Successful percutaneous management of hypothenar hammer syndrome with thrombosuction and catheter-directed intra-arterial thrombolysis

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ABSTRACT

Hypothenar hammer syndrome (HHS) is a rare vascular disorder leading to ulnar artery thrombosis or aneurysm and causing acute or chronic limb ischemia. The optimal approaches to managing this condition lack a definitive consensus and are essentially empirical, typically necessitating conservative methods for symptomatic relief, with surgical intervention reserved for cases for which conservative measures prove inadequate or when acute limb ischemia ensues. Limited data are available on percutaneous management for this condition. We present the case of a 36-year-old male powerlifter who developed acute digital ischemia due to HHS in the left hand that was managed successfully through an innovative approach using antegrade left brachial artery access and combining percutaneous thrombosuction and intra-arterial thrombolysis. This comprehensive approach resulted in restoration of blood flow and resolution of acute limb ischemia. The patient was subsequently prescribed short-term anticoagulation therapy and remained symptom free at 3 months of follow-up. This innovative strategy challenges traditional surgical approaches in HHS management, underscoring the importance of using minimally invasive techniques as a promising alternative and highlighting potential avenues for further research. (J Vasc Surg Cases Innov Tech 2024;10:101384.)

Keywords: Acute limb ischemia; Arterial thrombosis; Hand ischemia; Peripheral artery disease; Revascularization; Vascular medicine

Hypothenar hammer syndrome (HHS), a rare vascular overuse syndrome in adults, arises from repetitive compression or blunt trauma to the hypothenar eminence and causing ulnar artery aneurysm or thrombosis, leading to digital ischemia.[1] Treatment options range from conservative approaches to surgical excision and arterial reconstruction. We present a case of a powerlifter with acute digital ischemia due to HHS that was managed successfully with minimally invasive percutaneous thrombosuction and intra-arterial thrombolysis.

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Additional material for this article may be found online at https://www.jvscit.org.

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The editors and reviewers of this article have no relevant financial relationships to disclose per the Journal policy that requires reviewers to decline review of any manuscript for which they may have a conflict of interest.

2468-4287

https://doi.org/10.1016/j.jvscit.2023.101384

CASE REPORT

A 36-year-old man, an avid weightlifter with a history of anabolic steroid use, presented at the emergency department with a 2-hour history of sudden-onset pain in his fourth and fifth fingers of his left hand. He experienced a "popping" sensation in the palm, followed by immediate pain while performing squeezing wrist exercises with heavy weights. Within minutes, the affected fingers became numb, cold, and turned progressively blue (Fig 1). Examination showed absent ulnar artery pulsations, profound cyanosis, early signs of ischemia in the fourth and fifth fingers, tenderness in the distal left palm, and coolness in the affected fingers. No carotid or subclavian bruits were detected. Other examination findings were unremarkable. Laboratory tests, including complete blood count, metabolic panel, coagulation assays, sedimentation rate, and C-reactive protein, yielded normal results. An electrocardiogram exhibited normal sinus rhythm and no evidence of atrial fibrillation. The transthoracic echocardiographic findings indicated no cardiac source of emboli or mitral stenosis. The radiographic findings of the left hand were normal. Due to a suspected vascular injury, the patient underwent emergent computed tomography angiography of the left hand, which revealed ulnar artery thrombosis overlying the hook of the hamate (Fig 2). The imaging findings illustrated a distinctive corkscrew-like configuration of the ulnar artery, with emboli extending to the proper digital arteries of the fourth and fifth fingers. HHS with acute ulnar thrombosis, complicated by acute limb ischemia, was diagnosed. Given the rapid evolution of ischemic symptoms and concerns for viability, emergent intervention was pursued. A vascular surgery

Fig 1. Hypothenar hammer syndrome (*HHS*) fingers. Photograph of the affected left hand showing bluish discoloration of fourth and fifth fingers secondary to ischemia of the digital arteries after acute ulnar artery thrombosis.

