

# Vascular control for a forequarter amputation of a massive fungating humeral osteosarcoma

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Forequarter amputation is a radical operation performed for treatment of malignant neoplasms of the shoulder girdle not amenable to limb salvage. Traditional approaches involve bone and soft tissue resection, followed by ligation of the axillary vessels. We describe a technique to minimize blood loss whereby control of the subclavian vessels is performed before amputation of a large tumor associated with extensive venous congestion. A 34-year-old man presented with proximal humeral osteosarcoma. Surgery involved claviculectomy to facilitate vascular control of the subclavian vessels, followed by guillotine amputation at the proximal upper arm level and completion of the amputation as conventionally described. (*J Vasc Surg Cases* 2016;2:56-8.)

Forequarter amputation (FQA), or interscapulothoracic resection, is an extensive surgical procedure that entails removal of the entire upper extremity and shoulder girdle, including the scapula and clavicle. It was originally performed in the 19th century for traumatic upper extremity injuries.<sup>1,2</sup> Currently, indications for FQA include palliation or treatment of malignant neoplasms of the shoulder girdle or surrounding soft tissues that invade the glenohumeral joint, brachial plexus, or axillary vessels (primarily bone or soft tissue sarcomas) as well as recurrent sarcomas that have failed limb-sparing surgery. FQA is rarely indicated today as 90% to 95% of patients with bone and soft tissue sarcomas of the shoulder girdle can be successfully treated with limb-sparing surgery and adjuvant therapy.<sup>3</sup>

Although FQA is primarily performed by orthopedic surgeons, a multidisciplinary approach, including vascular surgeons, may be necessary if early vascular control is needed to prevent exsanguination with a massive tumor and significant venous congestion. Herein, we describe the operative management of a young man who presented with a large osteosarcoma of the proximal humerus not amenable to limb salvage, with emphasis on the steps taken to ensure adequate vascular control before definitive

amputation. Consent for the publication of this report was obtained from the patient.

## CASE REPORT

A 34-year-old man presented to the emergency department with a large, infected mass of the proximal right upper extremity. One year before the current presentation, he was evaluated at an outside institution, where a biopsy had demonstrated high-grade humeral osteosarcoma. Surgery was recommended at the time, but the patient refused treatment and traveled to his native Honduras to seek alternative therapy. On presentation, he was febrile to 102°F and tachycardic. On examination, the proximal right upper extremity was largely replaced by fungating tumor draining purulent fluid from an abscess cavity with significant edema extending along the entire right side of the chest. Laboratory findings included a hematocrit of 18.9% and a white blood cell count of 13.6/ $\mu$ L. Imaging studies demonstrated a destructive mass replacing much of the proximal humerus, with involvement of the glenohumeral joint and compression of the venous vasculature (*Fig 1*). He was started on antibiotics and resuscitated as a metastatic workup was pursued, which proved to be negative.

The oncology service recommended FQA with adjuvant therapy for curative intent, as the resection margins, including the chest wall, paraspinous muscles, thoracic outlet, and posterior cervical triangle, appeared free of disease by imaging. Neoadjuvant therapy was not an option as the patient was in septic shock and in need of immediate operative intervention to control the source of infection. A multidisciplinary operative intervention was planned with vascular surgery, orthopedics, and plastic surgery. Because of the size of the lesion and degree of venous congestion (*Fig 2*), the decision was made that proximal vascular control of the subclavian vessels was necessary before any resection and that guillotine amputation and rapid removal of the massively edematous arm would be required to control the source of venous congestion. A claviculectomy is routinely performed as part of an FQA. Performing this maneuver early in the operation afforded better exposure to the subclavian vessels and served to minimize bleeding. An attempt to expose the axillary vessels would have required dissection through a very congested chest wall and would have resulted in significantly more hemorrhage. An alternative method to

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Author conflict of interest: none.

Presented in the e-Poster Competition at the Society for Clinical Vascular Surgery Forty-fourth Annual Symposium on Vascular Surgery, Las Vegas, Nev, March 12-16, 2016.

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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.

2352-667X

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<http://dx.doi.org/10.1016/j.jvsc.2016.03.005>



**Fig 1.** Plain film illustrating a large destructive osseous lesion extending from the proximal humeral diaphysis to the humeral head and glenoid, with marked associated aggressive periosteal reaction as well as areas of pathologic fracture.



