Journal of the American College of Cardiology
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Published by Elsevier Inc.

Vol. 46, No. 11, 2005
ISSN 0735-1097/05/$30.00
doi:10.1016/j.jacc.2005.07.058

Vascular Communications of the Hand in Patients Being Considered for Transradial Coronary Angiography

Is the Allen's Test Accurate?

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OBJECTIVES The purpose of this study was to assess the accuracy of the Allen's test (AT) in predicting hand ischemia in patients undergoing transradial coronary angiography.

BACKGROUND Patients with poor vascular communications between the radial artery (RA) and ulnar artery (UA), as indicated by an abnormal AT, are usually excluded from transradial coronary angiography to avoid ischemic hand complications.

METHODS Over a four-month period, patients undergoing coronary angiography were screened for AT time. Circulation in the RA, UA, principal artery of the thumb (PAT), and thumb capillary lactate were measured before and after 30 min of RA occlusion.

RESULTS Fifty-five patients were studied (20 normal, 15 intermediate, 20 abnormal). Three patients with an abnormal AT were excluded, owing to absence of detectible flow in the distal UA. Patients with an abnormal AT were all men, had a larger RA (3.4 vs. 2.8 mm; $p < 0.001$), and smaller UA (1.9 vs. 2.5 mm; $p < 0.001$), compared with patients with a normal AT. After 30 min of RA occlusion in patients with abnormal AT, blood flow to the PAT improved (3.2 to 7.7 cm/s; $p < 0.001$) yet remained reduced relative to patients with normal AT (7.7 vs. 21.4 cm/s; $p < 0.001$. Thumb capillary lactate was elevated in patients with an abnormal AT (2.0 vs. 1.5 mmol/l; $p = 0.019$).

CONCLUSIONS After 30 min of RA occlusion, patients with an abnormal AT showed significantly reduced blood flow to the thumb and increased thumb capillary lactate (compared with patients with a normal AT) suggestive of ischemia. Transradial cardiac catheterization should not be performed in patients with an abnormal AT. (J Am Coll Cardiol 2005;46:2013–7) © 2005 by the American College of Cardiology Foundation

Radial artery (RA) cannulation carries a risk of RA occlusion with an incidence of 4.8% to 19% (1–7). This is usually of no consequence, because the hand receives blood from both the radial and ulnar arteries with extensive collateral channels; however, some patients have incomplete palmar arches and might not have adequate communications between the ulnar and radial arteries (8–10). In these patients, there is a potential risk of hand ischemia in the event of RA occlusion.

A simple bedside test to check for communications between the ulnar and radial arteries is the modified Allen's test (AT). Patients with an abnormal test will usually have their cardiac catheterization performed via the femoral artery, thus denying them the potential advantages of transradial cardiac catheterization. In patients undergoing coronary angiography, the incidence of an abnormal AT ranges from 6.4% to 27% (11,12).

Whether the AT can predict ischemic complications after RA cannulation is controversial, and some centers no longer exclude patients with an abnormal AT.

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Manuscript received February 5, 2005; revised manuscript received June 29, 2005, accepted July 11, 2005.

METHODS

Over a period of four months, patients undergoing cardiac catheterization at The Royal Jubilee Hospital were screened with the AT. On the basis of the AT, patients were categorized as normal (0 to 5 s, group A), intermediate (6 to 10 s, group B), or abnormal (>10 s, group C). Patients were enrolled consecutively until we reached a pre-specified number of subjects in each group.

Patients were excluded if they had symptomatic peripheral vascular disease, history of Raynaud's phenomenon, severe aortic stenosis, atrial fibrillation, bleeding disorder, or were not taking antiplatelet therapy. All patients gave informed consent.

Perfusion of the hand was assessed with:

1. Doppler ultrasound (SonoSite [Bothell, Washington] with 10-MHz hockey stick vascular probe). Blood flow was recorded at: 1) RA, at level of radial head; 2) distal radial artery, from dorsum of hand at base of first metacarpal; 3) ulnar artery (UA), and 4) principle artery of the thumb (PAT), from palmar surface of hand at most distal point before branching.
2. Pulse oximetry of thumb (Good = signal strength >50%; weak = signal strength <50%; absent = no waveform or saturation reading).

JACC Vol. 46, No. 11, 2005
December 6, 2005:2013–7

Abbreviations and Acronyms

ANOVA = analysis of variance
AT = Allen's test
PAT = principle artery of the thumb
RA = radial artery
UA = ulnar artery

3. Thumb capillary lactate concentration (Accutrend Lactate Analyzer, Boehringer Mannheim, Mannheim, Germany), a single drop of blood from the distal thumb was collected for analysis.

