

# Routine Preoperative Doppler Ultrasound Examination of Arterial System in Patients Undergoing Cardiac Surgery is Beneficial: A Retrospective Study

## Abstract

**Background:** Presence of peripheral vascular disease enhances surgical risk in cardiac surgical patients. Prior knowledge of peripheral arterial disease may help the physician make changes in the monitoring and cardiopulmonary bypass cannulation plans. It is claimed that the incidence of peripheral vascular disease in cardiac surgical patients ranges from 11 to 30%. **Aims:** This study was conducted to understand the characteristics of peripheral vascular disease and their implication on cardiac surgery. **Settings and Design:** This was a prospective study undertaken in a tertiary referral hospital. **Materials and Methods:** All adult patients who underwent cardiac surgery during the period of six months were included. A Doppler examination of the neck, upper limb, abdomen and lower limb was carried out by our inhouse radiologist. The incidence of peripheral vascular disease, the implication on invasive pressure monitoring site and cannulation for cardiopulmonary bypass or intraaortic balloon pump or extracorporeal membrane oxygenation were made note of. **Results:** During the said period, six hundred twenty eight patients underwent cardiac surgery, of whom five hundred and sixty-one patients who underwent CABG surgery. All these were subjected to Doppler examination. We observed peripheral arterial disease in 105 patients (20%). In general men suffered from PAD more often than women. Monitoring site of invasive arterial pressure, the choice of beating heart surgery, insertion of intraaortic balloon pump, femoral arterial route for cardiopulmonary bypass were some of the decision that were altered. **Conclusions:** Performing Doppler examination in cardiac surgical patients may yield important data that might prevent complications and support patient safety.

**Keywords:** Arterial, cardiac surgery, Doppler, femoral artery, peripheral vascular disease, pressure monitoring, radial artery, subclavian artery

## Introduction

The presence of peripheral vascular disease (PVD) in cardiac surgical patients complicates outcome.<sup>[1]</sup> Its presence may necessitate alterations in monitoring site or cardiopulmonary bypass (CPB) cannulations to perform cardiac surgery or insertion of intraaortic balloon pump (IABP) or extracorporeal membrane oxygenation (ECMO).<sup>[2]</sup> The incidence of PVD in patients undergoing coronary artery bypass graft (CABG) surgery varies from 11% to 30%.<sup>[3-6]</sup> Therefore, it may prudent to have prior knowledge about PVD in cardiac surgery. Many cardiac surgical centers do not routinely assess PVD prior to cardiac surgery. In the absence of the details of arterial quality or presence of obstruction or calcification, the cannulations

may either fail or result in stroke, ischemia of the limbs, bowel, or dissection of the arteries and inaccurate flow/pressure measurement. It is a routine practice at our facility to conduct Doppler ultrasound exam for patients scheduled for CABG surgery to understand the status of PVD. This study of examination of peripheral arterial vascular tree using Doppler and ultrasound was carried out to understand the need for continuing preoperative ultrasound and Doppler examination of peripheral arterial system.

## Methods

A retrospective study of Doppler and ultrasound evaluation data of patients undergoing CABG surgery during the period of April to September 2016 was

**Murali Chakravarthy, Dattatreya Prabhakumar, Benak Shivalingappa, Sonali Rao, Sumant Padgaonkar, Rajathadri Hosur, Chidananda Harivelam, Vivek Jawali<sup>1</sup>**

Departments of Anesthesia, Critical Care, and Pain Relief and <sup>1</sup>Cardiovascular Surgery, Fortis Hospital, Bengaluru, Karnataka, India

**Submitted:** 30-Jan-2019

**Accepted:** 12-Aug-2019

**Published:** 17-Jul-2020

### Address for correspondence:

Dr. Murali Chakravarthy, Department of Anesthesia, Critical Care and Pain Relief, Fortis Hospitals, Bengaluru - 560 076, Karnataka, India.

E-mail: mailchakravarthy@gmail.com

### Access this article online

**Website:** www.annals.in

**DOI:** 10.4103/aca.ACA\_18\_19

### Quick Response Code:



**How to cite this article:** Chakravarthy M, Prabhakumar D, Shivalingappa B, Rao S, Padgaonkar S, Hosur R, *et al.* Routine preoperative Doppler ultrasound examination of arterial system in patients undergoing cardiac surgery is beneficial: A retrospective study. Ann Card Anaesth 2020;23:298-301.

