Pseudoaneurysm Formation and Repair After Mohs Micrographic Surgery
A Report of 3 Cases
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Pseudoaneurysm is a well-known sequela of trauma and iatrogenic injury to the vasculature. We report 3 cases of postsurgical pseudoaneurysm after Mohs surgery.

OBSERVATIONS Three patients who underwent Mohs surgery for nonmelanoma skin cancers presented between 2 and 4 weeks after surgery with several days' history of painful, enlarging, pulsatile subcutaneous masses. The lesions were diagnosed as postsurgical pseudoaneurysm. During surgical repair of each lesion, we identified vascular outpouchings that were connected to the injured arteries by sinus tracts. In all 3 patients, we ligated the affected artery and the neck of each lesion and reapproximated the skin. All wounds healed well without further recurrence.

CONCLUSIONS AND RELEVANCE Most reported cases of pseudoaneurysm formation in the head and neck involve the superficial temporal artery and its branches, and they typically occur secondary to blunt force trauma. Our cases are unique in that they included 1 case of a superficial temporal lesion but also 2 cases outside this system: 1 of the lateral nasal artery and 1 of the angular artery. We propose operative repair as the treatment of choice for facial pseudoaneurysms that complicate dermatologic surgery.

Importance Pseudoaneurysm is a well-known complication of trauma and iatrogenic injury to the vasculature. We report 3 cases of postsurgical pseudoaneurysm after Mohs surgery.

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Pseudoaneurysm is a well-known sequela of trauma and iatrogenic injury, but to our knowledge, has not been reported as a complication of Mohs or other dermatologic surgery. In addition, only a small fraction of cases have been reported outside the superficial temporal artery. One of our 3 cases occurred in the superficial temporal system, whereas the other 2 involved the lateral nasal artery and the angular artery. Each case was unremarkable intraoperatively and at a 1-week wound check, but each subsequently presented with a pulsatile, painful subcutaneous nodule and was diagnosed as a pseudoaneurysm. We incised the overlying skin and repaired all 3 with figure-of-eight suture ligation with the patients under local anesthesia in the dermatologic surgery suite with no further complications.

Report of Cases
Patient 1
A man in his 80s with a history of atrial fibrillation who was taking warfarin sodium and 81 mg/d of aspirin underwent Mohs surgery for a basal cell carcinoma of the left nasal sidewall. We do not discontinue warfarin therapy before Mohs surgery as long as the preoperative international normalized ratio is less than 3.5, as was the case in this patient. The defect was repaired with a rhombic transposition flap without acute complications. The patient returned 1 week later for suture removal with minimal epidermal slough, but no hematoma was present and the patient was discharged (Figure 1A). Three weeks after surgery, the patient presented with a 3-day history of an expansile, pulsatile violaceous nodule at the site of his transposition flap. He reported mild pain. His international normalized ratio was 2.9. He returned 5 days later with further enlargement of the lesion (Figure 1B), and repair was initiated. In this case of a transposition flap, we used a handheld Doppler device to pinpoint the afferent and efferent feeding vessels to minimize the necessary incisions. We incised the overlying skin and repaired all 3 with figure-of-eight suture ligation with the patients under local anesthesia in the dermatologic surgery suite with no further complications.

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Patient 2
A man in his 70s with a history of atrial fibrillation who was taking warfarin underwent Mohs surgery for a squamous cell carcinoma of the nasal tip, followed by a linear closure. At suture removal, no hematoma was present (Figure 2A). Seventeen days after surgery, the patient returned to the clinic be-

Figure 1. Patient 1

Figure 2. Patient 2 and Patient 3

A, Patient 1 week after Mohs surgery with rhombic transposition flap repair. The wound shows some surface slough but no evidence of hematoma formation or nodularity in the flap region. B, Three weeks after Mohs surgery, the wound has healed, but a pulsatile violaceous nodule is apparent at the site of the angular artery.

A, Patient 2 at 1 week after suture removal. No hematoma or other complication is present. B, Patient 2 at 17 days after surgery with a pseudoaneurysm of the lateral nasal artery. C, Patient 3 at suture removal with a well-healing defect. D, Patient 3 at 4 weeks after Mohs surgery with a pseudoaneurysm of the superficial temporal artery.
cause of a 4-day history of an expanding, painful, pulsating, 1-cm subcutaneous nodule at the site of his surgery (Figure 2B). We diagnosed the patient as having a pseudoaneurysm of the lateral nasal artery.

We repaired the pseudoaneurysm by reopening the surgical scar and examining the mass. Directly visible was an organized hematoma with a sinus tract communicating with the injured lateral nasal artery. Figure-of-eight suture ligation of the artery and neck resulted in cessation of blood flow, and the hematoma was expressed. We closed the wound along the original suture line, and the wound healed well with no further recurrence.

