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Research Article

# Evaluation of the Effects of Ulnar Artery Flow and Allen's Test on Radial Artery Graft Preference

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## ABSTRACT

**Background:** This study is to evaluate the efficacy of preoperative and postoperative ulnar arterial flows and Allen's test in using radial artery graft.

**Materials and Methods:** We retrospectively reviewed the prospectively collected data of 30 patients who underwent coronary surgery in a single-center .Doppler ultrasonography and modified Bedford Allen's test was performed on all patients before surgery. It was understood from the records that the ulnar artery flows in the postoperative period were controlled by Doppler ultrasonography at the 3rd and 6th months.

**Results:** There was an increase in flow and velocity measurements in ulnar artery. The flow increased from 31 ± 21 ml/min to 46 ± 32 ml/min, and the speed increased from 56 ± 19 cm/sec to 78 ± 16 cm/sec. In the postoperative 3rd and 6th month Doppler USG, increased ulnar artery diameters and flows were found.

**Conclusion:** Allen's test and ulnar flow measurements guide the use of radial grafts in coronary bypass operation.

**Keywords:** Radial artery; Surgery; Cardiac; Ulnar artery; Graft survıvalcell

## INTRODUCTION

Arterial grafts are best choice for coronary bypass, because of their excellent long-term patency. Many surgeons consider the radial artery graft as a "reserve" graft, the long-term patency [1,2]. As full arterial revascularization is preferred, more radial artery grafts are required. Another dangerous clinical entity such as radial artery spasm is the development of hand ischemia. Therefore, it is indispensable to evaluate the adequacy of preoperative collateral intake. Different tests and imaging tools are used to evaluate collateral blood flows.

The aim of this study is to evaluate the efficacy of preoperative and postoperative ulnar arterial flows and Allen's test in coronary bypass surgery using radial artery graft.

## MATERIALS AND METHODS

We retrospectively reviewed the prospectively collected data of 30 patients who underwent coronary surgery in a single-center between March 2015 and April 2018 after obtaining the necessary ethical approval (No: 93471371-514.10- D: 26.11.2020 -XXXXXXXXXXX). Those with forearm trauma, diabetic patients, raynaud's syndrome, peripheral artery disease, and smokers were excluded from the study. All demographic characteristics of the patients were recorded (Table 1).

**Table 1:** Demographic characteristics of the patients.

| Patients;30 | No. (n) | Percent (%) |
|---|---|---|
| Age, mean (years) | Mean ± SD;67.30 | |
| Sex | | |
| Male | 18 | 60 |
| Female | 12 | 40 |
| HT | 12 | 40 |
| COPD | 6 | 20 |
| Carotid stenosis | | |
| 50% | 6 | 20 |
| 70% | 3 | 10 |
| Stroke | 3 | 10 |
| Death | 0 | 0 |
| Paresthesia | 6 | 20 |

**Note:** HT: Hypertension; COPD: Chronic obstructive pulmonary disease

Pre and postoperative arterial Doppler ultrasonography was performed in all patients. The brachial artery, radial artery, proximal, distal and middle parts of the ulnar artery, and superficial artery blood flow velocities (cm/sec) and flows were evaluated with a Toshiba Xario (Tokyo-Japan) 7.5-11 Mhz linear -orray transducer device. In the postoperative period, all flows were

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checked by Doppler USG. The modified Bedford Allen's test was performed on all patients before surgery. Ohmeda GE Handheld Pulse Oximeter device was used for the modified Allen's test. The saturation probe was placed on the thumb of the hand. Ulnar blood flow was evaluated after compression to the radial artery. The return of ulnar artery blood flow between 6 and 11 seconds was considered as sufficient collateral flow. Thus, the radial artery was used as a graft.

Radial and ulnar blood flows were measured from the wrist. Arterial flows were recorded in ml/min. Radial and ulnar artery diameters, flows and velocities were measured by color Doppler USG and recorded. Those with radial artery flow of 20 ml/min and a diameter above 0.20 cm were used as graft. In the postoperative period, doppler controls were performed in the first 3 months and 6 months and ulnar artery flows were checked. Ischemia and neurological examination for 6 months postoperatively in the hand where the radial artery was grafted.

### Statistical analysis

Calculations such as mean value and standard deviation were used in numerical parameters, and Student's "t" test and Chi-square test were used in statistical analysis. A statistically determined (p) value of 0.05 or less was considered significant.