This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

For reprints contact: reprints@medknow.com

carried out. Institutional review board approval waiver and patient consent waiver were obtained. Doppler exam of the following arteries was carried out for all the patients by the same radiologist: carotid artery, subclavian artery, upper limb arteries, abdominal aorta, its branches, iliac arteries, and the lower limb arteries. All the examinations were conducted using Philips CX 50 ultrasound machine (Bothell, WA 98021, USA). Linear 12–13-MHz probe was used for examination of superficial arteries and curvilinear 1–5-MHz probe for abdominal/groin arteries. Decisions about the site of arterial catheter insertion for pressure monitoring, choice of arterial conduit (when radial artery was chosen as one of the conduits), and aortic cannulation (when femoral artery was required for arterial return) for CPB and ECMO were made based on the findings of the Doppler ultrasound report. The required change/s in the surgical plan with respect to the site of arterial cannulation for pressure monitoring and enabling CPB were made preoperatively. The absence of disease of the femoral artery, external iliac, and the descending aorta formed important requirement for insertion of IABP. Similarly, the disease of femoral artery was deemed a contraindication for cannulation of femoral artery for either arterial cannulation for pressure monitoring or femoral-femoral CPB/ECMO during either minimal invasive surgery or repeat cardiac surgery.

### Definitions

**Normal artery:** An artery is termed normal when there is no calcification/atherosclerosis/obstruction to flow.

**PVD:** A vessel detected to have obstruction/turbulent flow on Doppler is considered to be diseased.

**Surgically significant PVD:** Vessels conventionally used for cannulation for either hemodynamic monitoring/CPB/IABP/ECMO insertion (such as radial artery/femoral artery/internal and external iliac arteries/abdominal aorta).

**Significant narrowing:** Empirically, narrowing of either >50% of lumen or inability to cannulate the vessel was deemed significant.

### Results

During the study period, a total of six hundred and twenty-eight patients underwent cardiac surgery at our facility, in whom Doppler ultrasound examination was conducted in five hundred and sixty-one patients before CABG surgery. The demographic details of the patients are presented in Table 1: one hundred and five patients (20%) had PVD; 88% of them were men and 9% had small vessel disease. Forty-six patients (forty-one males and five females) had surgically significant PVD suggesting the requirement for alteration in the surgical plan [Table 2]. Figures 1 and 2 show plaques in superficial and common femoral artery. Twenty-eight patients had occlusive internal carotid artery disease (5%). Patients with carotid stenosis were subjected to computerized tomographic (CT) scan of the head and

**Table 1: Demographic details, n=561**

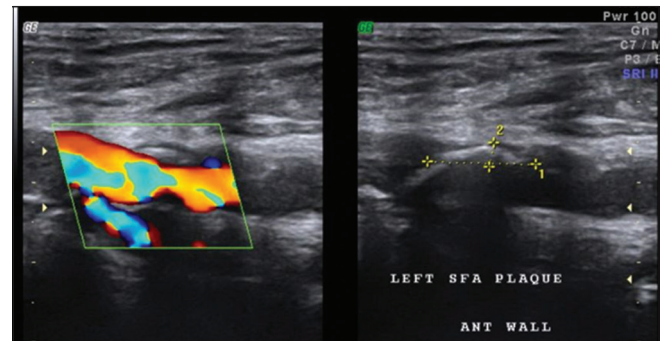
Variables	Values
Age - M±SD (range) in years	58.9±9.6 (21-84)
Male:female	421:94
Weight M±SD (range) in kgs	62.4±7.2
Tobacco use (M:F)	156:2
Hypertension (M:F)	213:29
Diabetes (M:F)	177:32
Obesity (M:F)	22:4
Renal dysfunction (M:F)	18:4

**Table 2: Details of patients with significant occlusions**

Variables	Values
Male:female	41:5
Calcifications	15
Occlusion	20
Absent flow	3
Significant narrowing	34
Associated diseased radial arteries	21
Positive Allen's test	3

