Clinical Evaluation of Blood Flow to the Hand

The False-Positive Allen Test

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In 1929 Allen described a test to be used for clinical evaluation of arterial blood flow to the hand. The patient was first instructed to make a tight fist for 1 minute to squeeze the blood out of the hand. During compression of either the radial or ulnar artery, Allen evaluated the flow through the uncompressed artery by checking the return of color to the hand and fingers when the patient was told to extend his fingers rapidly. In individuals with intact arterial trees, the pallor was quickly replaced by rubor. If the uncompressed artery was occluded by disease, pallor was maintained for a variable period of time depending on the degree of stenosis and available collateral circulation. Both hands were examined simultaneously.

A modification was suggested by one of us (I.S.W.) in 1952. In this modification, one hand was examined at a time. The patient was instructed to elevate his hand and clench his fist firmly, thus squeezing the blood from the vessels of the hand. The examiner then compressed both the radial and the ulnar arteries at the same time with his thumbs. The patient then lowered and opened his hand in a relaxed fashion carefully so as not to overextend it. The examiner then released the pressure over one of the arteries. If the patient’s hand flushed fully and rapidly, the artery released, the palmar arch, and the digital arteries were patent. If pallor persisted throughout the hand, the artery was occluded. Pallor in patches indicated insufficiency of the smaller vessels. Both major arteries to each hand should be examined.

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A general survey of the peripheral vascular system was performed on patients with cerebral vascular diseases. It was observed that with the Allen test different results could be obtained on the same person, especially when the patency of the ulnar artery was being examined. The patient when told to squeeze his hand and then to open it rapidly often maintained the opened hand in a hyperextended position (fig. 1). In some of these patients the pallor persisted, and this led to the false conclusion that the ulnar artery was occluded. If the ulnar artery was patent, as soon as the patient relaxed and slightly flexed his hand at the wrist joint, the pallor was quickly replaced by rubor in spite of continued pressure on the radial artery. If the test was repeated on the same patient with the hand slightly flexed, the “instantaneous” appearance of rubor revealed a free

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Figure 1

Patient is asked to open his hand rapidly. If not warned, the patient may hyperextend his hand as illustrated, and a false-positive Allen test is obtained.
passage for the blood through the ulnar artery (fig. 2). Thus it appeared that the overextension so commonly seen was a major cause of error in this test. According to Schwartz and Cooper, a positive Allen test may not indicate occlusive arterial disease. They suggested that false-positive results were common and they stressed the need for reevaluation of the test. Bauman applied the Allen test to 16 normal subjects and on the basis of the technique he used, found it to be positive in more than half of those tested. He concluded that the test had no value in the diagnosis of obliterative vascular disease. Nevertheless, the Allen test is widely used and is recommended in many well-known textbooks. The return of the rubor to the hand is said to be instantaneous in normals. No figures are given in seconds for the variation. This lack of information and our findings of "false-positive" Allen tests which may be eliminated by careful attention to the technique suggested that a more detailed study was warranted.

Methods
In a first series, the Allen test was routinely performed in 50 normal subjects and in 50 patients with cerebrovascular disease, but without vascular symptoms in their hands. In an additional 50 healthy persons the test was performed (1) with the hand hyperextended, (2) with the hand straight, and (3) with the hand slightly flexed after opening of the hand. The patients' ages ranged from 38 to 77 years. The time in seconds from the moment the patient opened his hand until flush appeared was recorded by using a stop watch. To hold the hand under examination in a slightly flexed position when opened, the examiner's hand was placed under the dorsum of the patient's hand (fig. 2).

Results
In the first group of 50 healthy individuals, 20 hyperextended their hands spontaneously and provoked a positive Allen test. A false-positive Allen test could be provoked in all individuals by having them hyperextend their hands forcefully. In the group of 50 patients who had suffered from a stroke, 24 hyperextended their hands spontaneously, and in 47 a positive Allen test could be provoked. In both groups, the pallor disappeared promptly after the hand was slightly flexed to approximately 20° from the straight position.

The results from the third group consisting of 50 normals are recorded in table 1. When the hand was hyperextended, marked variations were produced in the duration of pallor, the ulnar artery values being much higher than the radial. In the straight position, pallor lasted for more than 5 seconds in 34% of the hands when the ulnar artery was tested, and in 10% when the radial artery was tested. In one individual, keeping the hand in the straight position resulted in a prolongation of the pallor up to 13 seconds. In the slightly flexed position, no mean value for the four arteries exceeded 3 seconds and no single value exceeded 6 seconds. No statistical difference was obtained between men and women, or between the ulnar and the radial artery. Five subjects hyperflexed their hands at the first test and thus provoked a prolonged pallor of from 8 to 15 seconds. Tests with slight flexion and relaxation of the hand were repeated and gave figures in the range of 2 to 4 seconds in the same subjects.

Discussion
According to Allen and from our own experience, patients with total ulnar occlusions may maintain blanching as long as pressure obliterating the radial artery is continued.
Occlusion of the radial artery produces a similar effect when pressure is maintained which obliterates the ulnar artery. When the test is performed under optimal conditions with the hand slightly flexed as in figure 2, prolonged blanching of more than 6 seconds is unusual in normal subjects and should raise the suspicion of partial or total occlusion of the artery being tested.

The prolonged blanching period obtained in the hyperextended or forced-flexed position is assumed to be caused by mechanical pressure from the carpal structures. The stretching of the skin in the hyperextended position exerts an important influence on the skin color by forcing the blood out of the minute vessels of the skin layers. When performing the test, it is easy to demonstrate that indirect pressure on the uncompressed artery by pulling the skin too forcibly will interfere with the results and this should be avoided. In 10% of the normal individuals, forced hyperflexion of the hand provoked prolongation of the blanching period and normalized when only slight flexion was used.

**Summary**

One hundred fifty individuals of different ages without evidence of peripheral vascular impairment (100 normal persons and 50 patients with history of cerebral vascular disease) were examined with the Allen test; the radial and ulnar arteries were examined in both hands. A false-positive test could easily be obtained spontaneously or be provoked by intentional hyperextension of the hand more than 20° beyond the straight position. In the straight position of the hand, the time for appearance of rubor after opening of the hand exceeded 5 seconds in 34% of the normal persons. When a relaxed slight flexion at the wrist joint was used, the flush after opening the hand appeared at an average of 3 seconds for the ulnar artery and 2.75 for the radial artery. In 50 normal individuals examined with optimal technique described, no individual artery required more than 6 seconds for the flush to appear after opening of the hand.

The authors recommend that the Allen test be performed with the patient’s hand slightly flexed and relaxed.

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