Case Report

Inverse Modified Allen’s Test: an Inaccurate Predictor of Radial Artery Occlusion Compared to Doppler Ultrasound after Transradial Catheterization: Case Series and Review of Literature

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Abstract

Introduction: There is ever increasing evidence to suggest that transradial catheterization is associated with fewer access site complications, shorter length of stay, and improved patient comfort. A principle concern remains the potential for radial artery occlusion (RAO) with a reported incidence ranging from 10-30%. One of the traditional methods used to diagnose radial artery occlusion is inverse modified Allen test with pulse plethysmography which is then graded as Barbeau A-D according to increasing severity of occlusion.

Methods: We describe a series of patients undergoing transradial catheterization in whom we performed inverse modified Allen’s testing with pulse plethysmography and compared this with Doppler ultrasound in determining the presence of a radial artery occlusion.

Results: Three patients demonstrated a Barbeau grade of D on inverse modified Allen’s test following a successful diagnostic and interventional procedures; however, Doppler ultrasound demonstrated a patent radial artery with antegrade flow and no evidence of occlusion.

Conclusions: Inverse modified Allen test with pulse plethysmography is an inaccurate method to diagnose to radial artery occlusion and may yield false positive or negative results in comparison to Doppler ultrasound. The clinical presentation and diagnostic methods are discussed.

ABBREVIATIONS

- Radial artery occlusion (RAO)
- Past medical history (PMH)
- Modified Allen test (MAT)
- Hypertension (HTN)
- Electrocardiography (ECG)
- Pulse oximetry (PO)
- Plethysmography (PL)

INTRODUCTION

There is ever increasing evidence to suggest that transradial catheterization is associated with fewer access site complications, shorter length of stay, and improved patient comfort [1-3]. Transradial approach has demonstrated a very low (< 1%) incidence of relevant vascular access site complications; which, in comparison, occur in about 3% to 7% of patients undergoing procedures via the femoral route [4]. Recent trial data has suggested that percutaneous coronary interventions performed via a transradial approach may be associated with a lower risk of mortality [5]. A principle concern of transradial catheterization remains the potential for radial artery occlusion (RAO) with a reported incidence ranging from 10-30% [6,7]. While the vast majority of RAO remain clinically silent, the loss of radial artery patency may preclude future use of the ipsilateral transradial...
approach in any given patient [8]. One of the methods used to diagnose radial artery occlusion involves performance of an inverse modified Allen test with pulse plethysmography which is graded as Barbeau A through D according to increasing severity of occlusion with grade D signifying more severe occlusion [8].

To our knowledge, there has been no definite imaging studies confirming the accuracy of the inverse modified Allen’s test with plethysmography in the diagnosis of RAO in patients following transradial catheterization. Ruengsakulrach et al [9] showed that increased recovery time with the modified Allen test in preoperative patients predicts absence of flow in the dorsal digital thumb artery via Doppler ultrasonographic flow patterns. However, we observed a series of three cases where patients demonstrating a Barbeau grade of D after diagnostic and interventional procedures with Doppler ultrasound evidence of a patent radial artery with antegrade flow and no evidence of occlusion. We hereby, describe this series of patients undergoing transradial catheterization in whom we used inverse modified Allen’s test with pulse plethysmography in comparison to Doppler ultrasound to diagnose RAO.

CASE REPORT 1

58 year old male with past medical history (PMH) of hypertension (HTN) presenting with angina. Electrocardiography (ECG) did not demonstrate acute ischemic changes and cardiac biomarkers were within normal limits. The patient underwent Lexiscan nuclear stress test which revealed a large area of ischemia involving anterior and anteroseptal wall. Patient subsequently underwent coronary angiography via right radial arterial access. Radial artery patency was assessed by modified Allen’s test and demonstrated Barbeau grade A on plethysmography. Angiomax was administered and radial artery was cannulated in first attempt with 6 French (F) catheter. Following arterial sheath insertion, anti-spasm protocol was administered with intraarterial verapamil/nitrate. Coronary angiography confirmed the presence of a severe stenosis of the left anterior descending artery for which successful percutaneous intervention was performed. Following successful PCI, the radial sheath was removed and patent hemostasis was achieved by application of a regular size Terumo Interventional Systems (TR) band with inflation volume of 12 cc applied for a total of 3 hours.

Immediately post procedure, the patient was asymptomatic and demonstrated a 2+ radial pulse. Inverse modified Allen test was performed and demonstrated a reverse Barbeau grade D. However, color flow doppler ultrasound demonstrated patent flow in the radial artery with no evidence of occlusion (Figure 1a). Patient was discharged home in stable condition. During 1 month follow up visit, patient had a repeat color flow doppler ultrasound which again demonstrated patency and antegrade flow in the right radial artery (Figure 1b).