**Table 3: Difference in the arterial disease pattern**

	Male	Female
Aortoiliac disease	7	0
Ileofemoral disease	18	2
Femoropopliteal disease	19	3
Ant. and post. tibial artery disease	19	2
Distal plantar arch disease	1	0



**Figure 1: Showing eccentric anterior wall plaque in the left SFA color Doppler**

neck to understand the severity of occlusion and eight (among the twenty-eight) were subjected to unilateral carotid endarterectomy along with CABG [Figure 3] and two underwent bilateral carotid endarterectomy along with CABG. Table 3 shows the difference in the arterial disease pattern among the two sexes. Ninety-four patients (17.5%) with PVD were found to have occlusive disease of either arteries of the upper limb or the lower limb or both. One hundred and forty-six patients had calcified radial arteries. Of these patients with calcification of radial arteries, eighty-nine had normal lower limb arteries while the rest

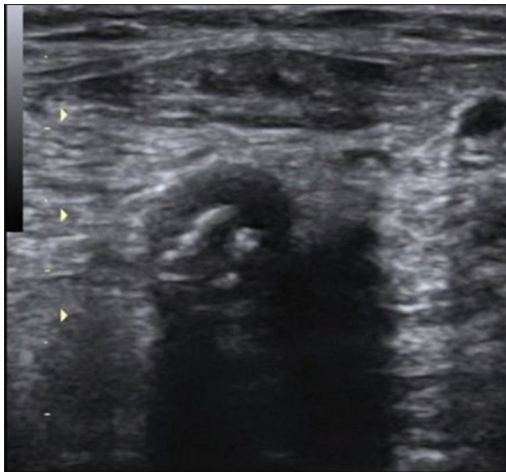


Figure 2: Showing thrombus in the right common femoral artery

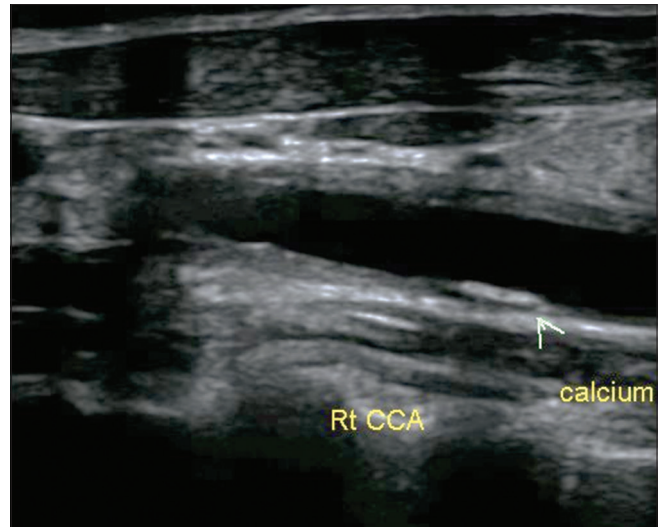


Figure 3: Showing Longitudinal Grey-Scale Image of the right Common Carotid Artery showing intima-media calcifications (arrowhead)

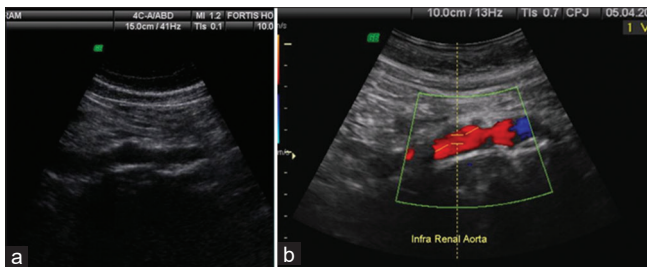


Figure 4: (a and b) Showing Abdominal aorta plaques (a) and limitation of flow as seen on Doppler (b)

(fifty-seven patients - 38%) had either diffuse calcification or narrowing of the lower limb arteries. Many of them received radial arterial cannulation for pressure monitoring instead of the institute protocol of femoral artery cannulation. In the rest ( $n = 90$ ), twelve patients had positive Allen's test (eleven males in them—all smokers), but radial artery study was normal in three patients. Among the patients studied, those with normal arteries, 20% were females and the rest males, those with PVD, 11.6% were females and 88.4% males. In patient #22, extensive calcific obstruction of the lower limb arteries precluded the use of mechanical support in the form of IABP; that patient was most likely to receive both CPB and IABP counter pulsation, because the caliber and distal run off in the coronary arteries was poor. Therefore, coronary revascularization was deferred. Patients 28 and 445 had poor left ventricular function; it was presumed that they might require mechanical support with IABP. However, surgery was carried out using CPB with an option to support the failing heart with mechanical support because of the disease of the lower aorta and internal iliac arteries.

