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Research Article

Association of Left Atrial Coupling Index with Infarction Site and Cardiac Biomarkers in Patients with First Episode of Acute Myocardial Infarction

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Abstract

Background: Acute myocardial infarction leads to elevation of left ventricular pressure, which is transmitted to the left atrium, resulting in changes in left atrial volume and function. LACI is a novel echocardiographic parameter that reflects the left atrioventricular interaction and may provide insight into infarction size and early risk stratification. ***Objectives***: To evaluate LACI and its association with infarction site and cardiac biomarkers, including troponin and N-terminal pro-B-type natriuretic peptide (NT-proBNP), in patients experiencing a first episode of acute myocardial infarction. ***Methods***: This cross-sectional study enrolled forty-two patients with the first episode of acute myocardial infarction. Peak serum troponin and NT-proBNP were recorded for each patient. Transthoracic echocardiography was performed to assess regional wall motion abnormality, left ventricular ejection fraction, and LACI, which was calculated as the ratio of left atrial end-diastolic volume to left ventricular end-diastolic volume. ***Results***: The mean LACI was 0.46±0.13, with significantly higher LACI values observed in patients with anterior myocardial infarction compared to inferior or lateral infarctions. LACI shows a positive correlation with troponin and NT-proBNP and was inversely associated with LV ejection fraction. Higher values were noted in patients with severe regional motion abnormality, particularly akinesia. Receiver operating characteristic (ROC) analysis demonstrated a moderate discriminatory ability for identifying patients with higher levels of cardiac biomarkers. ***Conclusions***: LACI may reflect the infarction severity and ventricular dysfunction and could serve as a useful noninvasive tool for risk stratification and assessment of hemodynamic burden.

Keywords: Acute myocardial infarction; Echocardiography; Left atrial coupling index; NT-proBNP; Troponin.

ارتباط مؤشر الاقتران الأذيني الأيسر مع موقع الاحتشاء والواسمات القلبية لدى المرضى المصابين بالنوبة الأولى من احتشاء عضلة القلب الحاد

الخلاصة

الخلفية: يؤدي احتشاء عضلة القلب الحاد إلى ارتفاع ضغط البطين الأيسر، والذي ينتقل إلى الأذين الأيسر ويؤدي إلى تغيرات في حجمه ووظيفته. ويعد مؤشر الاقتران الأذيني الأيسر معلمة جديدة في تخطيط صدى القلب تعكس التفاعل الأذيني البطيني الأيسر، وقد يوفر فهما لحجم الاحتشاء والتصنيف المبكر للمخاطر. **الأهداف**: تقييم مؤشر الاقتران الأذيني الأيسر وارتباطه بموقع الاحتشاء والواسمات القلبية، بما في ذلك التروبونين و NT-proBNP، لدى المرضى الذين يمرون بالنوبة الأولى من احتشاء عضلة القلب الحاد. **الطرائق**: شملت هذه الدراسة المقطعية اثنين وأربعين مريضا أصيبوا بالنوبة الأولى من احتشاء عضلة القلب الحاد. تم تسجيل ذروة التروبونين في المصل و NT-proBNP لكل مريض. أجري تخطيط صدى القلب عبر الصدر لتقييم خلل حركة الجدار الإقليمي، والكسر القذفي للبطين الأيسر، ومؤشر الاقتران الأذيني الأيسر، الذي تم حسابه كنسبة حجم نهاية الانبساط للأذين الأيسر إلى حجم نهاية الانبساط للبطين الأيسر. **النتائج**: كان متوسط مؤشر الاقتران الأذيني الأيسر 0.46±0.13، مع ملاحظة قيم أعلى بشكل ملحوظ لدى المرضى الذين يعانون من احتشاء عضلة القلب الأمامي مقارنة بالاحتشاءات السفلية أو الجانبية. يظهر المؤشر ارتباطا إيجابيا مع التروبونين و NT-proBNP، وكان مرتبطا عكسيا مع الكسر القذفي للبطين الأيسر. لوحظت قيم أعلى في المرضى الذين يعانون من خلل أشد في حركة الجدار الإقليمي، وخاصة في حالات انعدام الحركة. أظهر تحليل خصائص تشغيل المستقبل قدرة تمييزية معتدلة على تحديد المرضى الذين لديهم مستويات أعلى من الواسمات القلبية. **الاستنتاجات**: قد يعكس مؤشر الاقتران الأذيني الأيسر شدة الاحتشاء وخلل وظيفة البطين، وقد يكون أداة غير باضعة مفيدة لتصنيف المخاطر وتقييم العبء الديناميكي الدموي.

