BACKGROUND

Hypothenar hammer syndrome (HHS) involves repetitive blunt trauma or vibrational forces to the ulnar aspect of the hand, causing injury to the ulnar artery and potentially leading to thrombosis and distal ischemia.1 Signs and symptoms of hypoperfusion or ischemia to the ulnar digits may include pain, coolness, and pallor.2 Neuropathy of the adjacent ulnar nerve may occur.3

Conservative measures are appropriate for most cases and may include activity modification, smoking cessation, cold avoidance, and/or calcium channel blockers.2,4 Operative management is indicated when nonoperative management fails, or if critical ischemia is present. Reconstruction of the ulnar artery with venous and arterial interposition grafts has been described.4–9

Venous donor sites include the greater saphenous vein, dorsal venous arch of the foot, or flexor aspect of the arm but have high thrombosis rates.6,7,8 Previously described arterial donor sites include the descending branch of the lateral femoral circumflex artery, the deep inferior epigastric artery, or the serratus branch of the thoracodorsal artery.4,8,9

We present a case of acute HHS that resulted in a large, complex arterial defect in the hand after resection of thrombosed arterial segments. Successful treatment utilized an interposition graft from the subscapular arterial system, which included multiple branches to reconstruct the arterial defect with 1 contiguous graft.

CASE REPORT

A 53-year-old right-hand-dominant carpenter presented with a 2-week history of right-sided intermittent median and ulnar nerve paresthesias and ulnar-sided hand pain. His symptoms worsened acutely with the development of bluish discoloration and exquisite pain to the tip of the fourth digit. History revealed frequent repetitive trauma to the hypothenar eminence when he used the ulnar aspect of his hand “like a hammer” to forcefully turn a large wrench. Medical history included well-controlled type 2 diabetes with no history of smoking, cardioembolic disease, or coagulopathy.

The pulp of the fourth digit was cool to touch with a bluish hue, decreased capillary refill, and pain to
palpation. Pulse oximetry of the fourth digit was undetectable, and the ulnar arterial pulse was absent. Perfusion to the remaining digits was within normal limits, and the radial pulse was palpable. Despite the history of paresthesias, examination of the median and ulnar nerves was unremarkable. Computed tomographic angiography confirmed occlusion of the right distal ulnar artery, with limited flow through the superficial and deep palmar arches distally.

Acute symptoms of hypoperfusion prompted urgent exploration. Surgery took place through a carpal tunnel incision, extended distally and proximally. Thrombectomy was performed after a large clot was identified extending from the distal ulnar artery into the superficial palmar arch and its branches. Two segments of damaged intima were excised followed by primary anastomosis. Sympathectomy of all involved arteries was performed to further improve blood flow. Reasonable perfusion returned to the fourth digit intraoperatively. However, on postoperative day 1, the digit again became cool, lost detectable pulse oximetry, and developed sluggish capillary refill. The patient returned to the operating room emergently.

During the second surgery, a 2-team approach was used for exploration of the superficial palmar arch and harvest of the subscapular arterial interposition graft simultaneously. Thrombosis of the ulnar artery, superficial palmar arch, third and fourth common digital arteries, and palmar digital artery to the ulnar aspect of the small finger was identified. Thrombosed segments of artery were resected until healthy vessels with undamaged intima remained.

A curvilinear incision was made over the lateral chest to obtain an arterial graft from the subscapular system. The lateral border of the latissimus dorsi muscle was identified and retracted to expose the underlying thoracodorsal vessels. The descending and transverse branches of the thoracodorsal artery were dissected distally until they began to arborize within the latissimus dorsi muscle. Dissection continued proximally up the subscapular axis to identify the branch to the serratus anterior, the circumflex scapular artery, and the origin of the subscapular artery from the axillary artery for maximal length (Fig. 1).

Following graft harvest, the proximal end of the interposition graft (subscapular artery) was anastomosed to the ulnar artery in an end-to-end fashion. Additional 4 end-to-end anastomoses were performed to fully reconstruct the arterial defect (Fig. 2). Branches of the interposition graft were chosen to reconstruct each segment based on the length of the graft required and the size match between donor and recipient vessels. Figure 3 illustrates the specific branches that were used to reconstruct each portion of the arterial defect. Blood flow through the graft and to the distal targets of the hand returned fully.

Coagulation studies at the time of the initial diagnosis were normal. The patient was treated with ASA 81 mg po daily and a heparin infusion starting at 400 U/h and titrated to target PTT of 55–69.9 U/h for 3 days postoperatively. No anticoagulation medications were continued beyond the first 3 postoperative days. Informed consent...
was obtained from all individual participants included in the study.

RESULTS

Postoperatively, all digits remained well perfused with normal capillary refill, color, warmth, and sensation (Table 1). Pain resolved completely. A strong ulnar pulse was palpated at the volar wrist crease. Patency of the interposition graft was confirmed via CT angiography 6 weeks postoperatively (Fig. 4) and Doppler ultrasound 4 months postoperatively. Routine repeat CT angiography 6 months postoperatively showed graft occlusion. Because the patient remained asymptomatic, the exact timing of graft failure is unknown. Workup for a hypercoagulable state was not repeated at the time of graft failure. As the patient had returned to previous work duties it is possible the repeat thrombosis occurred as a result of ongoing repetitive trauma. CT angiography confirmed no flow through the anastomosis between the ulnar artery and the arterial graft at 6 months postoperatively. However, no signs of critical ischemia developed, and the patient’s symptoms remained drastically improved from the preoperative state. At the patient’s last postoperative visit, residual cold insensitivity was noted, but he had returned to full work duties and was otherwise asymptomatic. Clinical examination showed a negative Allen’s test.

