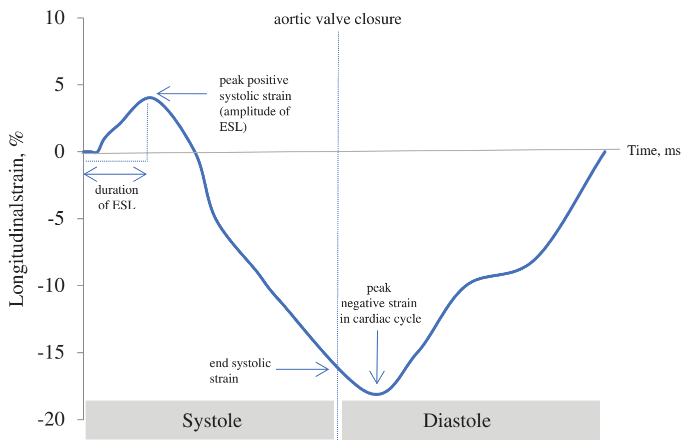


**Figure 3. Schematic drawing of early systolic lengthening. ESL, early systolic lengthening.**

variables are expressed as mean ± SD. A *P*-level of <.05 was accepted as statistically significant. For the interobserver reliability, the ICC method was used.

## RESULTS

Demographic characteristics of the patients according to TIMI risk groups are presented in Table 1. A statistically significant difference was not found between groups with regard to age, hypertension, diabetes, and smoking (59.81 ± 10.11 vs. 57.60 ± 12.80, *P* = .336; 64% vs. 67.1%, *P* = .479; 32% vs. 28.6%, *P* = .467; 48% vs. 77%, *P* = .472, respectively).

Patients were divided into 2 groups according to troponin value. Comparison of both groups according to conventional and 2-dimensional (2D)-speckle echocardiography parameters are presented in Table 2. A statistically significant difference was detected between group 1 and group 2 with regard to left ventricular end-systolic diameter (LVESD), left ventricular end systolic volume (LVESV) (3.2 ± 0.78; 3.50 ± 0.74, *P* = .031; 38.28 ± 13.63; 55.57 ± 32.17 *P* = .013 respectively), LV end-diastolic volume (LVEDV) (91.23 ± 20.57; 115.31 ± 49.54, *P* = .042), DESL, and number of the patients with ESL (15.56 ± 30.19; 24.02 ± 31.20, *P* = .009; 7 (28%); 46 (65.7%), *P* = .001 respectively). Other parameters can be seen in Table 2.

Patients were evaluated according to number of vessels with narrowing more than 50% and divided into 2 groups according to the ones with the presence of ESL (ESL +) and without ESL (ESL −) and troponin + and troponin − groups. There was a statistically significant difference in both analyses. Same analyses were done for continuous SYNTAX score values and similarly, like the first analysis, there was a statistically difference according to the syntax score between ESL +/− and troponin +/− groups (19.66 ± 10.81; 9.07 ± 9.53, *P* < .001; 16.52 ± 11.66; 10.68 ± 10.06, *P* = .023 respectively). These findings can be seen in Table 3.

## DISCUSSION

Our study shows that number of ESL positive patients were higher in troponin positive NSTE-ACS group than other group and in this patients DESL parameters were longer than other groups in echocaridographic examination. Also, we demonstrated that patients with ESL in the LV had higher SYNTAX scores. Our study is the first to show a linear relationship between the presence of ESL and SYNTAX score in patients with NSTE-ACS.

**Table 1. Demographic Characteristics of the Patients According to Thrombolysis in Myocardial Infarction Risk Groups**

| | Group 1 Troponin − Group (n = 25) | Group 2 Troponin + Group (n = 70) | *P* |
|---|---|---|---|
| Age (years) | 59.81 ± 10.11 | 57.60 ± 12.80 | .336 |
| Gender, F (%) | n = 4 (16%) | n = 16 (22.9%) | .280 |
| Hypertension (%) | n = 16 (64%) | n = 47 (67.1%) | .479 |
| DM (%) | n = 8 (32%) | n = 20 (28.6%) | .467 |
| Smoking (%) | n = 12 (48%) | n = 54 (77%) | .472 |

DM, diabetes mellitus; F, female.