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INTRODUCTION

Acute myocardial infarction (AMI) is a leading cause of both mortality and long-term disability worldwide [1,2]. Even with early perfusion, left ventricular pressure will increase, and that will be transmitted to the left atrium, affecting its volume, function, and later structural remodeling [3]. Several previous studies examined the effect of left atrial size and strain in patients with MI [4-6]; however, these studies assessed the left atrium alone and didn't capture how the left atrium and ventricle interact as a single functional unit, and for this purpose, LACI was introduced. LACI is calculated as the ratio of left atrial end-diastolic volume to left ventricular end-diastolic volume (LACI = LAEDV / LVEDV). It integrates the left atrium and left ventricle into a single measure rather than each chamber alone [7,8]. Many studies examine the role of LACI in heart failure

patients [9,10], but its role in myocardial infarction is still not well established, especially in the first episode. Cardiac troponin is a cornerstone in the diagnosis of MI, and its level is associated with infarction size [11]. N-terminal pro-B-type natriuretic peptide (NT-proBNP) is a biomarker released from the left ventricle in response to ventricular load and stress [12]. Therefore, these biomarkers representing infarction size and ventricular load were examined and correlated with LACI in the current study.

METHODS

Study design and setting

This study is an observational cross-sectional one, conducted in a tertiary teaching hospital in Iraq during the period from January to October 2025. Forty-two adult patients diagnosed with a first episode of acute MI were enrolled. Diagnosis of MI was made based on the fourth universal definition of MI [13].

Exclusion criteria

Many patients were excluded for having at least one of the following: previous MI, valvular heart disease, atrial fibrillation, non-ischemic cardiomyopathy, poor echocardiographic image quality, advanced renal or liver disease, thyroid dysfunction, use of inotropes, uncontrolled hypertension, or recent pulmonary embolism (less than three months' duration).

Intervention and outcomes measurement

For each patient, serial measurements of cardiac troponin and NT-proBNP were recorded, and the peak values were chosen for statistical analysis. Transthoracic echocardiography was done for all patients during the first 48 hours of admission and was performed according to the American Society of Echocardiography guidelines [14]. Echocardiographic assessment was done by a cardiologist and an echocardiographist who was blinded to the clinical data. Interobserver variability was assessed in 10 random cases. Regional wall motion abnormalities were assessed visually, and the biplane Simpson's method was used to measure ejection fraction as well as LA and LV volumes. LACI was calculated as the ratio of LAEDV to LVEDV. The infarction site was determined using ECG and echocardiographic findings.

Ethical considerations

The study was conducted in accordance with the principles of the Declaration of Helsinki, and the study protocol was approved by the local institutional ethical committee and the Iraqi Board of Medical Specialties. Study procedure and objectives were explained to the patients, and written informed consent was obtained for all participants before inclusion. Participation was voluntary, and the patients were assured that refusal of participation would not affect their medical care. All information was anonymized to protect the patients' privacy.

Statistical analysis

Data analysis was done using SPSS version 26. Assessment of correlation was done using Spearman analysis, and comparison of means between more than two groups was done by one-way ANOVA analysis with Bonferroni correction. ROC curves were used to assess the diagnostic ability of LACI to detect patients with higher values of cardiac biomarkers (values above the mean).