DISCUSSION

Long-term patency rates following venous interposition grafts for HHS are only 70%. Preliminary reports on the use of arterial interposition grafts for HHS have shown more promising results. A case series of 11 patients treated with arterial interposition grafts from the descending branch of the lateral femoral circumflex artery demonstrated patency of all arterial grafts using duplex ultrasound with follow-up ranging from 19 to 63 months. Although this was a small case series, a large randomized control trial comparing arterial and venous grafts for cardiac bypass surgery also demonstrated superior patency rates for arterial grafts at 1 year (91.8% versus 86.4%).

Despite occlusion of our patient’s interposition graft at 6 months, he achieved resolution of ischemic pain with persistent cold intolerance. This outcome was similar to the case series of 11 patients treated with arterial interposition grafts for HHS in which all patients had resolution of ischemic pain, but 64% had persistent cold intolerance. A large retrospective study of vascular interposition grafts for upper extremity and lower extremity arterial injuries revealed that occlusion of all of the venous interposition grafts occurred within 21 days of surgery, with 40% of the occlusions going on to require amputation. As our arterial graft thrombosed sometime between 4 and 6 months, we suspect that this later-term failure allowed for adequate time for collateral circulation, sustained symptom resolution, and hand salvage.

Use of the subscapular system allowed for the reconstruction of a 15-cm defect involving the ulnar artery, superficial palmar arch, palmar digital artery to the fifth digit.

| Follow-up Interval | Capillary Refill* | Two-point Discrimination* | Doppler Ultrasound† | CT Angiography |
|--------------------|------------------|-------------------------|-------------------|----------------|
| 2 wk               | Normal           | Normal                  | Present           | Patent         |
| 6 wk               | Normal           | Normal                  | –                 | Patent         |
| 4 mo               | Normal           | Normal                  | Present           | –              |
| 6 mo               | Normal           | Normal                  | –                 | Occluded       |

*Capillary refill and 2-point discrimination to D4 and D5.
†Doppler ultrasound to radial and ulnar digital vessels to D4 and D5.
digit, and branches to the third and fourth common digital vessels using only end-to-end anastomoses. The subscapular axis provided a variety of arterial branches of different lengths and calibers well suited to the reconstruction of the complex arterial defect. Graft harvest is simple and can be performed in the supine position without the need for an intraoperative position change.

**CONCLUSIONS**

This case report describes treatment of a case of HHS with an arterial interposition graft from the subscapular axis. The subscapular arterial system offered an optimal branching pattern, generous graft length, and vessel size match for the reconstruction of the large arterial defect in the hand. The technique described in this paper could be considered for the reconstruction of other hand defects involving the ulnar artery, superficial palmar arch, and common digital vessels.

**REFERENCES**

1. Conn J Jr, Bergan JJ, Bell JL. Hypothenar hammer syndrome: posttraumatic digital ischemia. Surgery. 1970;68:1122–1128. Available at: http://www.ncbi.nlm.nih.gov/pubmed/5483245. Accessed March 25, 2019

2. Lifchez SD, Higgins JP. Long-term results of surgical treatment for hypothenar hammer syndrome. Plast Reconstr Surg. 2009;124:210–216.

3. Dehmer RS, Houpt P. Surgical management of hypothenar and thenar hammer syndromes: a retrospective study of 31 instances in 28 patients. J Hand Surg Br. 2005;30:419–423.

4. Temming JE, van Uchelen JH, Tellier MA. Hypothenar hammer syndrome: distal ulnar artery reconstruction with autologous descending branch of the lateral circumflex femoral artery. Tech Hand Up Extrem Surg. 2011;15:24–27.

5. Johnson CH, Jensen MH, McBane RD, et al. Surgical pathology of hypothenar hammer syndrome with new pathogenetic insights. Am J Surg Pathol. 2013;37:1700–1708.

6. Thomson CH, Shah AK, Köhler G, et al. Mid-palm hand amputation: reconstruction of the superficial palmar arch. J Plast Reconstr Aesthet Surg. 2013;66:1155–1157.

7. Lee JJ, Ruta DJ, Lien JR, et al. Arcus venosus dorsalis pedis: morphological considerations for use in superficial palmar arch reconstruction. J Hand Surg Am. 2014;39:2243–2245.

8. de Niet A, Van Uchelen JH. Hypothenar hammer syndrome: long-term follow-up after ulnar artery reconstruction with the lateral circumflex femoral artery. J Hand Surg Eur Vol. 2017;42:507–510.

9. Chang Ahn H, Jones NF. 22 ischemia of the hand. In: Neligan PC, Chang J, eds. Plastic Surgery Volume Six Hand and Upper Extremity. 3rd ed. Elsevier Inc; 2013:467–485.

10. Desai ND, Cohen EA, Naylor CD, et al. Radial Artery Patency Study Investigators. A randomized comparison of radial-artery and saphenous-vein coronary bypass grafts. N Engl J Med. 2004;351:2302–2309.

11. Klocker J, Bertoldi A, Benda B, et al. Outcome after interposition of vein grafts for arterial repair of extremity injuries in civilians. J Vasc Surg. 2014;59:1633–1637.