Resting echocardiography is a modality used for the diagnosis and treatment of ACS through determining hypokinesia and akinesia which are LV segmental movement disorders developed during ischemia.[13]

Magnitude of ischemic area, duration of occlusion, and degree of collateral flow are the parameters leading to segmental movement disorder.[14] Echocardiography may be normal if transmural infarction is <5% as wall movement disorder cannot be detected. Wall movement disorder begins seconds after the ischemia and develops before both the ECG and clinical symptoms.[15] Widespread vascular disease is frequently observed in NSTE-ACS patients. Most studies also indicate that ECG and conventional echocardiography may not show findings of acute occlusion of coronary arteries in NSTMI patients. Two-dimensional STE is a safe method for diagnosis of LV functions and ischemic changes. It may evaluate myocardial involvement through further parameters, and therefore, determination of high risk and early treatment may improve prognosis.[3] Myocardial functions may be impaired due to several causes in ischemia and CAD. Systolic longitudinal functions decrease due to occlusive and significant coronary lesions, and decreased coronary blood flow leads to myocardial fibrosis and hypertrophy.[16] Studies have indicated that coronary artery stenosis impairs LV longitudinal functions; these functions may be displayed with 2D myocardial strain imaging. Choi et al[17] showed that resting PSLS decreases in patients with severe CAD. In our study, GLS was found to be lower in troponin-positive patients compared to the troponin-negative group, but no statistically significant difference was observed. Nucifora et al[18] revealed that systolic longitudinal strain develops in occlusive CAD.

Normally, LV pressure increases during isovolumetric contraction of LV, and contraction develops through the production of active power. However, myocardial segment cannot produce active power in ischemic myocardium, and LV may passively lengthen before shortening; this is defined as ESL.[5] While the nonischemic segment produces contractile power, this is weaker in the ischemic segment during isovolumetric contraction; therefore, ischemic segment is subjected to

**Table 2. Conventional and Speckle Tracking Echocardiographic Characteristics of the Study**

| | Group 1 Troponin – (n = 25) Group | Group 2 Troponin + (n = 70) Group | *P* |
|---|---|---|---|
| Left ventricle end-systolic diameter (cm) | 3.2 ± 0.78 | 3.50 ± 0.74 | .031 |
| Left ventricle end-diastolic diameter (cm) | 4.69 ± 0.62 | 4.92 ± 0.73 | .119 |
| Interventricular septum thickness (cm) | 1.10 ± 0.183 | 1.16 ± 0.22 | .177 |
| Posterior wall thickness (cm) | 1.03 ± 0.12 | 1.08 ± 0.17 | .142 |
| Left atrial diameter (cm) | 3.63 ± 0.373 | 3.48 ± 0.35 | .053 |
| Aorta diastolic diameter (cm) | 3.055 ± 0.267 | 3.09 ± 0.34 | .118 |
| Aorta systolic diameter (cm) | 3.188 ± 0.297 | 3.21 ± 0.34 | .170 |
| Left ventricle end systolic volume (mL) | 38.28 ± 13.63 | 55.57 ± 32.17 | .013 |
| Left ventricle end-diastolic volume (mL) | 91.23 ± 20.57 | 115.31 ± 49.54 | .042 |
| Left ventricle ejection fraction (biplane) | 58.71 ± 8.73 | 57.20 ± 8.70 | .263 |
| Left ventricle ejection fraction (teicholtz) | 64.29 ± 10.09 | 61.13 ± 10.65 | .172 |
| Left atrium volume index | 38.13 ± 12.86 | 39.00 ± 8.65 | .446 |
| Mitral E | 0.68 ± 0.19 | 0.74 ± 0.67 | .923 |
| Mitral A | 0.77 ± 0.21 | 0.75 ± 0.17 | .785 |
| Deceleration time | 218.77 ± 48.09 | 229.59 ± 43.21 | .729 |
| Lateral *e′* | 0.08 ± 0.031 | 0.11 ± 0.13 | .507 |
| Lateral *a′* | 0.15 ± 0.16 | 0.12 ± 0.14 | .562 |
| Lateral systolic mitrale | 10.20 ± 2.16 | 9.86 ± 1.77 | .458 |
| *E/e′* | 8.33 ± 1.99 | 8.44 ± 2.13 | .785 |
| Isovolumic relaxation time (ms) | 78.45 ± 22.48 | 83.48 ± 18.51 | .124 |
| Bulls-eye global strain | −14.37 ± 5.11 | −16.42 ± 3.93 | .095 |
| Apical twist | 10.00 ± 5.20 | 11.40 ± 7.41 | .405 |
| Basal twist | −4.65 ± 3.35 | −4.47 ± 5.05 | .783 |
| Anti-twisting velocity | −117.66 ± 45.70 | −131.31 ± 56.83 | .133 |
| Four-chamber left ventricle early systolic lengthening (ms) | 15.56 ± 30.19 | 24.02 ± 31.20 | .009 |
| Four-chamber left ventricle early systolic lengthening (n) | n = 7 (28%) | n = 46 (65.7%) | .001 |

lengthening by the nonischemic segment.[19] Left ventricular lateral wall action delays during LBBB, and passive early lengthening may develop even in the absence of ischemia. So the patients with LBBB were not included in our study.[20] Early systolic lengthening is a novel parameter and has been investigated in recent studies. As of today, numerous studies have demonstrated the usefulness of ESL in myocardial ischemia.[4,8,21,22] Early systolic lengthening was found to be correlated with the size of post-MI infarction area in STEMI.

