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## Carotid intima-media thickening predicts negative stress test in chest pain patients in an emergency department observation unit

Chest pain is a common presentation in the Emergency Department (ED) [1]. While most patients with chest pain are ultimately determined to have non-cardiac pain, a proportion of patients will have cardiogenic chest pain with no acute ECG changes and negative initial cardiac biomarkers.

The American Heart Association (AHA) recommends that patients in the ED with non-ultra low risk chest pain and the possibility for ACS be evaluated with serial ECGs, cardiac troponins and stress testing before discharge or within 72 h after discharge [2]. Thus, patients are frequently admitted to Observation Units (OU) for evaluation. The goal of stress testing is to evaluate for provoked ischemia requiring coronary intervention.

Ultrasound of Carotid Intima-Media Thickness (CIMT) has been proposed as a tool to non-invasively identify patients with increased atherosclerotic burden [3-6]. Studies have shown that CIMT is associated with cardiovascular disease [7-11]. The value of CIMT in the ED evaluation of chest pain is unknown. The goal of this study is to evaluate if CIMT in an ED OU population can be used as a tool to predict which patients will have a positive stress test.

This is an IRB approved, prospective, convenience sample of patients admitted to our ED OU with chest pain, dyspnea or coronary equivalents who received a stress test during their observation stay. The study was performed in a large, urban, academic ED with an annual volume of over 100,000 patients per year, an emergency medicine residency and emergency ultrasound fellowship.

CIMT scanning was performed with a Philips Sparq (Bothell WA) ultrasound machine using the L12–4 MHz linear transducer. The carotid artery was scanned at the level of the carotid bulb (Fig. 1). A registered vascular sonographer and ultrasound fellow performed scanning and data collection.

Three CIMT measurements were taken on each side 1 cm proximal to the carotid bulb (Fig. 2). The averages for each side were compared to a known standard for age and ethnicity [3]. The composite average of both sides was compared with the composite average of same reference standards. CIMT greater than the 75th percentile for age, gender and ethnicity was considered positive. Data was considered for 2 scenarios: average CIMT on *either* side or composite average CIMT of *both* sides. The reference standard differentiated patient ethnicity as black or white. For this study we used the categorization of white for all non-African ethnicities. Stress test results, interpreted by attending cardiologists, were considered the comparative standard. Results were categorized as positive or negative with indeterminate stress tests categorized as negative. Data was analyzed using Stata v 14.0 (College Station, TX).

The final analysis included 57 patients. Demographic and stress test information is shown in Table 1. Five patients had a positive stress test (8.8%).

When consideration was made for average CIMT of *either* side, 30 (52.6%) patients had a positive CIMT (Table 2). The sensitivity, specificity and negative predictive value (NPV) of CIMT for positive stress was 80% (0.95 CI 28.4–99.5%), 50% (0.95 CI 35.8–64.2%) and 96.3% (0.95 CI 81–99.9%) respectively with an odds ratio (OR) of 4 (0.95 CI 0.4–38.2 $p = 0.229$) using a univariate logistic regression analysis.

When consideration was made for average CIMT of *both* sides, 20 (35.1%) patients had a positive CIMT (Table 3). The sensitivity, specificity and NPV of CIMT for positive stress was 40% (0.95% CI 5.27–85.3%), 65.4% (0.95 CI 50.9–78%) and 91.9% (0.95 CI 78.1–98.3%) respectively with an OR of 1.3 (0.95 CI 0.2–8.2, $p = 0.81$) using a univariate logistic regression analysis.

Multiple studies have demonstrated a correlation between CIMT and increasing risk of cardiovascular disease. Chambless et al. [7] demonstrated a correlation between CIMT measurement > 1 mm and increased risk for coronary heart disease. O'Leary et al. [8] showed the risk of myocardial infarction or stroke increased with increasing CIMT. Coskun et al. [11] demonstrated that patients with CAD on angiography had a significantly thicker CIMT (1.48 ± 0.2 8mm vs 0.78 ± 21 mm).