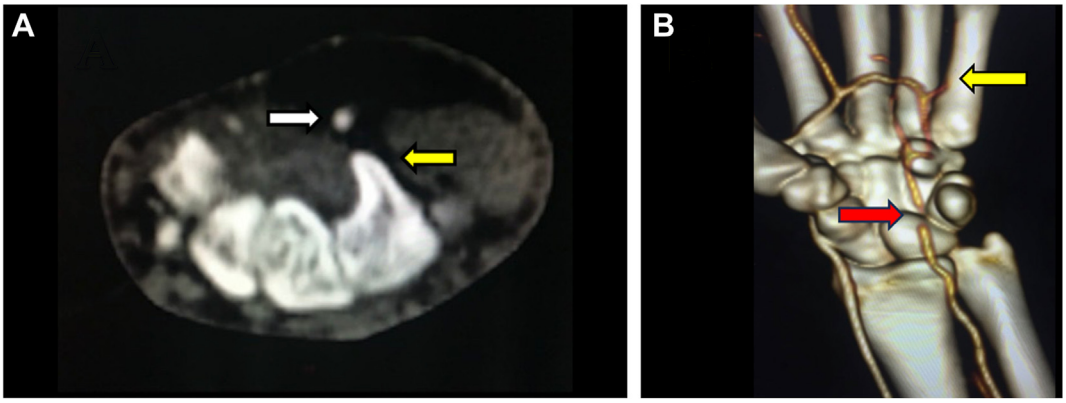

Fig 2. Computed tomography angiogram demonstrating hypothenar hammer syndrome (*HHS*). **A,** Cross-sectional image at the level of the wrist showing the ulnar artery (*white arrow*) passing directly above the hook of the hamate (*yellow arrow*). **B,** Three-dimensional reconstructed image demonstrating occlusion of the distal ulnar artery at the level of the wrist (*red arrow*) and absent filling of the digital arteries (*yellow arrow*).

consultation was sought, and both surgical and percutaneous approaches were deliberated with the patient, who opted for percutaneous endovascular management. The patient granted written informed consent for the report of his case details and imaging findings.

The patient was transferred to the cardiac catheterization laboratory. Antegrade left brachial access was established under ultrasound guidance distally over the humerus using a 6F sheath. The selection of a brachial artery approach, instead of the femoral artery approach, was decided by its proximity to the target hand lesion and limitations of reaching the target lesion from a femoral approach with the equipment available at the intervention. Angiography revealed thrombosis in the ulnar artery at the wrist level (Fig 3; Supplementary Video 1, online only). A 0.014-in. guidewire (Balance Middleweight wire; Abbott Cardiovascular) easily crossed the lesion, indicating acute thrombosis. Balloon angioplasty with a 2 × 10-mm, noncompliant balloon was performed twice at the lesion site at a pressure of 4 atm; however, no flow could be established (Fig 4, *A*). A novel approach for percutaneous thrombectomy was used with a 6F Thrombuster II thrombus extraction catheter (Kaneka Corp; Fig 4, *B*; Supplementary Video 2, online only). Repeated suction passes with the catheter across the lesion resulted in successful thrombus extraction and TIMI (thrombolysis in

