Aneurysms of the upper extremity

Thirty aneurysms in the upper extremity in 28 patients over the last 10 years are reviewed. Analysis showed that false aneurysms develop from penetrating trauma, while true aneurysms tend to arise in parts of the arterial tree exposed to blunt trauma. Penetrating injury to vessels should be thoroughly explored and repaired. Arterial aneurysm should be included in the differential diagnosis of masses in the upper extremity, especially after trauma. Three-phase radionuclide scanning is a useful tool for evaluating lesions of the distal arterial tree. When an aneurysm is suspected, early treatment is advised. Treatment options of resection and ligation versus reconstitution of vessel flow should be based on preoperative and intraoperative evaluation of circulatory status. (J HAND SURG 1987;12A:39-46.)

Paul K. Ho, M.D., LCDR, MC, USNR, Andrew J. Weiland, M.D., Michael A. McClinton, M.D., and E. F. Shaw Wilgis, M.D., Portsmouth, Va., and Baltimore, Md.

Aneurysms have been known since the time of Hippocrates and Galen. Ligation of the brachial artery near the origin of a false aneurysm was performed by Dominic Angel in 1710. Ulnar artery aneurysms and their treatment were described by Guattani in 1772 and by Griffith in 1897.1

Aneurysms in the upper extremity, although rare, are not uncommon. In a large series of arteriovenous (AV) fistulas and false aneurysms treated during the Korean War, more than 45% of the lesions were in the lower extremities, while only 3.8% involved the radial and ulnar arteries.2 Upper extremity false aneurysms accounted for 27.4% of all false aneurysms in the Vietnam Vascular Registry.3 True aneurysms of the upper extremity are even more uncommon.4

A review of the English-language literature disclosed that there has been no recent large series dealing with aneurysms of the upper extremity, and this prompted us to review our experience over the last 10 years at the Raymond M. Curtis Hand Center. The sites of reported aneurysms of the upper extremity since 1970 are detailed in Fig. 1.

![Fig. 1. Aneurysms of the upper extremity reported since 1970. (Vietnam experience not included.)](image-url)
### Table I. Summary of patients