RESULTS

The mean age of patients was 56.76 ± 10.2 years; males constituted 61.9% (n= 26), while females represented 38.1% (n= 16). The median of troponin was 1880 ng/L and it was 722.15 pg/mL for NT-proBNP. The mean LACI was 0.46 ± 0.13. There was no significant correlation between LACI and age or sex of patients, while there was a moderate positive correlation with troponin (Spearman's ρ= 0.546 and $p< 0.001$) and with NT-proBNP (Spearman's ρ= 0.411 and $p= 0.007$). In contrast, Spearman's ρ revealed a strong inverse relationship between ejection fraction (EF) and LACI (Spearman's ρ= – 0.737, $p< 0.001$). These correlations are presented in Table 1.

Table 1: Correlations of left atrial coupling index with cardiac biomarkers and ejection fraction

Parameter pair	Spearman's ρ	*p*-value
LACI and troponin	0.546	<0.001
LACI and NT-proBNP	0.411	0.007
LACI and EF	– 0.737	<0.001

LACI: Left atrial coupling index, NT-proBNP: N-terminal pro-B-type natriuretic peptide.

One-way ANOVA with Bonferroni correction revealed significantly higher LACI in patients with anterior MI than those with lateral or inferior MI ($p= 0.002$ and <0.001, respectively), with no significant difference between lateral and inferior infarctions. These findings are summarized in Table 2.

Table 2: Comparison of left atrial coupling index according to the infarction site

Comparison	Mean difference (I-J)	*p*-value
Overall ANOVA	-	<0.001
Anterior MI *vs*. Lateral MI	+0.142	0.002
Anterior MI *vs*. inferior MI	+0.165	<0.001
Inferior MI *vs*. Lateral MI	+0.022	>0.999

MI: Myocardial Infarction.

Regarding RWMA, LACI mean was significantly

higher in patients with akinesia than those with hypokinesia and normal wall motion (p= 0.007 and <0.001, respectively), as shown in Table 3.

Table 3: Comparison of left atrial coupling index according to regional wall motion abnormality

Comparison	Mean difference (I-J)	*p*-value
Overall ANOVA	-	<0.001
Normal *vs*. Hypokinesia	–0.0860	0.059
Normal *vs*. Akinesia	–0.2240	<0.001
Hypokinesia *vs*. Akinesia	–0.1380	0.007

RWMA: Regional wall motion abnormality.

Receiver operating characteristic (ROC) curves revealed moderate diagnostic ability of LACI to identify patients with higher troponin (AUC= 0.747) and patients with higher NT-proBNP (AUC= 0.740). ROC curves are visually illustrated in Figures 1 and 2.

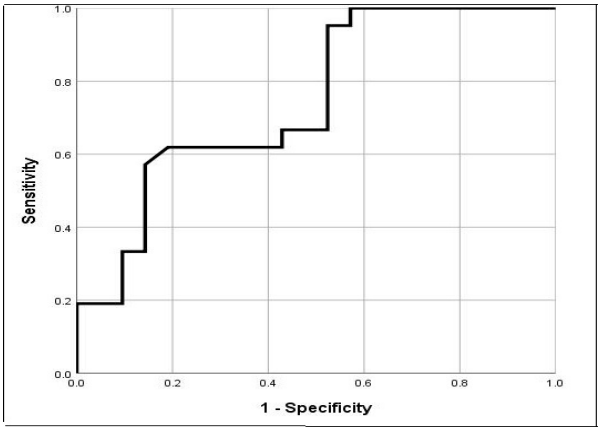

Figure 1: Receiver operating characteristic (ROC) curve of left atrial coupling index for predicting elevated troponin levels.