**Table 3. Number of Vessels with Lesion and SYNTAX Score in Troponin –,Troponin + Patients and in ESL – and ESL + Patients**

| Number of Vessels with Lesion | Troponin – Group (n = 25) | Troponin + Group (n = 70) | *P* |
|---|---|---|---|
| 0 | n = 9 (36.00%) | n = 7 (10%) | .044 |
| 1 | n = 7 (28%) | n = 31 (44.3%) | |
| 2 | n = 6 (24%) | n = 21 (30%) | |
| 3 | n = 3 (12%) | n = 11 (15.7%) | |
| SYNTAX score | 10.68 ± 10.06 | 16.52 ± 11.66 | .023 |
| **Number of Vessels with Lesion** | **ESL – (n = 42)** | **ESL + (n = 53)** | ***P*** |
| 0 | n = 13 (31.00%) | n = 3 (5.7%) | .010 |
| 1 | n = 15 (35.70%) | n = 23 (43.4%) | |
| 2 | n = 9 (21.4%) | n = 18 (34.00%) | |
| 3 | n = 5 (11.90%) | n = 9 (17%) | |
| SYNTAX score | 9.07 ± 9.53 | 19.66 ± 10.81 | .001 |

ESL, early systolic lengthening.

While very short DESL or absence of ESL is related with minimal myocardial damage, prolonged ESL is related with a wide infarction area and an occluded artery. Final infarct size is among the most important predictors of cardiovascular mortality.[23] Contrast-enhanced MRI is the gold standard for infarct area. Vartdal et al[6] measured DESL in acute anterior MI patients, demonstrating that DESL was able to distinguish between viable or nonviable myocardial tissue. Similarly, Kahyaoglu et al,[24] who suggested that ESL may be a useful parameter for identifying ischemic but viable myocardium. Zahid et al[7] have investigated the relationship between ESL and final infarct size in NSTE-ACS patients and found ESL superior to GLS and wall movement score index for detection of minimal infarct area. The ESL cutoff value was found as <50 ms in the group without a visible scar.

In the present study, ratio of ESL positivity is 65.7%, and DESL was found to 24.02 ± 31 ms in troponin-positive group. The cutoff value of <50 ms, which is found in the above mentioned study, is not similar in our study. Studies conducted with larger number of patients are required for the detection of a cutoff value. In the same study, the relationship between DESL and occluded coronary artery was found to be correlated as in the infarct area.[7] In another study by Smedruds et al,[4] a mean of 58 ms of DESL is shown to be valuable for the detection of significant CAD with optimal sensitivity and specifity.[4] In a recent study of low-risk individuals from the general population, median DESL was 22 ms[8] and another study conducted by Minamisawa and colleagues, involving 75 patients, demonstrated that the duration of myocardial ESL was significantly prolonged in patients with physiologically significant CAD compared to patients without CAD. Left ventricular ESL duration greater than 14.3 ms was able to differentiate patients with CAD from patients with non-significant CAD, with a sensitivity of 72.5% and a specificity of 55.6%.[22] Median DESL was 15 ms in troponin-negative group and 24.02 ms in troponin-positive group in our study. We observed a significant increase in DESL in troponin-positive patients. As it appears, the degree of ESL increases with ischemic burden, considering that ESL remained a significant predictor and may represent a useful tool for risk stratification of NSTE-ACS patients.

Transient ischemia followed by reperfusion can result in continued abnormal deformation despite the restoration of blood flow. This delayed appearance of abnormal deformation, known as ischemic memory imaging, can be particularly useful in cases where acute chest pain has resolved before seeking medical attention.[25,26] Various studies have shown that ESL has higher accuracy compared to systolic strain in identifying ischemic memory.[22,27] However, despite the introduction of ischemic memory imaging almost a decade ago, reference values for ESL in this context are not determined, and the precise time interval for reliable detection after ischemia remains unclear.

More recent studies have demonstrated that ESL has the ability to predict adverse cardiovascular events in various populations. These studies have shown that both ESL and other deformational patterns provide prognostic information that goes beyond conventional echocardiographic parameters and systolic strain. This holds true for diverse populations,[8,9,28-30] including the general population,[8] individuals with diabetes,[30] and those with acute ischemia.[9,28] In a recent study, Brainin et al[9] measured DESL with tissue Doppler strain in STEMI patients after primary percutaneous coronary intervention. They showed ESL duration was significantly prolonged in culprit lesion areas and ESL duration associated with prognostic information on the future risk of major adverse cardiovascular events (MACEs).In a similar manner, another study demonstrated that the assessment of ESL provides independent and additional prognostic information beyond the EuroSCORE II for cardiovascular disease and all-cause mortality in patients undergoing coronary artery bypass grafting.[28] This suggests that ESL evaluation can contribute to a more accurate risk stratification and prognosis determination for CABG patients.