## Discussion

This retrospective study was conducted to understand how both the incidence of PVD in five hundred sixteen patients undergoing cardiac surgery affected the planning of the proposed surgery. The quality of the abdominal

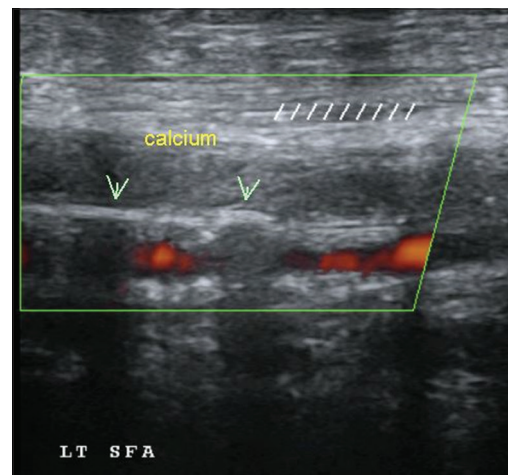


Figure 5: Longitudinal Doppler image showing intima-media calcification (arrow heads) with posterior shadowing of femoral artery

descending aorta, iliac artery, and femoral artery helped us decide if insertion of IABP catheter was feasible and safe. Patient #168 had calcified plaques in the abdominal aorta [Figure 4]; he may have required IABP during or after surgery. Because of the extensive calcification, the surgery was conducted under CPB. The surgical plan of patient #48 with common femoral artery thrombosis was changed by conducting the surgery with radial artery cannulation instead of the femoral artery cannulation (institutional protocol). Yet another patient #365 had plaques in femoral artery [Figure 5]; he underwent CABG under CPB instead of minimal invasive surgery, while the indwelling arterial pressure monitoring was carried out via radial artery (instead of femoral). In a study by Lamelas, among 2645 patients undergoing minimally invasive cardiac surgeries, there were 31 cerebrovascular accidents (1.17%), 2 compartment syndromes, 2 femoral arterial pseudoaneurysms, and 174 (6.65%) groin wound seromas.<sup>[7]</sup> These not only decide the degree of morbidity but also the mortality in cardiac

surgical patients. A strong correlation between male sex and PVD was observed in this study. Similar observations have been made by other workers as well.<sup>[8]</sup> As noted in our study, the presence of or occlusion of the radial artery did not seem to extrapolate to disease of the lower limb arteries. One hundred and forty-six patients had calcified radial arteries and those arteries were not used as conduits during coronary artery grafting. Patient #22 had obstruction of both internal iliac arteries. He had severe left ventricular dysfunction, severe mitral regurgitation, enlarged mitral annulus (32 mm), and diffuse coronary artery requiring multiple bypass. That patient may have required intra-aortic balloon pumping preoperatively. The patient's coronary artery bypass surgery was deferred because of this observation in the Doppler examination. He was managed medically. In two patients, #28 and 445, coronary artery bypass surgery was electively performed on CPB because of bilateral iliac artery disease, in whom passage of IABP may have proved harmful to the patient. In patients #22, 28, 501 and 545, both superficial femoral artery and profunda femoris were blocked bilaterally. Electively, radial arterial route was chosen to monitor intraarterial pressure instead of femoral, which otherwise is the practice at our facility.<sup>[9]</sup> Twenty-eight asymptomatic patients were found to have turbulent flow due to block/s in the internal carotid artery and after CT scan of the head and neck, two were subjected to carotid endarterectomy alongside CABG. The incidence of stroke after CABG in patients with severe carotid occlusive disease is high, such timely identification of high-risk patients is one of the advantages.<sup>[10,11]</sup>

The non-reliability of "Allen's test" has been shown by several workers and it was again shown by this study.<sup>[12]</sup> Calcified radial arteries may not mean occlusion, but these arteries may not be useful as conduits during CABG. Even the cannulation to monitor invasive blood pressure of such calcified arteries may be technically difficult; hence, their use either as conduit or route for monitoring may be discouraged. The non-invasive and inexpensive Doppler ultrasound examination of the arterial tree performed preoperatively was useful and several potential morbid procedures and complications were avoided.

