

DIAGNOSTIC ACCURACY OF ALLENS TEST FOR ULNAR COLLATERAL FLOW IN RADIAL ARTERY HARVESTING IN CORONARY ARTERY BYPASS GRATING

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Abstract: To treat coronary artery disease, coronary artery bypass graft (CABG) surgery is done worldwide (CAD). Before harvesting the radial artery for cardiac bypass surgery, Allen's test is frequently used to evaluate the hand's ulnar collateral blood supply. Using Doppler Ultrasonography as a gold standard, this study was created to evaluate the diagnostic precision of Allen's test for the ulnar collateral flow of the donor limb before radial artery harvesting. This cross-sectional study was conducted from January 2015 to September 2017 at the Jinnah Hospital in Lahore's Cardiac Surgery department. The consecutive sampling/non-probability method was employed. A signed consent form was obtained, and specific demographic data (name, age, and gender) was gathered. SPSS version 21 was used to enter and analyze all of the data. The patients in our study had a mean age of 50.91±9.13 years. The ratio of men to women was 1.3:1. The sensitivity, specificity, PPV, NPV and diagnostic accuracy of Allen's test was 77.05%, 81.36%, 81.03%, 77.42% & 79.17% taking Doppler test as gold standard. Allen's test, which uses Doppler ultrasonography as the gold standard, is a reliable and valid screening test for the ulnar collateral flow of the donor limb before radial artery harvesting, according to the findings of our study.

Keywords: Doppler Ultrasonography, Allen's Test, Diagnostic accuracy, Radial artery, gold standard

Introduction

Coronary artery bypass grafting is a common procedure used to treat individuals with coronary artery disease. The saphenous vein and the left anterior descending artery (LAD) are connected to other coronary arteries that are either blocked or stenotic during this procedure by using the left internal mammary artery as a conduit. The long-term survival of patients is improved by employing arterial rather than venous grafts, it has been shown. This is due to the fact that a venous graft only has a patency percentage of between 50 and 60 percent after the same 10 years, whereas an arterial graft has a patency rate of 90 percent. The two arterial graft types that are most frequently used are the left internal mammary artery and the radial artery (RA). Early on, the saphenous vein and the RA both have the same amount of patency; however, by the midway point, the RA has a higher level of patency than the saphenous vein (Al-Sabti et al., 2013; Athanasiou et al., 2011; Weiss et al., 2013). For the reasons mentioned above, the RA is harvested from the non-dominant forearm; nonetheless, a complete pre-operative examination is still necessary to ensure adequate flow in the ulnar

collateral artery. Non-invasive testing for the patency and completeness of the palmer arch is often sought shortly before radial artery harvesting for CABG procedures because Allen's test's reliability has been questioned. The palmer arch anatomy and its typical variations must be known to the sonographer and doctor analyzing the photographs (Baetz and Satiani, 2011). It appears that the modified Allen's test is considered negative in between 15% and 23% of people who are being considered for CABG.

The modified Allen's test has a specificity in the range of 97 percent with a cutoff of 6 seconds. As a result, if the modified Allen's test yields an unexpected result, a different non-invasive test should be carried out. This is required since the modified Allen's test's dramatically decreased sensitivity suggests that many patients may not be able to safely extract RA (Habib et al., 2012).

The RA is not employed if the Allen test is negative, or the perfusion index is lower than 45 percent (Rani et al., 2012). Flow-mediated vasodilation was used to examine the ulnar artery anatomy and functional responsiveness more than ten years after the RA was

harvested. Despite increased shear stress, there was no evidence of degeneration in any of these areas.

RA harvesting for CABG is not related to long-term donor limb vascular insufficiency, if sufficient pre-operative evaluation is performed (Schena et al., 2011). This is because CABG bypass surgery bypasses the right atrium. Following cannulation of the radial artery, certain studies have found an incidence of flow decrease or thrombosis ranging from 25 to 35 percent. In their study, Jarvis and colleagues discovered that the Allen test had a sensitivity of 54.5 percent, a specificity of 91.7 percent, and diagnostic accuracy of 78.5 percent when using a cutoff time of 6 seconds (Jarvis et al., 2000).