To our knowledge, this is the first study to evaluate CIMT in the ED evaluation of patients with chest pain. In our study we demonstrated a trend toward positive stress test with a positive CIMT. We showed that an abnormal unilateral average CIMT demonstrated a modest sensitivity for positive stress (80%) but high NPV (96.3%) and odds ratio 4 suggesting that patients with normal bilateral CIMT measurements are not likely to have a positive stress test. Interestingly this result less predictive for the composite average of both carotids (sensitivity 40%, NPV 91.9%, OR 1.3).

We found that a normal CIMT measurement for both carotid arteries correlates with a negative stress test with an extremely high negative predictive value. Our data suggest that given further study, CIMT measurement may be a reasonable determinate of disposition in ED patients with chest pain.

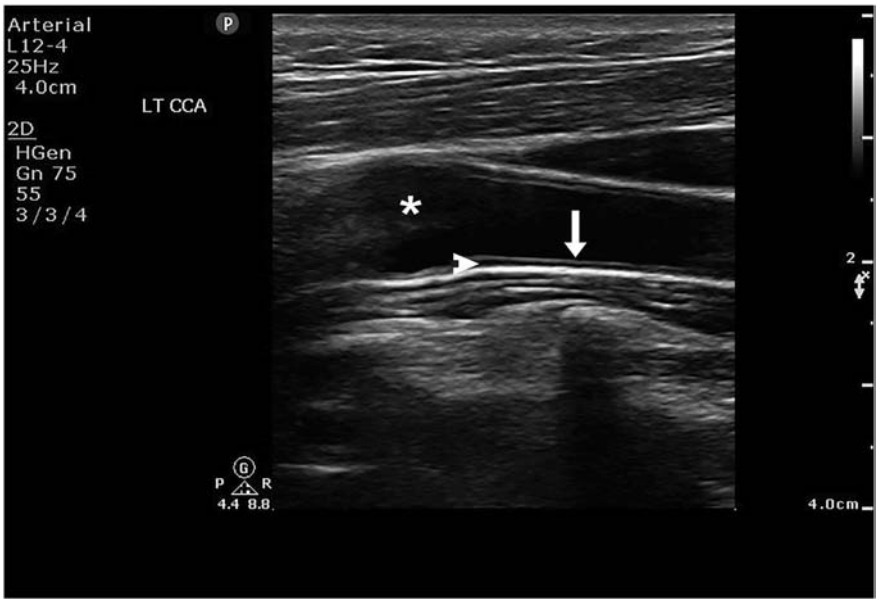


**Fig. 1.** Long axis of the common carotid artery at the level of the carotid bulb (*) with hyperechoic intima (arrow) and hypoechoic media (arrowhead).

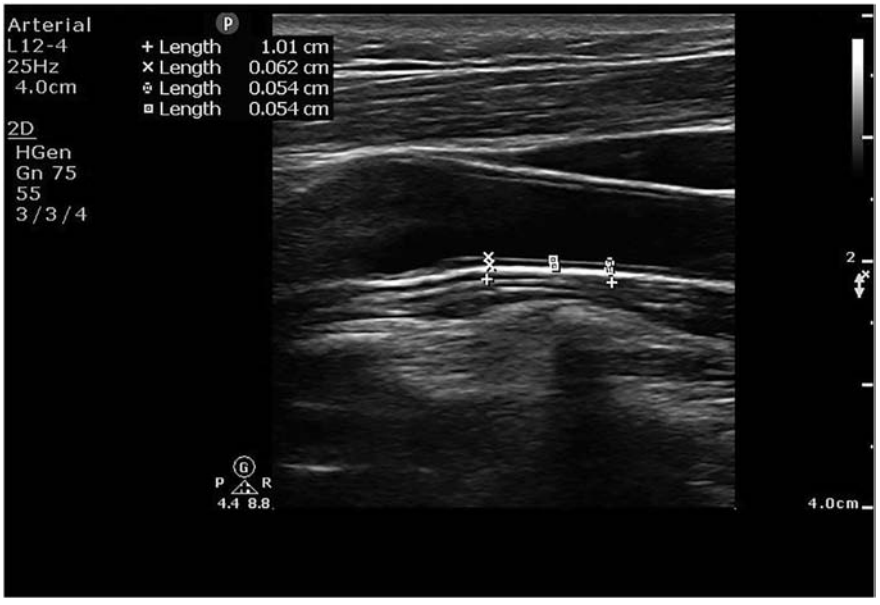


**Fig. 2.** CIMT measurements of the common carotid artery within 1 cm of the carotid bulb.

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**Table 1**
Patient demographic and stress tests information.