CASE REPORT 2

70 year old male with PMH significant for HTN and hyperlipidemia was recently diagnosed with severe mitral regurgitation and was referred for preoperative cardiac catheterization before mitral valve repair. Patient underwent diagnostic cardiac angiography via right radial access. Radial artery patency was assessed by modified Allen’s test and demonstrated Barbeau grade A on plethysmography. Angiomax was administered and radial artery was cannulated in first attempt with 5 French (F) catheters. Following arterial sheath insertion, anti-spasm protocol was administered with intraarterial verapamil/nitrate. Coronary angiography showed no significant coronary artery disease. Radial artery sheath was removed and patent hemostasis was achieved by regular size TR band with inflation volume of 14 cc which was applied for a total of 3 hours. Immediately post procedure, the patient was asymptomatic and demonstrated a 2+ radial pulse. Inverse

Figure 1a Color flow dopplershowing patent flow in the radial artery three hours after transradial catheterization.
modified Allen test was performed and demonstrated a reverse Barbeau grade D. Color Doppler Ultrasound showed patent flow in the radial artery with no evidence of occlusion (Figure 2a). Patient was discharged home in stable condition. During 1 month follow up visit, patient had a repeat color flow doppler ultrasound which again demonstrated patency and antegrade flow in the right radial artery (Figure 2b).

CASE REPORT 3

68 year old male with PMH significant for HTN, hyperlipidemia, mitral valve prolapse with severe mitral regurgitation was referred for preoperative cardiac catheterization before mitral valve replacement. Patient underwent diagnostic cardiac angiography via right radial access. Radial artery patency was assessed by modified Allen’s test and demonstrated Barbeau grade A on plethysmography. Angimax was administered and radial artery was cannulated in first attempt with 5 French (F) catheter. Following arterial sheath insertion, anti-spasm protocol was administered with intra-arterial verapamil/nitrate. Coronary angiography showed no significant coronary artery disease. Radial artery sheath was removed and patent hemostasis was achieved by regular size TR band with inflation volume of 14
cc which was applied for a total of 3 hours. Immediately post procedure, the patient was asymptomatic and demonstrated a 2+ radial pulse. Inverse modified Allen test was performed and demonstrated a reverse Barbeau grade D. Color Doppler Ultrasound showed patent flow in the radial artery with no evidence of occlusion (Figure 3a). Patient was discharged home in stable condition. During 1 month follow up visit, patient had a repeat color flow doppler ultrasound which again demonstrated patency and antegrade flow in the right radial artery (Figure 3b).

**DISCUSSION**

Modified Allen test (MAT) has traditionally been used to identify patients at increased risk from radial artery catheterization. MAT can be influenced by a number of factors including overextension of the wrist, skin tension over the ulnar artery, and operator error [10]. Also, palpation of radial pulse does not imply radial artery patency. Radial pulse can be felt because of macrocollateral circulation from the palmar arches [11]. Barbeau et al have shown that modified Allen test combined with plethysmography more accurately diagnose RAO [10]. Greenwood et al showed transradial catheterization should not be performed in patients with abnormal MAT [12].

At our center, preprocedurally we use modified Allen’s test (MAT) combined pulse oximetry (PO) and plethysmography (PL) to evaluate ulnopalmar arch patency and inverse MAT combined with PO and PL to diagnose RAO. Considering benefits and increasing popularity of transradial approach it becomes imperative not to unnecessarily exclude patients from radial artery catheterization. Although, there is anecdotal data available showing high correlation of MAT combined with PO and PL to Doppler ultrasound in diagnosis of radial artery occlusion, it is not 100 percent accurate. Hence, we wanted to compare MAT combined with PO and PL to Doppler ultrasound to more accurately diagnose RAO. Our case series shows that Doppler ultrasound more accurately demonstrates the adequacy of the ulnopalmar arch compared to MAT combined with PO and PL. Real-time ultrasound use also facilitates successful radial artery puncture [13], improves first attempt success rate [14], increases efficiency [15] and can be particularly useful in patients with difficulty in palpating radial pulse [16].

Given the potential safety benefit of the transradial approach, efforts to reduce the incidence of RAO and henceforth, appropriately recruiting more patients for radial artery catheterization are of significant interest. Leipzig investigators [6] have shown decrease incidence of radial artery occlusion with application of a smaller sheath size and higher incidence of RAO by vascular ultrasound.

We present a case series of 3 cases where reverse Barbeau was grade D suggesting radial occlusion but Doppler ultrasound showed patency of radial artery. This is important because reverse Barbeau has been used as a surrogate outcome of radial artery patency in randomized trials of measures to reduce radial artery occlusion.

We are conducting a study at our institution comparing Doppler ultrasound with MAT combined with PL and PO to diagnose radial artery occlusion after transradial catheterization.

**LIMITATIONS**

This is a case report series but a larger prospective observational study is needed to compare diagnostic accuracy of reverse Barbeau and ultrasound.

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I would like to thank our library staff Arthur Deschamps for helping us retrieving the articles from pubmed.
Figure 3a Color flow dopplershowing patent flow in the radial artery three hours after transradial catheterization.

Figure 3b Color flow dopplershowing patent flow in the radial artery at month follow up.

REFERENCES