**Fig 2.** Intraoperative picture demonstrating the massive size of the affected right upper extremity and the normal left upper extremity.

control arterial inflow in this situation would have been to embolize or to plug the subclavian artery through an endovascular approach; however, this was not done, given the relatively simple and expeditious access to the subclavian vessels that removal of the clavicle afforded. With the patient positioned supine, a paracavicular incision was made, through which a claviclectomy was performed, and the subclavian vessels were exposed and encircled with Silastic loops. Proximal subclavian artery control was obtained central to the dorsal scapular artery, which served to minimize bleeding during the division of the levator scapulae and rhomboid muscles. The limb could not be exsanguinated of venous blood with an Esmarch bandage because of the grossly infected nature of the tumor. A meticulous dissection was attempted, and the blood loss was significant immediately after skin incision. To minimize further potential blood loss, the subclavian artery was clamped and a guillotine amputation was performed at shoulder level (Fig 3). The subclavian vein was then occluded with a vessel



**Fig 3.** Guillotine amputation of the right upper extremity at the shoulder level.

loop, and the wound was rapidly packed. After removal of the bulk of the specimen, soft tissue bleeding was mostly controlled. The axillary vessels were then ligated, as were the nerves of the brachial plexus, to prevent neuroma formation. The remainder of the FQA was completed in standard fashion, with curative intent, and the wound was closed primarily over drains.

The patient received 14 units of packed red blood cells, 8 units of plasma, 2 units of platelets, and 3 liters of crystalloid. Much of this was secondary to the significant resuscitation he required for treatment of sepsis. He had an uncomplicated postoperative course and was discharged to a rehabilitation facility on postoperative day 5. Surgical pathology demonstrated high-grade osteosarcoma with positive margins. At 6-month follow-up, he was tolerating adjuvant chemoradiation therapy.

## DISCUSSION

Advancements in chemoradiation protocols and surgical technique have made limb-sparing surgery the standard of care for most cases of upper extremity sarcomas. Today, FQA is reserved for very large proximal humeral or scapular tumors associated with fractures, hemorrhage, infection, neurovascular involvement, failed resection, or tumor progression despite neoadjuvant therapy.<sup>3</sup> Although the perioperative mortality associated with FQA is low, reported as 3% in one study, the overall prognosis of the patients undergoing this procedure is dismal because of the aggressive nature of the malignant neoplasms for which FQA is performed.<sup>4</sup> In a review of studies that included at least 10 patients undergoing FQA, survival beyond 5 years was reported to be 14% to 38%. For the subset of patients undergoing surgery with palliative intent, the median overall survival was 5 to 21 months.<sup>5</sup> A single-center retrospective review reported a similarly poor median overall survival of 9.8 months.<sup>4</sup>

The original anterior and posterior approaches to FQA were described by Berger and Littlewood, respectively.<sup>6</sup> Today, the most common technique begins with the patient in a semilateral position, and the majority of the

procedure is performed anteriorly. The anterior limb of the utilitarian incision is used, and the pectoralis major muscle is detached from the clavicle. A clavicular osteotomy is performed to allow control of the subclavian vessels. A posterior incision is then made to detach the scapula from the rhomboid, trapezius, levator scapulae, and latissimus dorsi muscles. The scapula is then resected from the chest wall, and an axillary incision is made to connect the anterior and posterior incisions. The subclavian vessels and brachial plexus are ligated, and the forequarter is removed.<sup>3,7</sup> An excellent illustration of this operative technique is provided by Malawar and Sugarbaker.<sup>3</sup> A posterior approach is seldom used, particularly in the setting of large tumors that displace the subclavian vessels and make these structures vulnerable to injury.

There are additional variations in the surgical technique for FQA, including the timing of vascular control. The patient in this report presented with massive edema of the upper extremity and chest. Therefore, it was decided that early proximal control of inflow would be necessary to limit blood loss. Options for this included claviclectomy with control of the subclavian vessels and mini-median sternotomy with brachiocephalic control. The decision was made to proceed with the former, less morbid procedure. Before occlusion of the subclavian vein, a guillotine amputation was performed to minimize venous hypertension and bleeding from raw surfaces during resection. Ultimately, the axillary vessels were ligated at the amputation site, and the subclavian vessels were unclamped. The remainder of the operation proceeded with improved hemostasis.

## CONCLUSIONS

Advancements in operative technique and adjuvant therapy have made limb-sparing surgery the standard of care for most patients with advanced-stage proximal upper extremity sarcomas. Nonetheless, FQA is still indicated in select cases, and vascular surgeons should be familiar with this procedure. In cases of large tumors with venous congestion and associated sepsis, we advocate for early subclavian vessel control and guillotine amputation of the congested extremity, followed by formal vessel ligation and forequarter resection.

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Submitted Jan 5, 2016; accepted Mar 12, 2016.