The above measurements were compared at baseline, immediately after RA occlusion (except capillary lactate), and after 30 min of RA occlusion with an RA compression device (Fig. 1). This device placed focal pressure over the RA at the wrist without affecting UA flow. Obstruction of RA flow was confirmed with Doppler. The hand was kept warm before and between measurements. Heparin 70 IU/kg (to a maximum of 5,000 IU) was given before RA compression if the patient was not already heparinized.

Patients were studied either before angiography (majority) or after their procedure if they were heparinized and the RA had not been cannulated.

Statistical analysis. Several methods of statistical analysis were used to analyze the data. Differences between Allen's groups for baseline characteristics were analyzed with analysis of variance (ANOVA) for continuous variables and chi-square tests for categorical variables. The normality assumptions for ANOVA were assessed with the following tests available in Proc Univariate of SAS 9.1 (SAS Institute, Cary, North Carolina): Shapiro-Wilk, Kolmogorov-Smirnov, Anderson-Darling, and Cramer-von Mises. If the normality assumption was violated, the Kruskal-Wallis non-parametric test was used instead. Paired *t* tests were used to compare blood flow at different times for a given Allen's group. Correlations in the data were investigated with the Pearson product-moment correlation. All analyses were done with SAS 9.1 (SAS Institute).

RESULTS

Over a four-month period, 55 patients were studied—20 normal, 20 abnormal, and 15 intermediate AT. Three patients with an abnormal AT were excluded because of absent ulnar flow at baseline. The baseline characteristics are summarized in Table 1.

Results are summarized in Table 2. The diameter of the RA became larger (group A = 2.8 mm, group B = 3.2 mm, group C = 3.4 mm; p = 0.0016) and the UA smaller (group A = 2.5 mm, group B = 2.2 mm, group C = 1.9 mm; p = 0.0002) as the AT time increased.

Blood flow to the PAT was significantly reduced immediately after RA occlusion in all groups, but more marked in patients with an abnormal AT (group A: 29.7 to 16.1 cm/s; group B: 26.3 to 7.8 cm/s; group C: 29.4 to 3.2 cm/s). After 30 min of RA occlusion, flow improved significantly (group A: 16.1 to 21.4 cm/s; group B: 7.8 to 14.6 cm/s; group C: 3.2 to 7.7 cm/s).

Capillary blood lactate levels after 30 min of RA occlusion increased as AT time increased (group A = 1.46 mmol/l; group B = 1.87 mmol/l; group C = 2.1 mmol/l; p = 0.007). The degree of lactate elevation correlated with blood flow in the PAT (r = −0.4; p = 0.004).

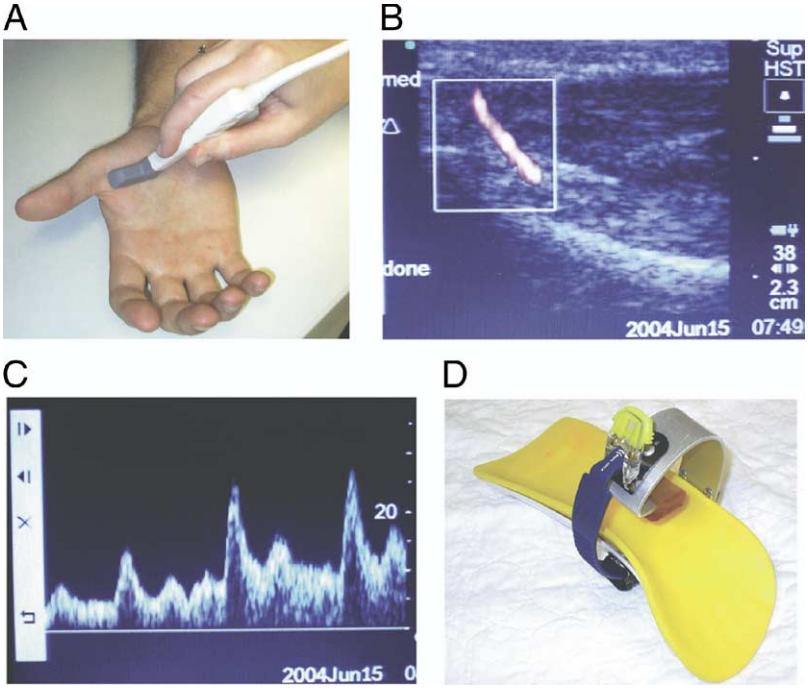

Figure 1. **(A and B)** Visualizing the principal artery of the thumb (PAT) with color Doppler. **(C)** Pulsed-wave Doppler of the PAT as the clamp is removed from the radial artery. **(D)** Clamping device used to occlude the radial artery.