The authors have obtained patient consent for using the images and other clinical information reported in the journal, and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

### Limitations of this study

For a prevalence study, the sample size might be inadequate. A mix of patients with valvular lesions, grown-up congenital heart lesions, in addition to a cohort consisting of patients with ischemic heart disease may have exposed the actual problem. Magnetic resonance imaging may have provided better understanding of arterial tree. Some of the decisions, such as deferring surgery in a patient with severe obstructive

calcific disease of the descending aorta (in patient #22), may be considered moot. However, for objective risk stratification of PVD, we chose to err on the safer side. Correlation of EUROScore I/II may have added value to the existing literature.

### Conclusion

Preoperative Doppler ultrasound examination is a non-invasive cheap method of the assessment of PVD and may be conducted routinely prior to cardiac surgery.

### Financial support and sponsorship

Nil.

### Conflicts of interest

There are no conflicts of interest.

### References

- Rankin JS, He X, O'Brien SM, Jacobs JP, Welke KF, Filardo G, *et al.* The Society of thoracic surgeons risk model for operative mortality after multiple valve surgery. *Ann Thorac Surg* 2013;95:1484-90.
- Waterworth PD, Soon SY, Govindraj R, Sivaprakasam R, Jackson M, Grayson AD. Factors which influence the cardiac surgeon's decision not to operate on patients referred for consideration of surgery. *J Cardiothorac Surg* 2008;26:3-9.
- van Straten AH, Firanescu C, Soliman Hamad MA, Tan ME, ter Woort JF, Martens EJ, *et al.* Peripheral vascular disease as a predictor of survival after coronary artery bypass grafting: Comparison with a matched general population. *Ann Thorac Surg* 2010;89:414-20.
- Sutton-Tyrrell K, Rihal CS, Sellers M, Burek K, Trudel J, Roubin G, *et al.* Long-term prognostic value of clinically evident vascular disease in patients undergoing coronary revascularization in the Bypass Angioplasty Revascularization Investigation (BARI). *Am J Cardiol* 1998;81:375-81.
- Rihal CS, Eagle KA, Mickel MC, Foster ED, Sopko G, Gersh BJ. Surgical therapy for coronary artery disease among patients with combined coronary artery and peripheral vascular disease. *Circulation* 1995;91:46-53.
- Field ML, Al-Alao B, Mediratta N, Sosnowski A. Open and closed chest extrathoracic cannulation for cardiopulmonary bypass and extracorporeal life support: Methods, indications, and outcomes. *Postgrad Med J* 2006;82:323-31.
- Lamelas J, Williams RF, Mawad M, LaPietra A. Complications associated with femoral cannulation during minimally invasive cardiac surgery. *Ann Thorac Surg* 2017;103:1927-32.
- Wada M, Takeshima T, Nakamura Y, Nagasaka S, Kamesaki T, Kajii E, *et al.* Association between smoking and the peripheral vestibular disorder: A retrospective cohort study. *Sci Rep* 2017;7:16889.
- Chakravarthy M, Thimmannagowda P, Jayaprakash K, Prabhakumar D, Jawali V. Routine femoral artery pressure monitoring in cardiac surgery. *J Cardiothorac Vasc Anesth* 2009;23:932-3.
- da Rosa MP, Portal VL. Carotid stenosis and coronary artery bypass grafting. *Rev Assoc Med Bras* 2011;57:317-21.
- Tsunekawa T, Sawada M, Kato T, Motoji Y, Kinoshita T, Hirakawa A, *et al.* The prevalence and distribution of occlusive lesions of the cerebral arteries in patients undergoing coronary artery bypass graft surgery. *Semin Thorac Cardiovasc Surg* 2018;30:413-20.
- Baetz L, Satiani B. Palmar arch identification during evaluation for radial artery harvest. *Vasc Endovascular Surg* 2011;45:255-7.