Allen's test, upper arm and fore-arm Doppler Ultrasonography were performed on 145 patients who were slated to undergo CABG in a study that was conducted by Kohonen et al. After that, Allen's test was evaluated alongside other, more objective diagnostic tools, and its sensitivity, specificity, and accuracy were computed. Allen's test was positive (average) for most patients, while 23 percent were negative (abnormal). An ultrasound examination found that 10 of the patients had anatomical abnormalities, while 17 of the patients had circulatory impairments. Thirteen patients showed anomalies not just in their circulation but also in their anatomy. Allen's test has a sensitivity of 73.2 percent, while its specificity reached 97.1 percent (Kohonen et al., 2007). To evaluate the diagnostic accuracy of Allen's test for the ulnar collateral flow of the donor limb before radial artery harvesting, the purpose of my study is to use Doppler Ultrasonography as the gold standard, which has been utilized in a variety of studies to confirm the accuracy of Allen's test and other tests (Agrifoglio et al., 2005; Al-metwalli, 2019; Chen et al., 2009; Mussa et al., 2005; Ronald et al., 2005; Wood et al., 2013).

In the short term, the patency of arterial grafts may be comparable to that of saphenous vein grafts. However, arterial grafts have been shown to significantly improve long-term outcomes, such as significantly improved long-term survival, significantly reduced rates of recurrent angina, significantly fewer cardiac events such as myocardial infarction, and significantly fewer operations. Allen's test is an efficient test that not only provides direct information on the patency of the ulnar artery but can also anticipate future complications of the hand and may be of great assistance in the decision-making process during the harvesting of the radial artery in CABG.

In the published research, contradictory findings have been recorded, such as one study indicating a high level of sensitivity while another study indicated a low level. This study will allow surgeons

to outline recommendations for pre-operative assessment to harvest RA with fewer post-operative ischemia problems of the hand. Additionally, this study will give complete arterial coronary revascularization.

Methodology

After receiving approval from the hospital's ethics council, this cross-sectional study was carried out from January 2015 to September 2017 in the cardiac surgery department of Jinnah Hospital in Lahore. With a 95 percent confidence level, a sample size of 120 cases was calculated. The expected percentage of ulnar collateral flow was 33 percent, and the sensitivity and specificity of Allen's test were 54.5 percent and 91.7 percent, respectively, with a 13 percent and 6 percent margin of error. According to the estimated sample size, non-probability / sequential sampling was employed to acquire the data.

The current study comprised patients receiving CABG under general anesthesia who were 40 to 80 years old and of either gender. Patients with Reynaud's illness diagnosed on history and clinical examination, peripheral vascular disease diagnosed on history and clinical examination, and Doppler Ultrasonography, as well as those with ASA III and IV, were excluded from the study. A signed consent form was obtained, and specific demographic data (name, age, and gender) was gathered. A cardiac surgeon performed Allen's test to determine whether the patient had adequate UCF. The patient was asked to clench their fist while the radial and ulnar arteries were compressed firmly at the wrist, keeping the hand at the level of the heart. After slowly opening their wrist and partially extending their fingers while releasing the ulnar artery, the patient's hand was brought to their heart. (Figure 1)

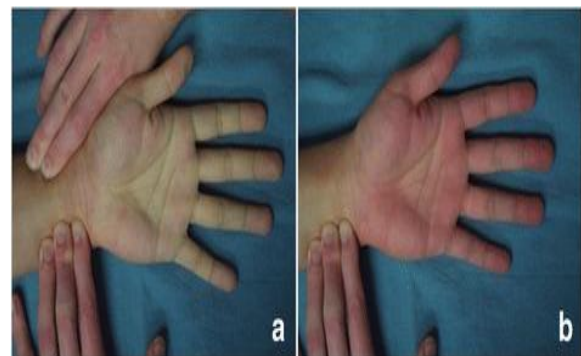


Figure 1: Allen's test in reverse. a. The pallor is brought on by the blockage of the hand's radial and ulnar arteries. b. A quick return of redness to the hand after the radial artery pressure is released, indicating that blood is flowing through the radial artery

A consultant radiologist used a 10 MHz transducer to perform Doppler ultrasonography to measure the PSV in the ulnar artery at the wrists before and after radial artery compression; an increase in ulnar artery velocity of at least 20% from baseline with radial artery compression was regarded as positive for UCF.

