Injection Injury of an Aberrant Superficial Radial Artery Requiring Surgical Intervention

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Introduction

We report a patient with an anomalous superficial radial artery (A. antebrachialis superficialis dorsalis). The encountered vessel coursed abnormally superficial to the tendons of the extensor pollicis brevis (EPB), abductor pollicis longus (APL) and extensor pollicis longus (EPL), as it passed through the anatomical snuffbox, before penetrating the first dorsal interosseous muscle. This “superficial radial artery” was mistaken for a vein and cannulated with an angiocatheter. Subsequently, the patient sustained an extravasation and thrombotic injury secondary to a promethazine injection eventually requiring surgical intervention for attempted salvage.

Case Report

An eighty-eight year old right handed white female nursing home resident underwent endoscopic retrograde cholangiopancreatography (ERCP) for an obstructive biliary stone.

During the recovery period, the patient received what was thought to be an intravenous injection of promethazine hydrochloride (Phenergan, Wyeth Pharmaceuticals, Madison, NJ) for post-operative nausea and vomiting. The patient developed ecchymosis and differential darkening of the skin on the right thumb and index finger over the next 5 days and eventually presented to our clinic 5 days later for consultation.

The patient’s medical history was significant for hypertension, diabetes, cholelithiasis and gastrointestinal bleeding. On physical exam, the patient’s right hand appeared to have suffered a vascular injury, with the tip of the thumb and index fingers appearing purple along with mottling of the other fingers. At the wrist the radial artery was not palpable with an intact ulnar artery pulse, and Doppler signals were absent in all digits. Allen’s test was abnormal with loss of Doppler signal in the palm with ulnar artery occlusion. The patient was started on medical therapy consisting of aspirin, calcium channel blockers, an axillary block and clopidogrel (Plavix, Bristol-Myers Squibb, Princeton, NJ). The patient was admitted and diagnostic studies including an arteriogram were ordered.

Arteriogram

The arteriogram of the right upper extremity demonstrated a normal brachial artery, with normal branching at the elbow into the ulnar and radial arteries. However, the radial artery was occluded at the wrist just distal to its patent superficial palmar branch (Fig. 1). In the hand the princeps pollicis artery and its branches, the radial aspect of the deep palmar arch and its branches to the index and middle are all absent and presumed to be occluded (Fig. 2). The ulnar artery supplied an incomplete superficial palmar arterial arch and

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Fig. 1 An arteriogram of the right forearm showing occlusion of the distal radial artery (*black arrows*), and patency of the superficial palmar branch of the radial artery (*gray arrow*)

gave off two common digital arteries (Fig. 2). Based upon the arteriogram findings and unsuccessful medical intervention, the patient was scheduled for immediate operative exploration and bypass.

Surgical Approach

Upon intraoperative exploration of the radial aspect of the distal wrist, an initial longitudinal incision was made over the anatomical snuff box that revealed that the radial artery was not in its normal anatomic position. Further dissection was

Fig. 2 An arteriogram of the right hand displaying occlusion of the princeps pollicis artery and its branches (*black arrows*), the radial aspect of the deep palmar arch (*black diamond*) and the deep palmar arch's branches to the index and middle finger (*gray diamonds*). The ulnar artery and its two common digital arteries are noted by the *gray arrow*

conducted to isolate the portion of the radial artery spanning from the bifurcation of its dorsal and palmar branches to the bifurcation of the princeps pollicis and deep palmar branches. It was then noted that this portion of the radial artery coursed superficial at all times to the tendons of the extensor pollicis brevis (EPB), the abductor pollicis longus (APL) and most notably the extensor pollicis longus (EPL) (Fig. 3). This portion of the radial artery was found to be thrombosed (Fig. 4). In situ vein grafting using the cephalic vein was unsuccessfully attempted as it too was clotted off. A 12-cm segment of the basilic vein was used for reversed interpositional radial artery bypass (Fig. 5). Thrombectomy and embolectomy was conducted using a 2-mm Fogarty catheter to the origin of the common digital artery in the second web space of the right hand. The patient tolerated the procedure well, and a radial pulse was palpable distal to the vein graft and Doppler signals were obtained in all fingers. Unfortunately, the patient presented 1 month later with a necrotic right thumb and index finger, and subsequently underwent amputation of those two digits with fillet flap reconstruction using the soft tissues of the index finger.