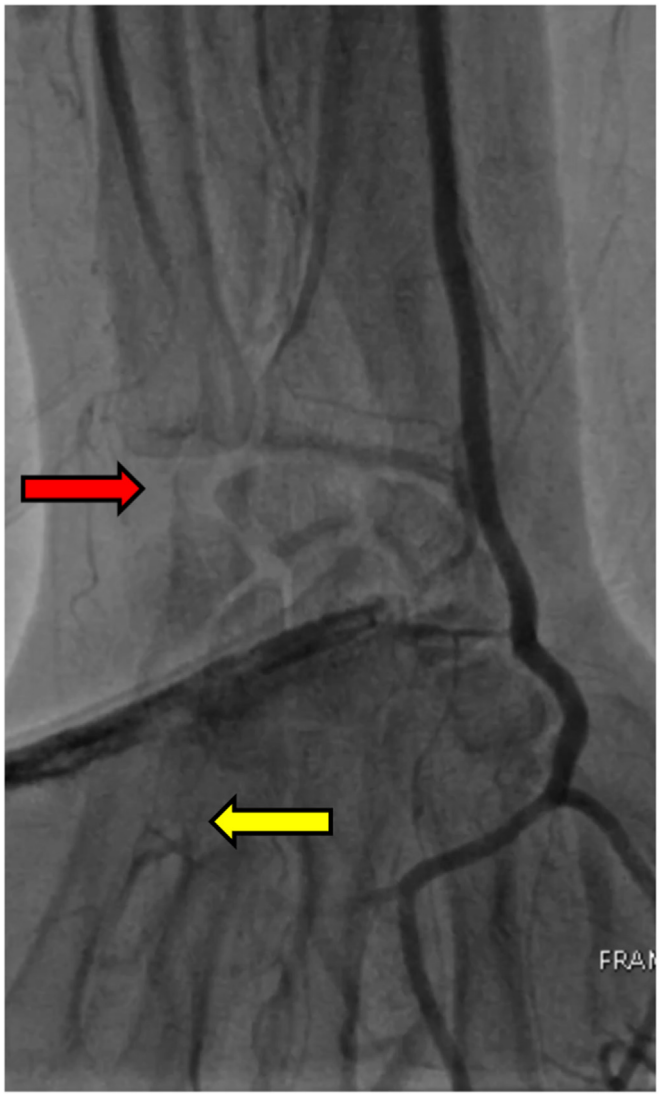

Fig 3. Contrast angiogram showing delayed filling suggesting thrombotic occlusion of the distal left ulnar artery (*red arrow*) consistent with hypothenar hammer syndrome (*HHS*), with absent flow noted in the digital arteries of the fourth and fifth fingers (*yellow arrow*).

myocardial infarction) I flow restoration. Subsequent intra-arterial thrombolysis with alteplase, delivered at a controlled rate of 10 mg over 5 minutes, via the thrombosuction catheter was performed. The final angiogram revealed a minor residual thrombus at the lesion site with successful achievement of TIMI III flow (Fig 4, *C*; Supplementary Video 3, online only). Access site hemostasis was achieved with manual compression. Intravenous heparin was administered at 10 U/kg/h for 24 hours, followed by oral anticoagulation for 3 months. Doppler ultrasound, performed after 24 hours, revealed normal flow in the brachial, ulnar, and radial arteries and the palmar arch, with resolution of pain and digital mottling. At 3 months of follow-up, his symptoms had abated.

DISCUSSION

HHS is an uncommon vascular overuse disorder, characterized by recurrent blunt trauma to the ulnar artery at the hypothenar eminence level, resulting in aneurysm formation or vessel occlusion that rapidly progresses to acute limb ischemia. There is a striking >9:1 male predominance, with the dominant hand implicated in ~75% cases.[2] Thoroughly investigating a patient's occupational or recreational trauma history is essential for an accurate diagnosis, because HHS is common among those with repetitive hand movements in various professions, including athletes and weightlifters.[3] The use of recreational substances such as anabolic steroids, as in our patient, further enhances the risk of thrombosis.[4]

The pathophysiology stems from the course of the ulnar artery through Guyon's canal, where repetitive use of the hypothenar portion of the hand as a tool to hammer, push, or squeeze hard objects, compresses the superficial branch of the artery against the hamate bone, resembling a "hammer," leading to an "anvil" effect, injuring its intimal layer, and causing distal arterial ischemia through vasospasm, platelet aggregation, and thrombus formation.[3,5] Ferris et al[5] proposed that HHS patients possess inherent ulnar artery abnormalities, characterized by a "corkscrew" configuration with alternating stenosis and ectasia and histopathologically resembling fibromuscular dysplasia. The clinical presentation varies from mild discoloration and cold intolerance to severe ischemia, with symptoms including localized pain in the second to fifth digits, paresthesia, numbness, and, possibly, a palpable pulsatile mass in cases with a notable aneurysmal segment.[6] The differential diagnosis encompasses Raynaud disease, connective tissue disorders, vasculitis, cardiac source arterial emboli, thromboangiitis obliterans, atherosclerosis with secondary thrombosis, and thoracic outlet syndrome.[7]