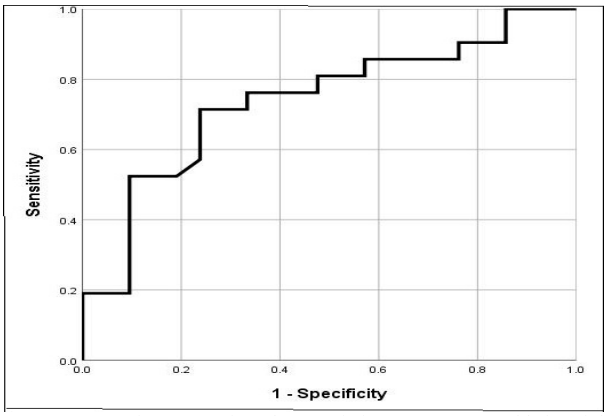

Figure 2: Receiver operating characteristic (ROC) curve of left atrial coupling index for predicting elevated NT-proBNP levels.

DISCUSSION

Although there is no universal cut-off normal value for LACI, many studies used 0.33 as an upper normal limit [8]. The mean LACI in this study was 0.46 ± 0.13, which is higher than the levels of the normal or non-infarcted population. This could be explained by the loss of contractile myocardium in MI, leading to elevation of filling pressure, LA volume, and hence LACI. Similar findings were revealed by Wu et al [15]. Troponin is positively associated with infarction size [11,16], so we used troponin as a surrogate for infarction size in this study. By applying this, the positive correlation between LACI and troponin is assumed to be due to more diastolic burden on the left atrium in larger infarctions. In the present study, LACI had a positive correlation with NT-proBNP, which is consistent with the physiological role of natriuretic peptide as a marker of ventricular wall stress and filling pressure [12,17,18]. Wu et al also demonstrated higher LACI in STEMI patients who had higher levels of NT-proBNP [15]. LACI levels were higher in anterior MI patients, as anterior MI is usually associated with larger myocardial involvement, more systolic dysfunction, and subsequently higher filling pressure when compared to lateral or inferior infarction [19], which is similar to previous studies that revealed more pronounced left atrial remodeling in patients with larger infarctions [3,20]. Regarding regional wall motion, progressive increase in LACI with worsening regional wall motion abnormality was observed and was highest in patients with akinesia, which further supports the association between infarction size and LACI, as severe RWMA reflects more severe myocardial injury [21]. ROC analysis indicated that LACI could help as an add-on tool in early risk stratification of patients, especially when results of biomarkers are delayed or unavailable, particularly in resource-limited centers, as it revealed a moderate diagnostic ability to detect patients with higher biomarkers. Many studies have evaluated ROC performance of LACI for long-term prognostic outcomes, such as recurrence of atrial fibrillation [22], but limited data exist regarding its role in patient stratification according to biomarker severity in acute MI. These findings require validation with a larger prospective multicenter study.

Study limitations

This study has several limitations. First, a small sample size, which limits the generalizability of the findings. This limitation was primarily due to the single-center design, strict inclusion criteria of the first episode of MI, and the use of extensive exclusion criteria to limit confounding factors. Second, a cross-sectional observational study with no follow-up of patients, which prevents assessment of the prognostic significance of LACI. Third, cardiac troponin was used as a surrogate for assessing infarction size instead of the more reliable cardiac MRI assessment, which was unavailable at our center.

Conclusion

In patients with a first episode of acute MI, LACI was

significantly associated with infarction severity markers such as elevated cardiac biomarkers, anterior MI, impaired systolic function, and more severe RWMA, so it may have potential prognostic value, requiring longitudinal confirmation. As LACI can be easily obtained from standard echocardiographic views, it may aid in early risk stratification of patients after MI, which is further supported by its moderate ability to detect patients with higher biomarkers on ROC analysis; however, it should be considered as an adjunct to these biomarkers, not as a replacement for them.

Conflict of interests

The authors declared no conflict of interest.

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Data sharing statement

Data can be shared with the corresponding author based on a reasonable request.

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