<table>
<thead>
<tr>
<th>Patient</th>
<th>Side</th>
<th>Location</th>
<th>Cause</th>
<th>Type</th>
<th>Diagnostic tests</th>
<th>Present</th>
<th>Treatment</th>
<th>Follow-up</th>
</tr>
</thead>
<tbody>
<tr>
<td>J. J.</td>
<td>L-ND</td>
<td>Axillary A</td>
<td>Stab</td>
<td>False</td>
<td>Arteriogram</td>
<td>6 hr</td>
<td>Resection w/axillary artery repair and posterior cord repair</td>
<td>1 yr</td>
</tr>
<tr>
<td>A. A.</td>
<td>L-D</td>
<td>Axillary A</td>
<td>GSW</td>
<td>False</td>
<td>Arteriogram</td>
<td>1 yr</td>
<td>Presented w/gangrene of hand 2° emboli; thrombectomy unsuccessful; subsequent amputation</td>
<td>10 yr</td>
</tr>
<tr>
<td>C. C.</td>
<td>R-D</td>
<td>Brachial A</td>
<td>Shrapnel</td>
<td>False</td>
<td>Arteriogram</td>
<td>37 yr</td>
<td>Resection w/end-to-end repair</td>
<td>10 yr</td>
</tr>
<tr>
<td>M. F.</td>
<td>L-ND</td>
<td>Anterior interosseous</td>
<td>Stab</td>
<td>False</td>
<td>Arteriogram scan</td>
<td>48 hr</td>
<td>None</td>
<td>7 yr</td>
</tr>
<tr>
<td>I. R.</td>
<td>L-ND</td>
<td>Anterior interosseous</td>
<td>Stab</td>
<td>False</td>
<td>Arteriogram scan</td>
<td>3 wk</td>
<td>At 18 had decompression for compartmental syndrome; resection and ligation</td>
<td>1 year</td>
</tr>
<tr>
<td>E. G.</td>
<td>R-D</td>
<td>Radial A, forearm</td>
<td>Lac</td>
<td>False</td>
<td>None</td>
<td>7 mo</td>
<td>Resection and ligation</td>
<td>3 yr</td>
</tr>
<tr>
<td>D. D.</td>
<td>R-D</td>
<td>Radial A, wrist</td>
<td>Blunt trauma</td>
<td>True</td>
<td>Arteriogram</td>
<td>2 yr</td>
<td>Resection w/vein graft</td>
<td>Recurrence</td>
</tr>
<tr>
<td>W. S.</td>
<td>R-D</td>
<td>Radial A, wrist</td>
<td>Arterial cannula</td>
<td>False</td>
<td>Arteriogram Scan</td>
<td>2 mo</td>
<td>Aneurysm in vein graft; resection and ligation</td>
<td>18 mo</td>
</tr>
<tr>
<td>R. D.</td>
<td>L-D</td>
<td>Radial A, wrist</td>
<td>Stab</td>
<td>Unk</td>
<td>Scan</td>
<td>24 hr</td>
<td>No record of treatment</td>
<td>1 yr</td>
</tr>
<tr>
<td>P. H.</td>
<td>R-D</td>
<td>Radial A, wrist</td>
<td>Lac</td>
<td>False</td>
<td>Scan arteriogram Preop PVRs</td>
<td>1 mo</td>
<td>Resection w/repair of defect</td>
<td>6 yr</td>
</tr>
<tr>
<td>M. M.</td>
<td>R-D</td>
<td>Radial A, wrist</td>
<td>Lac</td>
<td>False</td>
<td>Scan PVRs</td>
<td></td>
<td>Resection and repair of defect</td>
<td>No recur</td>
</tr>
<tr>
<td>A. B.</td>
<td>L-ND</td>
<td>Ulnar A, forearm</td>
<td>Lac</td>
<td>False</td>
<td>Scan negative arteriogram Preop PVRs</td>
<td>10 day</td>
<td>Had decompression at 72 hr for compartmental syndrome; resection and ligation</td>
<td>3.5 yr</td>
</tr>
<tr>
<td>S. W.</td>
<td>L-ND</td>
<td>Ulnar A, forearm</td>
<td>Lac</td>
<td>False</td>
<td>Scan</td>
<td>2 wk</td>
<td>Resection w/repair of defect</td>
<td>No recur</td>
</tr>
</tbody>
</table>

A. artery; D. dominant; ND, nondominant; No recur, no recurrence.

### Materials and methods

All medical records for 1974 to 1984 of cases with the diagnosis of aneurysms located in the upper extremity were reviewed. The following information was tabulated: history, clinical presentation, diagnostic tests, treatment, pathology reports, and postoperative course. Where available, arteriograms and three-phase radionuclide scans were reviewed. Further patient follow-up was carried out through mailed questionnaires and telephone interviews. Follow-up ranged from 1 year to 10 years, with an average of 3 1/2 years.

Our study consisted of thirty aneurysms in 28 patients. Twenty-six were traumatic in origin; two mycotic aneurysms were associated with previous drug injections and two cases had no history of trauma.

Anatomic classification was as follows (Fig. 2): two of the axillary artery (both false), three of the brachial artery (one false, two mycotic), two of the anterior interosseous artery (both false), seven of the radial artery (five false, one true, and one unknown), ten of the ulnar artery (four true, six false), six of the various digital arteries (two false, four true).

Diagnostic tests performed included 12 arteriograms and 16 bone scans; five patients had both, and five patients had preoperative or intraoperative pulse volume recordings.

Treatment consisted of the following: Nine aneurysms were resected and the vessels were repaired end to end. Five aneurysms were resected and the arterial defect was repaired. One aneurysm was treated with thrombectomy and repair. Ten aneurysms were resected and the vessels ligated, and three aneurysms were re-
Aneurysms of upper extremity 41