Ultrasound Doppler mapping is an initial noninvasive tool for evaluating the ulnar artery, and angiography remains the definitive diagnostic reference for confirming HHS. Multislice computed tomography angiography provides an accurate assessment of the proximal segments, identifying obstruction or embolic sources and excluding bone irregularities.[8] Catheter-based angiography remains the gold standard for thorough hand ischemia evaluations, revealing pathognomonic indicators such as ulnar artery tortuosity ("corkscrew" appearance), aneurysms, segmental occlusion over the hamate hook, and intraluminal emboli in occluded digital arteries.[3]

Due to the absence of randomized trials and comprehensive comparative studies, the optimal management strategies lack consensus, resulting in empirical treatment practices tailored to ischemia severity and local norms, with conservative measures such as smoking cessation, protective measures, medication use, and local

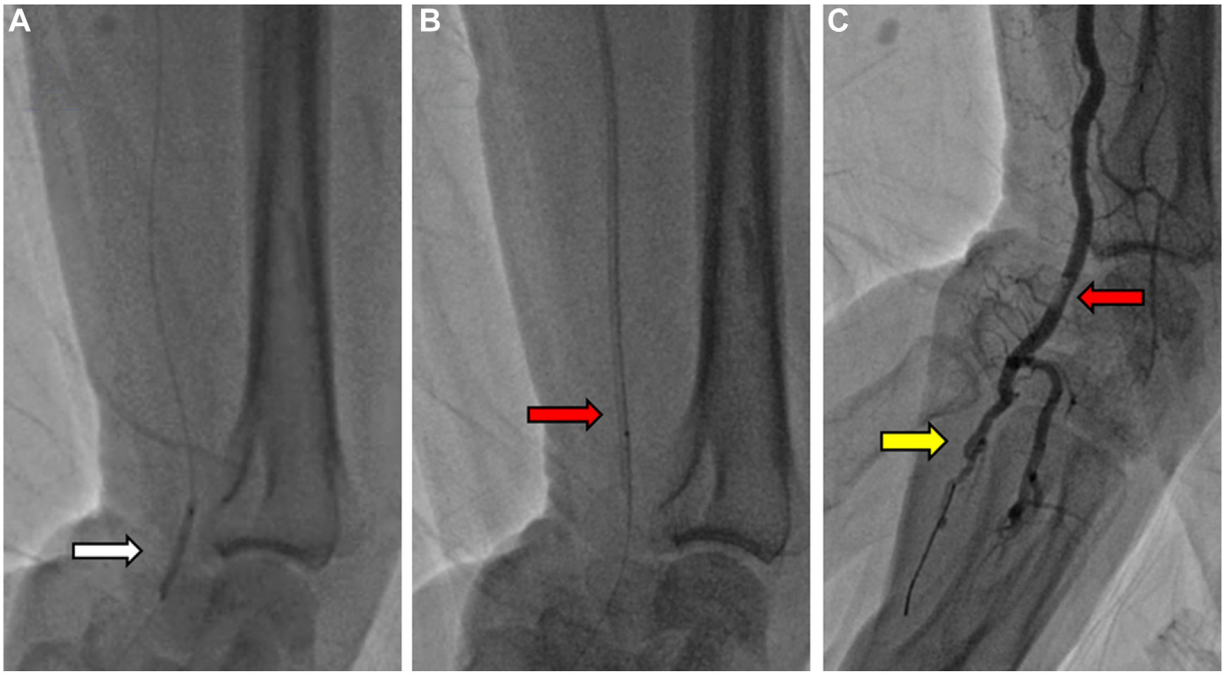

Fig 4. Angiograms depicting successful percutaneous revascularization of left ulnar artery after balloon angioplasty, percutaneous thrombectomy with a thrombus aspiration catheter, and intra-arterial thrombolysis. **A,** Angiogram depicting balloon angioplasty performed at the thrombotic lesion site with a 2 × 10-mm non-compliant balloon (*white arrow*). **B,** Angiogram showing percutaneous thrombectomy performed with a 6F Thrombuster II thrombus extraction catheter (*red arrow*). **C,** Final contrast-enhanced angiogram after intra-arterial thrombolysis depicting complete recanalization of the ulnar artery. Also illustrated is the distinctive "corkscrew-like" configuration of the ulnar artery (*yellow arrow*). A minor residual thrombus at the lesion site is also noted (*red arrow*).

care showing promising symptomatic improvement rates of ≤83% in small case series.[2] Surgery has been the primary approach when conservative methods fail, especially in the setting of ischemic signs in multiple digital arteries and inadequate collateral circulation.[9] Surgical alternatives encompass arterial ligation, excision of thrombosed or aneurysmal segments with subsequent end-to-end anastomosis, and arterial resection with subsequent venous or arterial graft reconstruction.[10]

