

# Perioperative considerations of an extended forequarter amputation for recurrent high-grade radiation-induced sarcoma: A case report

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## Abstract

Forequarter amputation is a radical surgical procedure involving removal of the entire upper extremity and shoulder girdle and is most commonly performed in the management of aggressive upper extremity malignancies. A number of perioperative challenges can arise during extended resections including postoperative respiratory compromise due to altered chest wall mechanics, potential need for lung isolation, selecting appropriate sites for vascular access, complex fluid and hemodynamic resuscitation, optimizing conditions for free flap viability, and managing pain and the psychological impact of such a significant operation. Here we present a case of an extended forequarter amputation with a multidisciplinary team for the management of a recurrent high-grade radiation-induced sarcoma.

## Introduction

Forequarter (interscapulothoracic) amputation is a radical surgical procedure involving removal of the entire upper extremity and shoulder girdle. It was initially used in the early 19<sup>th</sup> century to manage severe traumatic injuries but now is most commonly indicated in the management of malignant tumors of the arm, axilla, shoulder and scapula [1]. Occasionally, tumors will also invade the chest wall requiring an extended en-bloc resection of the extremity, chest wall and rarely, the lung to achieve negative margins.

Radiation-induced sarcoma is an aggressive malignancy originating in irradiated bone or soft tissues, and the majority of tumors are high grade [2]. Patients with radiation-induced sarcomas have a 5-year survival rate of 17% to 58% with surgical resection being the primary means of treatment [3].

A number of perioperative challenges can arise during extended forequarter amputations including postoperative respiratory compromise due to altered chest wall mechanics, potential need for lung isolation, selecting appropriate sites for vascular access, optimizing conditions to ensure flap viability, and managing pain and the psychological impact of such a significant operation.

All information was de-identified in this case report.

## Case report

A 66-year-old woman (59 kg and BMI of 24) presented to our institution for evaluation of a recurrent radiation-induced 9 x 9 x 12 cm high-grade spindle cell sarcoma involving the right axilla, scapula, glenohumeral joint, base of neck, chest wall, and right upper lung pleura with encasement of the brachial plexus and axillary vessels.

Her other past medical history was significant for a remote history of right arm deep vein thrombosis for which she was anticoagulated with warfarin, hypertension, history of doxorubicin-induced systolic heart failure (transthoracic echo showing left ventricular ejection fraction of 40-45%), chronic right arm pain due to tumor involvement of the brachial plexus (taking MS contin 30 mg TID as well as morphine immediate release for a daily morphine equivalent of 180 mg), chronic iron deficiency anemia with a preoperative hemoglobin of 10.5, and generalized anxiety disorder (on lorazepam 0.5 mg TID PRN).

She was scheduled for an extended forequarter amputation involving a multidisciplinary surgical approach involving orthopedic surgery, plastic surgery, cardiothoracic surgery, neurosurgery and otorhinolaryngology. General anesthesia was induced with 100 mcg fentanyl, 100 mg lidocaine, 100 mg propofol, and 50 mg rocuronium intravenously. A left-sided 37 French double lumen endotracheal tube was placed and appropriate position was confirmed with fiberoptic bronchoscope. The bronchial cuff remained deflated until lung isolation was required. Left radial arterial, left antecubital 16 gauge peripheral IV and left femoral two-lumen central line catheters were placed. Core temperature was monitored and maintained between 35.1°C (first recorded temperature) and 37.1°C with a gradual increasing trend during the procedure. The patient was given 2 g of cefazolin and 2 g of tranexamic acid intravenously.