Table I. Cont’d

<table>
<thead>
<tr>
<th>Patient</th>
<th>Side</th>
<th>Location</th>
<th>Cause</th>
<th>Type</th>
<th>Diagnostic tests</th>
<th>Present</th>
<th>Treatment</th>
<th>Follow-up</th>
</tr>
</thead>
<tbody>
<tr>
<td>R. V.</td>
<td>R-D</td>
<td>Ulnar A, wrist</td>
<td>Lac</td>
<td>False</td>
<td>Arteriogram</td>
<td>2 wk</td>
<td>Resection and repair end-to-end</td>
<td>No recur</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>False</td>
<td>None</td>
<td></td>
<td>Recurrence</td>
<td>1 yr</td>
</tr>
<tr>
<td>W. W.</td>
<td>R-D</td>
<td>Ulnar A, wrist</td>
<td>Blunt trauma</td>
<td>True</td>
<td>Scan</td>
<td>1 mo</td>
<td>Resection w/end-to-end repair</td>
<td>3 yr</td>
</tr>
<tr>
<td>R. H.</td>
<td>R-D</td>
<td>Ulnar A, wrist</td>
<td>Blunt</td>
<td>True</td>
<td>Arteriogram</td>
<td>2 mo</td>
<td>Resection w/primary repair</td>
<td>5 yr</td>
</tr>
<tr>
<td>S. C.</td>
<td>R-D</td>
<td>Ulnar A, wrist</td>
<td>Lac</td>
<td>False</td>
<td>Scan</td>
<td>2 wk</td>
<td>Resection w/primary repair</td>
<td>18 mo</td>
</tr>
<tr>
<td>S. F.</td>
<td>R-D</td>
<td>Ulnar A, wrist</td>
<td>Lacrosse ball</td>
<td>True</td>
<td>Scan</td>
<td>1 mo</td>
<td>Resection w/vein graft</td>
<td>3.5 yr</td>
</tr>
<tr>
<td>L. E.</td>
<td>L-ND</td>
<td>Radial digital A II</td>
<td>UNK</td>
<td>True</td>
<td>Scan</td>
<td></td>
<td>Resection and ligation</td>
<td>1.5 yr</td>
</tr>
<tr>
<td>F. M.</td>
<td>L-ND</td>
<td>Radial digital A I</td>
<td>Puncture</td>
<td>False</td>
<td>Scan</td>
<td>2 mo</td>
<td>Resection and ligation</td>
<td>2 yr</td>
</tr>
<tr>
<td>B. J.</td>
<td>R-D</td>
<td>Ulnar digital A V</td>
<td>Unknown</td>
<td>True</td>
<td>None</td>
<td></td>
<td>Resection and ligation</td>
<td>5 yr</td>
</tr>
<tr>
<td>E. K.</td>
<td>L-ND</td>
<td>Radial digital A of IV</td>
<td>Volley ball</td>
<td>True</td>
<td>Scan</td>
<td>2 mo</td>
<td>Resection and primary repair</td>
<td>1 yr</td>
</tr>
<tr>
<td>W. V.</td>
<td>L-ND</td>
<td>Radial digital A II</td>
<td>Unknown</td>
<td>True</td>
<td>Scan</td>
<td></td>
<td>Resection and ligation</td>
<td>1 yr</td>
</tr>
<tr>
<td>S. M.</td>
<td>R-D</td>
<td>Ulnar A</td>
<td>Blunt trauma</td>
<td>True</td>
<td>Scan</td>
<td>2 mo</td>
<td>Resection and end-to-end repair</td>
<td>1 yr</td>
</tr>
<tr>
<td>J. V.</td>
<td>L-ND</td>
<td>Ulnar A</td>
<td>Lac</td>
<td>False</td>
<td>None</td>
<td>3 wk</td>
<td>Resection and end-to-end repair</td>
<td>No recur</td>
</tr>
<tr>
<td>T. K.</td>
<td>L-ND</td>
<td>Digital A V</td>
<td>Lac</td>
<td>False</td>
<td>None</td>
<td>5 wk</td>
<td>Resection and ligation</td>
<td>No recur</td>
</tr>
<tr>
<td>D. W.</td>
<td>L-ND</td>
<td>Brachial A</td>
<td>Drug injection</td>
<td>Myotic</td>
<td>Arteriogram</td>
<td>3 wk</td>
<td>Resection, attempted repair with recurrence; ligation</td>
<td>No recur</td>
</tr>
<tr>
<td>W. T.</td>
<td>Brachial A</td>
<td>Drug injection</td>
<td>Myotic</td>
<td>None</td>
<td></td>
<td>Resection, end-to-end repair</td>
<td>1 yr</td>
<td></td>
</tr>
</tbody>
</table>

Follow-up showed no recurrence in eight of the nine cases in which aneurysms were resected and the affected vessels were repaired primarily with end-to-end anastomosis. One case recurred at 1 month after resection of a false aneurysm with primary repair. This was re-explored, the recurrent false aneurysm was resected, and the vessel was ligated. Follow-up at 3 years showed no recurrence.