Intra-arterial thrombolysis is increasingly achieving acceptance as an alternative or adjunctive revascularization strategy for severe hand and digital ischemia, particularly when performed in the acute setting, although limited reports have discussed its use in HHS management.[11,12] A recent study substantiated the efficacy of intra-arterial thrombolysis for acute HHS, especially within 30 days of symptom onset, with higher angiographic patency rates when combined with the use of fibrinolytic agents and heparin.[13] Additionally, prolonged thrombolysis durations >24 hours did not confer benefits concerning arterial patency or clinical outcomes, advocating its use primarily for acute and subacute HHS presentations.[13] The systematic reviews highlight excellent limb salvage rates with percutaneous embolectomy or catheter-directed thrombolysis for upper limb ischemia, although distal pulse restoration and angiographic findings might not consistently correlate with the clinical outcomes or overall limb salvage success.[13,14] This suggests that a reduction in thrombotic deposits, even if not leading to complete restoration of arterial perfusion in digital and hand arteries, could still suffice to ameliorate clinical symptoms by ensuring adequate blood flow. Although mechanical thrombectomy devices have been used to address occlusions of upper extremity dialysis grafts, their use for occluded vessels in the forearm or hand has not been documented.[15] An innovative paradigm integrating thrombosuction as a preliminary step preceding intra-arterial thrombolysis, as demonstrated in our case report, holds the potential to mitigate the arterial thrombus burden and reduce angiographic thromboembolic complications and, thus, enhance subsequent intra-arterial thrombolysis outcomes. Importantly, mechanical thrombosuction as a preemptive strategy for diminishing thrombus burden, followed by intra-arterial thrombolysis, represents an unexplored domain in the existing literature. This method, directed toward limb salvage, remains a focal point of ongoing research, necessitating further outcomes-driven exploration.

CONCLUSIONS

HHS is a remediable and preventable cause of upper extremity digital ischemia, characterized by recurrent

blunt trauma impacting the ulnar artery at the hypothenar eminence, leading to aneurysm or vessel occlusion and culminating in acute limb ischemia. A meticulous evaluation of occupational or recreational trauma is imperative. Although percutaneous options exist, data remain limited. Our case demonstrates an innovative approach using balloon dilatation, thrombosuction, and intra-arterial thrombolysis to treat this rapidly advancing condition that departs from the conventional surgical paradigm that has conventionally underpinned the management of this condition.

DISCLOSURES

None.

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Submitted Oct 3, 2023; accepted Nov 13, 2023.

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