The researcher himself made a comparison between the results and those of Allen's test. In a structured proforma, all the data was entered.

Version 21.0 of SPSS was used to input and analyze all the data that had been gathered. Age was determined using the mean and standard deviation. For the ulnar collateral flow (based on Allen's test and Doppler USG), frequency and % were estimated. To determine the diagnostic efficacy of Allen's test using Doppler ultrasonography as the gold standard, 2 x 2 tables were created. Age, gender, high blood pressure, and diabetes mellitus were stratified in the data. After stratification, 2 x 2 tables were created to estimate the diagnostic efficacy of Allen's test using Doppler ultrasonography as the gold standard in terms of sensitivity, specificity, PPV, and NPV.

Results

In this present study, a total of 120 cases were enrolled. The mean age of the patients was 50.91±9.13 years, with minimum and maximum ages of 40 & 60 years, respectively. In our study, 68 (56.67%) patients were males, and 52 (43.33%) were females. The male-to-female ratio was 1.3:1. (Figure 2)

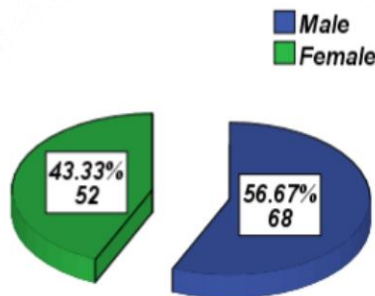


Figure 2: Frequency distribution of gender

The study results showed that diabetes mellitus was found in 54(45%) cases and not in 66(55%) cases. Similarly, hypertension was noted in 61(50.8%) patients. (Table-1)

Table 1 Frequency distribution of diabetes mellitus

		Frequency	Percent
Diabetes Mellitus	Yes	54	45.0
	No	66	55.0
	Total	120	100.0
Hypertension	Yes	61	50.8
	No	59	49.2
	Total	120	100.0

In our study, Allen's test diagnosed positive ulnar collateral flow of donor limb before radial artery harvesting in 58 (48.3%) patients, and Allen's test diagnosed negative ulnar collateral flow of donor limb before radial artery harvesting in 62 (51.7%) patients. In this study, the Doppler test diagnosed positive ulnar collateral flow of the donor limb before radial artery harvesting in 61 (50.83%) patients. Doppler test diagnosed negative ulnar collateral flow of donor limb before radial artery harvesting in 59 (49.17%) patients. (Table 2)

Table 2 Frequency distribution of Allen's and Doppler's test

		Frequency	Percent
Allen's Test	Positive	58	48.3
	Negative	62	51.7
	Total	120	100.0
Doppler's test	Positive	61	50.83%
	Negative	59	49.17
	Total	120	100.0

The study results showed that the sensitivity of Allen's test was 77.05%, specificity was 81.36%, PPV was 81.03%, NPV was 77.42%, and diagnostic accuracy was 79.17%, taking the Doppler test as the gold standard. (Table 3, 4)

Table 3 Comparison of Allen's test with the Doppler test

		Doppler		Total
		Positive	Negative	
Allen	Positive	47	11	58
	Negative	14	48	62
Total		61	59	120

Table 4: diagnostic accuracy of Allen's test

Parameters	Value
Sensitivity	77.05%
Specificity	81.36%
Positive Predictive Value	81.03%
Negative Predictive Value	77.42%
Diagnostic Accuracy	79.17%

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In this study, in ≤60 years cases, the sensitivity, specificity, PPV, NPV and diagnostic accuracy of Allen's test were 80.65%, 81.25%, 80.65%, 81.25% and 80.95%, respectively, taking Doppler as the gold standard. Similarly, in >60 years, Allen's test's sensitivity, specificity, PPV, NPV and diagnostic accuracy were 73.33%, 81.48%, 81.48%, 73.33%

and 77.19%, respectively, taking Doppler as a gold standard. We also calculated these parameters and Comparison of Allen's test with the Doppler test stratified by gender, hypertension, and diabetes. (Table 5)

Table 5 Comparison of Allen's test with the Doppler test stratified by age, gender, diabetes and hypertension.