**Patient 3**
A man in his 50s, who was not taking blood-thinning agents, underwent Mohs surgery for a basal cell carcinoma of the lateral forehead, and his 8-mm defect was repaired linearly (Figure 2C). Three weeks after surgery, he presented with a 3-day history of a small subcutaneous nodule without any surface change or visible color as in the prior cases. A covering physician aspirated the lesion, thinking it was a small hematoma. One week later, the patient returned with a 1-cm pulsatile and violaceous subcutaneous nodule that had become painful (Figure 2D). At this point, the diagnosis of pseudoaneurysm was made, and we exposed and ligated the afferent and efferent vessels. The patient healed with no further recurrence.

**Discussion**
Injury to the vasculature is inevitable in cutaneous surgery. Minor trauma to the vessels is quickly noted and easily managed intraoperatively, and the surgical wound heals without complication. Even so, postoperative complications, such as hematoma formation and hemorrhage, occasionally occur. Previous studies have reported bleeding complications of Mohs surgery in less than 1% of cases. Other authors have quantified the slightly higher likelihood of bleeding complications associated with anticoagulant and antiplatelet drugs. Anticoagulant therapy is routinely continued when necessary because of increased morbidity and mortality with cessation.

Although hemorrhage and hematoma are the most common bleeding complications in skin surgery, other less common and rarely considered entities can occur after cutaneous surgery: true aneurysm, false aneurysm or pseudoaneurysm, and arteriovenous fistula. True aneurysms include outpouching of all layers of the vessel wall. Arteriovenous fistulae arise from trauma typically occur rapidly in larger vessels and can cause hemodynamic compromise. False aneurysms or pseudoaneurysms consist of an organized hematoma that communicates with the injured artery via a sinus tract. These entities can be differentiated based on clinical, radiologic, and surgical findings.

On the basis of the delayed onset, lack of vessel wall elements in the aneurysmal sac, and the finding of arterial lumen that communicates with organized thrombus, we diagnosed our patients as having pseudoaneurysm. A pseudoaneurysm develops when trauma disrupts the arterial wall and blood extravasates into the soft tissue that surrounds the injured artery. The extraluminal blood typically forms a hematoma when tissue pressure exceeds intraluminal pressure and the coagulation cascade predominates. When the pressure from the artery exceeds the capacity of the coagulation cascade, the hematoma may canalize and remain in persistent communication with the lumen of the artery. The anatomy of the fully developed pseudoaneurysm consists of a hematoma with bidirectional flow through a defined neck in communication with lumen of the injured artery (Figure 3).

The reported incidence of pseudoaneurysm after procedures such as cardiac catheterization varies from 0.05% to 8.0%. To our knowledge, there have been no reports after Mohs procedures or other dermatologic operations of the head and neck. Hundreds of cases after blunt trauma have been reported, but reports in the head and neck outside the superficial temporal artery and its branches are rare. It is possible that these lesions are more common than indicated and that they typically are treated as hematomas or spontaneously resolve.

Diagnosis is typically based on history and physical examination. Patients present 1 to 4 weeks after trauma or surgery with a pulsatile subcutaneous mass synchronous with the cardiac cycle. Pain is common. Manual compression of the mass can diminish pulsation. Diagnostic testing may be useful for deeper lesions, and duplex ultrasonography can highlight afferent and efferent flow within the lesion. In contrast, arteriovenous fistulae demonstrate continuous unidirectional flow on color flow imaging. We did not perform duplex ultrasonography given the small (<1 cm) size of our lesions.

**Figure 3. Pseudoaneurysm Anatomy**

The organized hematoma without vessel wall components connected to the arterial lumen via a sinus tract. H indicates organized hematoma; L, arterial lumen; N, neck.
Suture ligation of the implicated artery is historically considered the treatment of choice, although other specialists now commonly use newer modalities, such as thrombin injection, for larger lesions.12 Smaller lesions can spontaneously remit, but pain can be limiting, and given the ease of access to facial vessels, ligature remains optimal in these locations. In the first case report, the lesion doubled in size during 5 days of observation, and the patient experienced increased pain, which prompted our decision to repair the pseudoaneurysm. In the third case report, aspiration alone failed to resolve the pseudoaneurysm, and it recurred. These findings suggest that immediate surgical repair on presentation is optimal to avoid further lesional growth that causes potential repair dehiscence, patient discomfort, and more complex operative management. Our patients experienced favorable outcomes with minimal scarring after careful repairs and epidermal reapproximation.

Iatrogenic injury to the facial vasculature is frequent in cutaneous surgery, and this is an important diagnosis for dermatologists and surgeons to consider. The presented cases are unique in that they occurred after Mohs surgery, and reports of pseudoaneurysm of any cause outside the superficial temporal artery are rare. Our lesions were located in the lateral nasal artery, the angular artery, and the superficial temporal artery. Despite the potential for significant morbidity, treatment is typically straightforward and excellent outcomes are possible with accurate diagnosis and prompt management. We did not encounter the need for extensive diagnostic workup and propose surgical ligation with the patient under local anesthesia as the first-line treatment of small (<2-3 cm), uncomplicated facial pseudoaneurysm.

REFERENCES