## RESULTS

RA and UA diameters (cm), flows (ml/min) and velocity media (cm/sec) are presented in Table 2. Diameter, flow and velocity measurements of RA at wrist level were measured as 0.23 ± 0.06 cm, 24 ± 16 ml/min and 47 ± 16 cm/sec, respectively. The UA was measured as 0.26 ± 0.02 cm, 31 ± 22 ml/min and 56 ± 19 cm/sec.

**Table 2:** Doppler ultrasonography of the radial and ulnar artery.

| | Radial artery | Ulnar artery |
|---|---|---|
| Diameter (cm) | 0,23 ± 0,06 | 0,26 ± 0,02 |
| Flow (ml/min) | 24 ± 16 | 31 ± 22 |
| Flow rate (cm/sec) | 47 ± 16 | 56 ± 19 |

Flow and velocity measurements in UA were performed by compressing the radial artery. There was an increase in flow and velocity measurements. The flow increased from 31 ± 21 ml/min to 46 ± 32 ml/min, and the speed increased from 56 ± 19 cm/sec to 78 ± 16 cm/sec. In the postoperative 3rd and 6th month Doppler USG, increased ulnar artery diameters and flows were found (Table 3), ($p<0.005$).

**Table 3:** Changes in ulnar artery flow and diameter after 6 months.

| Ulnar artery | Preoperative | Postoperative | P value |
|---|---|---|---|
| Diameter (cm | 0,26 ± 0,02 | 0,29 ± 0,04 | 0,018 |
| Flow (ml/min) | 31 ± 22 | 48 ± 12 | 0,012 |

At the end of the 6th month, there was no evidence of ischemia in the extremity where the radial artery was used as a graft. There was no neurological finding. Significant increases in ulnar blood flows occurred in patients who underwent Allen's test and the radial artery was used as a graft.

## DISCUSSION

Today, full arterial revascularization is preferred especially in young patients in coronary bypass surgery. Radial artery graft is the most commonly used free arterial graft after internal mammarian artery graft. The most common problems in using radial artery; ischemia, infection and neurological complications [1].

In order to minimize the complications while obtaining radial artery graft; measurement of ulnar and radial flows with preoperative doppler ultrasonography and Allen's test are widely used. The Allen's test is a simple and reliable method used in the evaluation of the collateral circulation of the hand [2].

Modified Allen's test has been developed to reduce false positive results. We used the Bedford modified Allen's test in our study. If the time to measure resaturation after radial artery compression with pulse oximetry was between 6 and 11 seconds, we evaluated the presence of sufficient collateral flow. We evaluated the measurements of 6 seconds or less as insufficient collateral flow. In the literature, there are studies evaluating less than 5 seconds as complete negativity, while more than 10 seconds positivity [3]. Some studies have shown that ulnar artery flows and velocities increased significantly in the second postoperative month [4,5]. We found that ulnar flows increased from 31 ± 22 ml/min to 48 ± 12 ml/min in 6 months. Similarly, we observed an increase in the ulnar artery diameter.

Although the values of UA and RA were close to each other in all tests, an increase was observed in flow (53.1%) and velocity (40.6%) of UA with RA compression. They found insufficiency in ulnar artery velocity in 1.7% with radial artery compression [6].

However, in many studies, it has been reported that the ulnar artery and compensation mechanisms are involved, and ischemia does not develop, and neurological complications such as paresthesia are very rare [7,8]. In our study, we did not find any signs of hand ischemia in any of the 30 patients. No serious neurological complication occurred.

In the preoperative and intraoperative evaluations (Allen's test, Doppler ultrasonography, back flow from intraoperative RA, etc.), cases with hand ischemia and reverse cephalic vein bypass have also been reported, although collateral circulation was sufficient. In addition, accessory RA may be involved. RA may also show anatomical variation at the rate of 9.6%, and this may be most often in the form of tortuous [9-11].

In the study in which radial artery grafts were evaluated for about 20 years, postoperative ulnar flows increased considerably and the plamar digital peak systolic flows confirmed this. In this study, it was reported that there were no symptoms in the upper extremity [12,13].

## LIMITATIONS OF STUDY

Our study has limitations such as the short-term and limited cases, and the inability to predict arteriosclerosis in the ulnar artery, which may develop rapidly later.

## CONCLUSION

Use of Bedford modified Allen's test for screening radial artery harvest may unnecessarily exclude many patients from use of this graft and may also place a number of patients at risk for finger ischemia from such harvest. In conclusion, the modified Allen's test and adequate ulnar flows are highly predictive for radial artery graft use.

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