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The patient was positioned in left lateral decubitus position and the right arm, chest wall and neck were prepped and draped. The plastic surgery team began by preparing the forearm for a free fillet flap, but delaying the anastomosis until the extremity was removed. The surgical teams then performed a right forequarter amputation with neck dissection and lymphadenectomy, costotransversectomy from C7 to T2, and chest wall resection. The brachial plexus, external jugular vessels and internal jugular vein were divided. Left lung isolation was required during the chest wall resection involving the first through fifth ribs, sternoclavicular joint, a portion of the manubrium, right upper lobectomy, and total lung pulmonary decortication. The right upper extremity was then removed from the body, leaving a 17 x 25 centimeter defect. The plastic surgery team then removed the free fillet flap from the extremity on a sterile back table, and inset the free forearm fillet flap, anastomosing the brachial artery and vein of the free fillet flap to the lingual artery and anterior cervical vein, respectively. Then 2000 units of heparin were administered intravenously. Reconstruction of the chest wall was performed with a 15 x 18 cm Goretex mesh, and the flap was inset and incisions reapproximated. The surgical time of the procedure was 10 hours and 21 minutes.

Estimated blood loss was 1200 ml. Urine output was 2850 ml. A total of two units of packed red blood cells were transfused. The hemoglobin ranged from 6.7 to 12.2 g/dL during the case. The patient received 1.5 L of albumin and 4.8 L of plasmalyte during the procedure. Intermittent hypotension was treated with low-dose phenylephrine and ephedrine. For analgesia the patient was given a total of 4 mg of hydromorphone and 50 mg of ketamine intravenously throughout the case as well as a dexmedetomidine infusion at 0.4 mcg/kg/hr during the case.

At the conclusion of surgery a Cook airway exchange catheter was used to place a single lumen endotracheal tube and the patient was taken to the intensive care unit intubated. Three hours later the patient developed a significant intra flap hematoma necessitating massive transfusion and a return to the operating room where multiple areas of bleeding were identified and controlled. Subsequently, the patient was noted to have venous congestion in the flap and a clot was removed from the venous anastomosis site. Her free flap ultimately failed and was removed despite resuscitation, optimization of perfusion using leach therapy and mixed venous oxygen monitoring of the flap. On post op day 4 the patient was taken for a chest wall closure using a rectus abdominal myocutaneous flap and open tracheostomy. She remained in the intensive care unit receiving ventilator support for 32 days and then was discharged home on post op day 64. On 3 month follow up the patient had no evidence of recurrence and a well healed flap.

## Discussion

Sarcomas arising from the chest wall and axilla can require complex procedures to achieve negative margins when surgery has a curative intent. Extended forequarter amputations where the neck, spine and/or chest wall are involved are particularly challenging and require a multidisciplinary approach including the anesthesiologist, who plays an important role in the care of these patients. A number of perioperative challenges arise during forequarter amputations.

## Pulmonary considerations

Muscles contributing to respiration that may be disrupted by an extended forequarter amputation include the intercostal, sternocleidomastoid, pectoralis, serratus anterior, scalene, and upper trapezius muscles [4]. Loss of function in these muscles may reduce pulmonary function and may possibly contribute to postoperative

respiratory complications. In a cross sectional cohort study of patients with spinal cord injuries and loss of accessory muscles of respiration the mean FEV1 was 55% predicted in C4 to C5 injuries and 78% predicted in T1 to T6 spinal cord injuries, respectively [5]. Resection of ribs, chest wall and accessory muscles of respiration alter pulmonary mechanics and increase the likelihood of needing ventilator support in the postoperative period. Additionally, an extended resection may compromise phrenic nerve and diaphragmatic function, significantly altering respiratory function. Patients should be counseled about the possibility of prolonged ventilation and even a tracheostomy.

Depending on the depth of resection and proximity to the pleura, lung isolation may be needed. Positioning of the patient may limit access to the patient's head and make it more challenging to exchange a double lumen ETT although there may be increased risk for complications associated with leaving a double lumen ETT in place for an extensive surgery.