Discussion

Variations in the origin and course of the principle arteries of the upper extremity and hand have long been studied by anatomists and surgeons [1–6]. The Swiss anatomist Von Haller studied the arterial anastomoses of the radial and ulnar arteries in the hand as early as 1753. At the beginning of the twentieth century, Manners-Smith conducted compar-

Fig. 3 Intraoperative photograph of the right hand and forearm showing the course of the distal radial artery to be superficial at all times to the tendon of the extensor pollicis longus (*black arrows*)

Fig. 4 Intraoperative photograph displaying thrombosed segment of distal radial artery (black arrows)

ative studies of the arteries of the hand of human and lesser primates [1]. Most notable among other studies include those of McCormack, Sachs, and Coleman and Anson, in addition to the substantial historical review and cadaveric study of Rodríguez-Niedenführ [1, 2, 4, 5]. Over a dozen arterial anatomical anomalies of the upper extremity have been documented, the most common being the brachioradial artery or the “high origin” of the radial artery [5].

The vascular anomaly we report here was first properly named by Adachi in 1928 as *Arteria antebrachialis dorsalis superficialis*, or the superficial radial artery [3]. It has previously been reported to exist [3–8] and has been estimated to have an incidence of ~0.5–1% [3–5, 7]. Accidental cannulation or injection of the superficial radial artery has been reported [6, 10, 11], as has a report of surgical intervention necessary due to vascular compromise secondary to repetitive abuse [9]. To our knowledge there is no report of accidental injection or cannulation of this vascular anomaly requiring surgical intervention, which has led us to question the claim by Ghouri et al. that there is no anatomical contraindication to cannulation of this superficial radial artery [11]. To better understand the circumstances of this case, a brief review of the arterial development of the hand is helpful.

The distal radial artery arises from the development of the superficial brachial artery, which divides into two heads, one superficial division and one deep division. These divisions are those which become the dorsal branch of the radial artery and are distinct from the superficial palmar branch of the radial artery. The deep division courses deep to the tendons of the snuffbox and the superficial courses over the tendons of the snuffbox. Normally, at the end of embryological development, the superficial division regresses and the deep division becomes the dominant vessel [7]. Anomalies arise when the superficial fails to regress, and is thought to be homologous or vestigial to the superficial division of the dorsal branch of the radial artery of primates [5]. Two types of anomalies exist, Manners-Smith I,

where the deep division completely regresses, and there is only a superficial division that courses over the tendons of the snuffbox, as in our patient. The other and more common variation is Manners-Smith II, in which the deep and superficial divisions remain, with the superficial being of greater caliber [7]. It is thought that these variations have a genetic influence, occur equally among the sexes and are usually unilateral [4, 5].

Risk factors for inadvertent arterial injection include lack of attention by the operator, dark skin, obesity, thoracic-outlet syndrome, anatomical variations and lack of cooperation on the patient’s behalf during injection [6]. Intra-arterial injection can result in a clinical syndrome of pain, pallor, skin mottling, ischemia and tissue necrosis [10], but in previous reports of accidental injection of an anomalous superficial radial artery, none resulted in such severe necrosis that required surgical intervention [6, 10, 11]. Although in those cases it was not documented, it is possible that those patients had the Manners-Smith II variation of the superficial radial artery or an intact palmar arch, both of which would allow unimpaired blood flow to the hand. The significance of the vascular findings in our case is that injection of the Manners-Smith I variant combined with an incomplete palmar arch can result in a severe clinical picture consisting of digital loss. Therefore, we conclude that presence of a superficial radial artery and an abnormal Allen’s test is a contraindication to intra-arterial injection or cannulation of the radial artery at the wrist.

Obviously diagnostic arterial studies such as arteriogram and MRA are helpful preoperatively for any elective vascular surgery of the hand, and can shed further light on puzzling clinical situations as this case. However, this case report should remind all healthcare personnel, that the best method to prevent this situation is: palpation, palpation, palpation. An inadvertent arterial injection can easily be prevented by palpation for the presence of a pulse, a

Fig. 5 Intraoperative photograph showing completion of reversed interpositional radial artery bypass using basilic vein

simple and inexpensive tool. A thorough knowledge of all possible variants is not as critical as the simple appreciation that these variations in fact do exist and have the potential for serious sequelae should they be compromised.

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