The five aneurysms treated with resection and repair of the arterial defect showed no recurrence at follow-up.

There was one case of gangrene of the hand secondary to axillary artery aneurysm emboli. Treatment consisted of thrombectomy and repair. Subsequent amputation was necessary. There was no recurrence at 10-year follow-up.

The ten cases treated with resection and ligation had no recurrences.
Fig. 2. Arterial tree with anatomic location of aneurysms. 
F = false aneurysm, T = true aneurysm, U = unknown type, M = mycotic aneurysm.

In the three cases treated with resection and vein graft, one recurrence resulted in a false aneurysm that was subsequently treated with resection and ligation of the vessel ends. There was no recurrence at 1-year follow-up.

One patient with false aneurysm in an anterior interosseous artery refused treatment. At 7-year follow-up by telephone interview the patient reportedly had no problems. In one case there was no record of treatment and follow-up was not available.

All eight ulnar artery aneurysms in the area of Guyon's canal had paresthesias in the ulnar nerve distribution that resolved with treatment. One case of ulnar artery aneurysm at the level of the proximal palm had thromboembolic phenomenon leading to ischemia of the ulna two digits. The ischemia resolved with resection of the aneurysm and end-to-end vessel repair.

Complications occurred in one case of recurrence in the nine cases that were repaired primarily with end-to-end anastomosis and in one case of recurrence in the three cases that were vein grafted. There was one case of gangrene caused by axillary artery aneurysm emboli that necessitated forearm amputation.

Of the 14 preoperative radionuclide scans, 13 were helpful in diagnosing aneurysms (Fig. 3). The remaining scan failed to show a vessel defect with a pulsatile hematoma 24 hours after the patient had a stab wound.

Discussion

Aneurysms can be classified into traumatic and non-traumatic varieties. The traumatic group includes true and false aneurysms. A true aneurysm arises from contusion of an artery, with damage to the arterial wall media and subsequent weakness and dilatation of the arterial wall. Dilatation of the arterial wall results in subsequent aneurysm formation. The histologic finding of arterial wall elements of muscle and elastin fibers in the aneurysm wall confirm the diagnosis of a true aneurysm.** (Fig. 4). False aneurysms can occur after
a penetrating injury to the vessel wall, which results in acute pulsatile hematoma. The hematoma is contained by the surrounding tissues and enlarges, with a subsequent chronic fibrous wall developing (Fig. 5). A false aneurysm has a wall formed by clotted blood and fibrous tissue.\(^{31, 34}\) Nontraumatic aneurysms are classified as mycotic, arteriosclerotic, or idiopathic in origin.

Our experience supports previous published reports that false aneurysms develop from penetrating trauma and true aneurysms tend to arise from parts of the arterial tree which are superficial in location and thus subject to blunt trauma. The ulnar artery at the hypothenar eminence is a frequent location for aneurysm formation; it lies relatively superficial and unprotected, and the hook of the hamate has an anvil-like effect, which results in compressive arterial injury with trauma.\(^{4, 10, 13, 15, 18, 20-22, 24, 26, 35}\) Less well known is aneurysm formation in the superficial branch of the radial artery at the wrist, where it is relatively unprotected by the overlying skin, subcutaneous tissues, and a small portion of the abductor pollicis brevis tendon. In this location the trapezial ridge can produce trauma to the vessel, analogous to that produced in the hypothenar area by the hamate.\(^{4, 6, 14, 35}\)

The five digital artery aneurysms in our series (four true and one false) were surprising since there have been only five reported cases of digital artery aneurysms in the literature.\(^{29-33, 39}\) There has been only one reported case of a true digital artery aneurysm.\(^{39}\) It is possible that the digital arteries, in their course over the condylar eminences of the phalanges, are relatively unprotected and therefore are subject to blunt injury leading to aneurysm formation.

Mycotic aneurysms are very rare. The two cases in this series were associated with previous drug injections. They belong to a separate category of lesion and are discussed in a separate report.\(^{37}\)

After penetrating trauma, suspicion of vessel laceration should lead to thorough exploration and repair to
prevent false aneurysm formation. Aneurysms should be part of the differential diagnosis of masses in the upper extremity, especially after trauma.