## Hemodynamic considerations

Fluid shifts, blood loss and hemodynamic instability can be significant and in all cases arterial access and large bore venous access are mandatory. The anesthesiologist may also consider placement of a central venous catheter to assist with optimization of monitoring and resuscitation. The optimal location for a central line should be determined on a case-by-case basis. Clearly, ipsilateral jugular or subclavian access is not an option, but in certain cases contralateral jugular or subclavian access may be feasible. In some cases the femoral vein may be the best location for central access though this has to be weighed against the risk of infection. Hypotension is common during this operation and, in addition to fluid resuscitation, judicious use of vasopressors is often necessary.

## Free flap considerations

A number of strategies have been proposed to increase the chance of flap viability, including optimizing both macrocirculation and microcirculation to ensure adequate flap perfusion, temperature management, optimizing hemoglobin and oxygen carrying capacity.

In a recent retrospective review of 104 patients undergoing free flap surgery for cancer of the head and neck a goal-directed fluid management strategy using stroke volume variation led to reduced intra-operative fluid administration and shorter hospital length of stay [6]. Another retrospective review of 168 patients undergoing free flap surgeries found that the lowest perioperative hemoglobin was a significant predictor of flap failure and suggested that an appropriate lower limit of transfusion commencement is 8.75 g/dL [7]. Since bleeding and thrombosis are major reasons for flap compromise and alterations in the coagulation cascade are common both intraoperatively and postoperatively, thromboelastography has been advocated as a useful tool in monitoring for coagulopathy [8]. Whether vasopressor use negatively effects free flap microcirculation remains controversial, however a recent retrospective propensity-score matching analysis of 2376 patients undergoing free flap surgery did not see any association with vasopressor use and pedicle compromise or flap failure rates however they did see less risk of venous congestion in the vasopressor group [9]. If there are clinical concerns about the effect of alpha-agonists such as phenylephrine on flap microcirculation, the anesthesiologist may administer an inotrope such as dopamine or dobutamine if the patient needs blood pressure support.

## Pain management

Patients undergoing forequarter amputations may have significant perioperative pain as well as a high incidence of phantom limb pain. In a review of 30 patients undergoing forequarter amputations in one center found that all patients had evidence of phantom limb pain [10]. A case report of 4 pediatric patients who underwent forequarter amputations described all patients having phantom limb pain, however it did not persist past 4 weeks in any patient [11].

Case reports have described using brachial plexus catheters, including interscalene catheters infusing local anesthetics for up to 14 days after forequarter amputations [10,12]. A recent case report describes successfully using a cervical erector spinae plane block catheter during a forequarter amputation [13].

In addition to regional anesthesia a multimodal analgesic approach may include the use of agents with NMDA receptor antagonism such as ketamine, methadone or magnesium, alpha-2 agonists such as dexmedetomidine, lidocaine infusions, anticonvulsants such as gabapentin, and NSAIDs.

## Psychological and ethical considerations

Patients may have significant psychological stress knowing they are undergoing a radical and life-altering operation with a risk of morbidity and mortality. Operative mortality has been described as between 0 and 10% [14,15]. In a retrospective review of 40 patients undergoing forequarter or hindquarter amputations the operative mortality was 2.5%. This study described the most common complications being wound infection and flap necrosis with 35% of patients developing a wound complication [14].

Amputations have a significant psychological impact. The prevalence of psychiatric disorders among amputees has been described as between 32 and 64% with depression ranging from 10.4% to 63% and posttraumatic stress disorder ranging from 3.3 to 56.3% [16]. Extensive discussions with the patient by both the surgical teams and the anesthesiologist may ease perioperative anxiety and help the patient understand the goals of the operation and recovery period including managing pain, functional limitations and underlying medical conditions.

## Conclusion

An extended forequarter amputation involves a multidisciplinary team and the anesthesiologist plays an important role in navigating a number of perioperative challenges including challenging airway management, intraoperative lung isolation, complex hemodynamic and fluid resuscitation, challenging pain management, anticipating

postoperative respiratory compromise, and employing appropriate temperature, fluid and coagulation management to optimize conditions for free flap viability.

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