Parameters	Construct	Sensitivity	Specificity	PPV	NPV	Diagnostic Accuracy
Age (years)	≤60 (years)	80.65%	81.25%	80.65%	81.25%	81.25%
	>60 (years)	73.33%	81.48%	81.48%	73.33%	77.19%
Gender	Male	71.43%	84.85%	83.33%	73.68%	77.94%
	Female	84.62%	76.92%	78.57%	83.33%	80.77%
DM	Yes	83.87%	78.26%	83.87%	78.26%	81.48%
	No	70%	83.33%	77.78%	76.92%	77.27%
Hypertension	Yes	86.67%	83.87%	83.87%	86.67%	85.25%
	No	67.74%	78.57%	77.78%	68.75%	72.88%

Discussion

This current cross-sectional survey was carried out at the cardiac surgery department of Jinnah Hospital in Lahore to evaluate the diagnostic accuracy of Allen's test for the ulnar collateral flow of the donor limb before radial artery harvesting. The gold standard for this evaluation was Doppler ultrasonography. Carpentier et al. were the ones who pioneered the use of the radial artery (RA) graft for coronary artery bypass grafting (CABG) in the early 1970s (Carpentier et al., 1973). However, the use of the RA graft was quickly phased out due to unsatisfactory short-term results (Geha et al., 1975). Allen's test, which Edgar Allen first published in 1929, has since developed into the most frequent method for evaluating palmar arch patency (Cable et al., 1999). Our research showed that Allen's test had a sensitivity of 77.05 percent, a specificity of 81.36 percent, a positive predictive value (PPV) of 81.03 percent, a negative predictive value (NPV) of 77.42 percent, and a diagnostic accuracy of 79.17 percent when compared to the gold standard of the Doppler test. Several of the investigations, the findings of which are detailed further below, suggest that our research was correct. According to the findings of Jarvis and colleagues, the diagnostic accuracy of Allen's test was 78.5 percent, while its sensitivity was 54.5 percent. The specificity of the test was 91.7 percent (Jarvis et al., 2000). Allen's test is a simple bedside test that should be performed in both directions to rule out the possibility of radial artery obstruction, which could make flap harvesting more difficult. These findings are from a study conducted by Andrew Foreman and his colleagues and published in 1963. Radial artery occlusion will become more prevalent as

endovascular access treatments increasingly rely on the radial artery as the access vessel of choice. According to the findings of another study by Mika Kohonen and colleagues, most patients had a negative Allen test, although 23% of them got a positive result (abnormal) (Kohonen et al., 2007). An ultrasound examination uncovered structural irregularities in 10 patients and circulatory deficiencies in 17 patients. Thirteen patients had anomalies in their circulation in addition to their anatomical makeup. According to the results of our investigation, the Allen's test has a sensitivity of 73.2 percent and a specificity of 97.1 percent. There were no unusual occurrences during the recovery process of the arms that had harvested radial grafts. Abu Omar et al. observed that 88 percent of people with a positive Allen test were free of any forearm artery occlusive disease in their Doppler ultrasonographic studies (Abu-Omar et al., 2004). They also found that RA could be harvested without hand ischemia problems. There have also been reports of severe ischemia in the hands of individuals who had negative Allen test results (Fox et al., 1999; Manabe et al., 2002; Tatoulis et al., 2002). The modified Allen test, in conjunction with plethysmography, has been proven to provide a more accurate diagnosis of RAO by Barbeau et al. with a six-second cutoff, the modified Allen's test has a specificity that is in the range of 97 percent (Barbeau et al., 2004). Because of this, an additional non-invasive test should be performed if the modified Allen's test returns an abnormal result. This is necessary because the relatively lower sensitivity of the modified Allen's test indicates that the RA may

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not be safe to harvest in most patients (Habib et al., 2012).

Starnes compared the modified Allen's test with a Doppler ultrasound assessment of the superficial palmar arch blood flow during RA compression to digital blood pressures taken before and after RA compression (P) (Starnes et al., 1999). This was done to determine whether or not the modified Allen's test was more accurate. They found that their series had a false positive rate of fifty percent, and they defined the 'maximum sensitivity' for P for both arms of the experiment.

Conclusion

According to our study results, the Allen test is a good and valid screening test for the ulnar collateral flow of the donor limb before radial artery harvesting, using Doppler Ultrasonography as the gold standard.

Conflict of interest

The authors declared absence of conflict of interest.

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