| Patient demographics | | |
|---|---|---|
| | Frequency ($n = 57$) | Percent |
| Gender | | |
| Male | 20 | 35% |
| Female | 37 | 65% |
| Ethnicity | | |
| White | 24 | 42.1% |
| Black | 21 | 36.8% |
| Hispanic | 10 | 17.5% |
| American Indian | 1 | 1.8% |
| Asian | 1 | 1.8% |
| Age | | |
| Mean Age | 53 | |
| Min Age | 33 | |
| Max Age | 79 | |
| Stress test | | |
| | Frequency (n = 57) | Percent |
| Exercise stress ECHO | 33 | 57.9% |
| Pharmacologic stress ECHO | 22 | 38.6% |
| Pharmacologic nuclear stress | 2 | 3.5% |

**Table 2**
2 × 2 table for positive CIMT on either side.

| | Stress Pos | Stress Neg | |
|---|---|---|---|
| CIMT Pos | 4 | 26 | 30 |
| CIMT Neg | 1 | 26 | 27 |
| | 5 | 52 | 57 |

**Table 3**
2 × 2 table for positive composite average CIMT.

| | Stress Pos | Stress Neg | |
|---|---|---|---|
| CIMT Pos | 4 | 16 | 20 |
| CIMT Neg | 1 | 36 | 37 |
| | 5 | 52 | 57 |

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## Consent for emergency treatment: Emergency department patient recall and understanding

Informed consent is a crucial component of patient autonomy and shared decision-making. Previous studies have shown that comprehension of a variety of types of informed consent by patients is poor [1-3]. This study was undertaken to identify patient recall and understanding of the emergency department (ED) Consent for Treatment document.

In this prospective survey study design, eligible participants included ED patients age 18 and older, who were able to communicate, not in distress, and consented to participate. After signing informed consent document per ED registration protocol, a convenience sample of patients meeting the inclusion criteria were invited to participate.

A total of 293 patients consented to participate (95% participation rate). The mean age was 52 and the majority of participants were female (58%) and White (62%). The majority of participants stated that they had signed a consent document ($N = 272$; 93%). A minority of patients read the entire document (7%) or read part of the document (11%). Most patients did not read the document (36%) or received only a verbal explanation (45%) (Table 1). Many patients did not recall anything about what they signed ($N = 107$; 39%). The most frequently recalled elements of consent included consent for treatment ($N = 144$; 52%), information regarding finances and billing ($N = 36$; 13%), and privacy rights ($N = 12$; 4%) (Table 2).

Reading the document prior to signing was associated with African American ethnicity ($p = 0.01$). Age, gender, mode of arrival, and triage level were not associated with reading the document (Table 3). Respondents who indicated they didn't know what they had consented to were significantly older (median 56 years) than respondents who remembered something from the consent form (median 47; $p = 0.01$). A

**Table 1**
Did you read the document prior to signing?

| | |
|---|---|
| Yes, I read the entire document | 20 (7%) |
| Yes, I read part of the document | 31 (11%) |
| No, I did not read the document | 101 (36%) |
| No, I did not read the document but I received a verbal explanation | 126 (45%) |

**Table 2**
What did you consent to?[a]

| | |
|---|---|
| Don't know | 107 (39%) |
| Treatment | 144 (52%) |
| Attending physician | 0 (0%) |
| Privacy/HIPAA | 12 (4%) |
| Photography | 0 (0%) |
| Finances, billing | 36 (13%) |
| Personal property | 0 (0%) |
| Patient rights | 9 (3%) |

[a] More than 1 response possible. Percentages are calculated based on $n = 276$.