In our experience, three-phase radionuclide scanning can be a useful adjunct, with clinical findings in the diagnosis of aneurysms in the upper extremity. Fifteen of the 16 scans showed an aneurysm, making arteriography unnecessary (Figs. 6 and 7). In the early examination of a mass after penetrating trauma scanning may not be helpful, as shown in patient A. B. In acute and chronic lesions proximal to the upper forearm, arteriography is the diagnostic procedure of choice in view of the added detail needed for surgical treatment (Fig. 8).

Forearm compartment syndrome, with penetrating trauma as a precursor of later aneurysm formation because of the hidden arterial injury, has been previously reported. There were two cases in this study where initial decompression for compartment syndrome failed to include thorough vessel exploration. This resulted in subsequent false aneurysm formation. Compartment syndromes that occur after penetrating trauma should raise the suspicion of underlying vessel injury. Thorough vessel exploration is recommended at the time of fasciotomy, and arteriography may be indicated in selected cases.

When an aneurysm is suspected, early exploration and treatment is indicated in view of the possible complications of rupture and thromboembolic phenomena. Treatment in the proximal upper extremity should consist of resection and vascular reconstruction. More distally in the forearm and hand, where collateral circulation may be adequate, treatment should be based on preoperative and intraoperative evaluation of circulatory status. We have found the use of non-invasive vascular studies helpful in deciding on treatment. The combined use of radionuclide scanning preoperatively, bidirectional Doppler, and digital plethysmography preoperatively and intraoperatively can provide invaluable information as to the adequacy of collateral flow.

Digital pulse volume recording can be used as a quantitative Allen test, either preoperatively or intraoperatively. At surgery, once the aneurysm is resected, the proximal portion clamped, and the tourniquet released, if there is good backflow and normal digital pulse volume recordings, there is the choice of ligation of the vessel. Gelberman et al. reported on the forearm arterial injuries and showed that the single unrepaired arterial injury caused consistent alterations in vascularity of the hand with up to 46% increase in flow velocity in the intact artery; however, there were few...
signs of ischemia or symptoms of cold intolerance. Previous series with replanted digits have shown that pulse volume recordings of less than 75% correlated with cold intolerance. Vessel repair in the forearm has shown variable results of patency at follow-up, ranging from 49% after repair of lacerations to 71% for repair after aneurysm resection. In view of the small, although existent, complication of aneurysm recurrence after vascular reconstruction both in this series (2 cases) and in previous reports, it would be reasonable to perform vessel ligation if the digital pulse volume recordings show good perfusion. If microvascular reconstruction is to be undertaken, the following principles of microvascular repair should be followed. The arterial segment should be resected until normal intima, as judged under the operating microscope, is seen and anastomosis is carried out without tension, with a reverse vein graft if necessary. Digital occlusion for 15 minutes of the contralateral arterial postrepair repair in the forearm has been previously described. Contraindications to vein grafting include the complete absence of backflow, which indicates more distal obstruction. Revascularization in that case will result in stasis and thrombosis.

Summary

Thirty cases of aneurysms in the upper extremity are presented. Analysis shows that false aneurysms result from penetrating arterial injury and blunt trauma results in true aneurysm formation. Penetrating injury to vessels should be thoroughly explored and repaired. Three-phase scanning can be useful in the diagnosis of aneurysms in the distal upper extremity. When an aneurysm is suspected, early treatment is advised. Treatment options of resection and ligation versus resection and reconstitution of vessel flow should be based on objective evidence of adequate circulation. Digital pulse volume recordings are helpful in this regard.

We thank the following physicians of the Union Memorial Hospital and the Raymond M. Curtis Hand Center for their contribution of case material to this paper: Dr. Ali Daneshvar, Department of Pathology, Dr. Lawrence E. Holder, Department of Nuclear Medicine, Dr. Gaylord L. Clark, Dr. A. Lee Dillen, Dr. Louis S. Elias, Dr. Frederick C. Hansen, Dr. George T. Lazar, Dr. J. Russell Moore, Dr. Anne B. Redfern, Dr. William L. Vetter, Dr. Steward Wright, and Dr. Michael Yaremchuk.

REFERENCES