The SYNTAX score determines plaque load indirectly and may be a marker of systemic atherosclerosis.[31] This score is used for coronary artery complexity and correlated with early and late outcomes after percutaneous coronary intervention (PCI).[2] The SYNTAX score was shown to predict MACE in patients with stable and unstable CAD.[32] Şahin et al[33] showed that SYNTAX score is a predictor of no reflow development during the procedure. Akgun et al[34] showed that SYNTAX score is associated with distal embolism and TIMI3 flow during percutaneous coronary intervention in ST-elevation MI. Karabağ et al[35] showed SYNTAX score is a powerful tool to predict inhospital and long-term mortality from all causes in STEMI patients treated with PCI.[35]

Strain echocardiography was shown to be useful for the prediction of complexity of CAD and severity of vessel involvement before CAG in NSTE-ACS patients. A correlation was detected particularly between layer-specific longitudinal strain and SYNTAX score. Layer-specific STE is suggested to be useful for clinicians for making a decision for PCI or CABG by predicting the severity of complex CAD.[36] Similarly, in our study, the presence of a correlation between ESL and SYNTAX score suggests that ESL could be useful for the prediction of complex CAD and treatment selection, although treatment selection was not analyzed in our study. Further studies are required.

In a recent study, patients with NSTEMI were compared in terms of 2D and 3-dimensional (3D) global and regional longitudinal strain with the SYNTAX score. The results showed significantly lower values of 2D GLS, 3D GLS, global circumferential strain, area strain, and global radial strain in the high score group compared to the low score group of patients.[37] Abdulrezak et al[38] found that there was a statistically significant positive correlation between the SYNTAX score and each of LVEDD and LVESD. On the other hand, a statistically significant negative correlation was observed between the SYNTAX score and GLS. In our study, we found that in troponin-negative patients, LVESD, LVESV, and LVEDV measurements were significantly lower compared to troponin-positive patients. Additionally, troponin-positive patients had a significantly higher SYNTAX score compared to troponin-negative patients. These findings indicate that troponin-positive patients have larger ventricular dimensions and a higher burden of CAD, as reflected by the SYNTAX score, compared to troponin-negative patients. Similarly, Vrettos et al[39] show that GLS values were inversely related to SYNTAX score values. In this study, we observed a significant increase in the SYNTAX score in patients in the ESL + group in the left ventricle compared to the ESL – group.

Our study is the first that investigates the relationship between ESL and SYNTAX score, and the linear correlation between ESL and SYNTAX score has indicated the usefulness of ESL for the detection of severity of CAD. We found ESL is associated with increased number of vessels with lesion and higher SYNTAX score in patients with NSTE-ACS. This finding suggests that ESL in the left ventricle is associated with a higher burden of CAD, as reflected by an elevated SYNTAX score. We know that the SYNTAX score and ESL can predict the prognosis in patients with CAD.[9,28,35]

Since our study demonstrated a linear relationship between ESL and the SYNTAX score, the presence of ESL may predict a poor prognosis in patients with NSTE-ACS. Further studies with longer follow-up and larger patient populations are needed to evaluate the long-term prognosis in these patients.

### Study Limitations

In our study, SYNTAX score could be found low when ESL is positive. The reason may be the following: echocardiography and CAG were not performed on the same day. The patients were given anticoagulant treatment during this period, so coronary occlusion could have been resolved before CAG for treatment selection, and further studies are required.

## CONCLUSION

Early systolic lengthening is associated with higher SYNTAX score in patients with NSTE-ACS. Therefore, ESL development and prolonged DESL may be associated with high risk and poor prognosis in patients with NSTE-ACS.

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**Ethics Committee Approval:** The approval for the study was obtained from the Koşuyolu Heart Training and Research Hospital Local Ethics Committee (decision number 2023/05/678).

**Informed Consent:** Written informed consent was obtained from the patients who agreed to take part in the study.

**Peer-review:** Externally peer-reviewed.

**Author Contributions:** Concept – T.U., Ç.G.; Design – T.U., N.Ö.; Supervision – C.K., N.Ö.; Resources – E.E., M.Ç.; Materials – T.U., R.D.A.; Data Collection and/or Processing – T.U., E.E., Ç.Ö., R.B.B.; Analysis and/or Interpretation – T.U. N.Ö.; Literature Search – T.U., S.İ.; Writing – T.U.; Critical Review – All Authors.

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