J Shoulder Elbow Surg (2016) 25, 207-215

ELSEVIER

Journal of Shoulder and Elbow Surgery

www.elsevier.com/locate/ymse

Complications after surgery for metastatic humeral lesions

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Background: Knowledge of surgical outcome and its predictors helps inform patients and aids in surgical decision-making. We aimed to assess the outcome—reoperation and systemic complication rate—of surgery for humeral metastases, myeloma, or lymphoma. Our null hypothesis was that there are no factors associated with these outcomes.
Methods: We included 295 consecutive patients in this retrospective study: 134 (45%) proximal, 131 (44%) diaphyseal, and 30 (10%) distal impending or pathologic fractures. Proximal lesions were treated by intramedullary nailing (43%, n = 57), prosthesis (34%, n = 46), plate-screw fixation (22%, n = 30), and a combination (n = 1). Diaphyseal lesions were treated by intramedullary nailing (69%, n = 91), plate-screw fixation (30%, n = 39), and a combination (n = 1). Distal lesions were treated by plate-screw fixation (97%, n = 29) and intramedullary nailing (3.3%, n = 1).
Results: We found 25 (8.5%) reoperations, and 17 (5.8%) patients had 18 systemic complications: pneumonia (3.7%, n = 11), pulmonary embolism (1.3%, n = 4), sepsis (0.68%, n = 2), and fat embolism (0.34%, n = 1). No factors were independently associated with reoperation. Logistic regression analysis demonstrated that favorable cancer status (i.e., a higher modified Bauer score: odds ratio, 0.48; 95% confidence interval, 0.29-0.80; $P = .005$) was independently associated with a decreased systemic complication rate.
Conclusion: Poor cancer status was an independent predictor of postoperative systemic complications. This could help inform the patient and anticipate postoperative problems.
Level of evidence: Level III, Case Series, Treatment Study.

Keywords: Humerus; operative; surgery metastases; carcinoma; myeloma; lymphoma

Indications for surgery of a metastasis, myeloma, or lymphoma lesion of the humeral vary from a completed pathologic fracture, through a lesion at risk for fracture (i.e., impending fracture), to a solitary lesion. The decision for surgery is not always clear, and many factors are considered, including expected survival, systemic load, anatomic location, tumor type, size of the lesion, fracture

This study was approved by our Institutional Review Board: No. 2013P001994. A waiver of informed consent was granted.

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1058-2746/$ - see front matter © 2016 Journal of Shoulder and Elbow Surgery Board of Trustees.
http://dx.doi.org/10.1016/j.jse.2015.08.009

risk, and expected outcome.[3,10,18,21] Several criteria are proposed to assess the fracture risk, of which the Mirels classification is most commonly used.[17] Metastasectomy is occasionally warranted in patients with a solitary metastasis as some studies suggest that this improves survival in patients with renal cell carcinoma[1,2]; however, this finding is contradicted by others.[8,16] Operative treatment for metastatic humeral lesions is often palliative and aims to stabilize the bone for the remaining lifetime of the patient to preserve quality of life while minimizing the risk of complications.[4,10,21] Most previous studies are relatively small and focus on a single surgical technique.[10,13,24] This study aims to assess the outcome—reoperation and 30-day systemic complication rate—of surgery in a larger cohort of patients with metastatic humeral lesions treated in various ways. Our null hypothesis was that there are no factors associated with reoperation and complications among patients operatively treated for metastatic humeral lesions. In addition, we assessed differences in estimated blood loss, anesthesia time, duration of hospital admission, and 30-day survival among surgical strategies. Knowledge of complication rate and its predictors can help inform the patient and aid in surgical decision-making.

Methods

Study design and subjects

We assessed reoperations and 30-day systemic complications and risk factors for these outcomes in patients who underwent surgery for metastatic humeral lesions. Medical record data were obtained of patients who had an *International Classification of Diseases, Ninth Revision* (ICD-9) code (733.11) for a metastatic fracture or a *Current Procedural Terminology* code (24391 and 24498) for prophylactic fixation of the humeral between 1998 and 2013 at 2 tertiary care orthopedic oncology referral centers. We reviewed all medical records of identified patients to assess eligibility. A final consecutive series of 295 patients with a metastatic humeral lesion—impending or pathologic fractures—was included. We included only the first surgery per patient if patients had bilateral lesions (12 patients) so as not to violate the assumption of independence.[5] Inclusion criteria were patients older than 18 years who underwent intramedullary nailing, plate-screw fixation, endoprosthetic reconstruction, or a combination. No patients underwent distal or intercalary endoprosthetic reconstruction. We included patients regardless of follow-up duration as we considered all reoperations, short and long term, to be relevant. We included metastases from solid tumors, multiple myeloma, and lymphoma. We excluded patients who underwent only revision surgery at our institutions or who underwent fixation with noninterlocking nails (4 patients were treated with Rush rods).

Description of operative procedures

The surgeon together with the patient decided for surgery and selected the operative strategy on the basis of life expectancy, systemic load, tumor type, location, and size of the lesion. Orthopedic oncologists performed 286 of the 295 surgeries (97%); the remainder were performed by trauma surgeons.

There were 237 (80%) pathologic fractures and 58 (20%) impending fractures. Proximal lesions without significant involvement of the humeral head were treated by intramedullary nailing (43%, 57 of 134 cases; 45 pathologic and 12 impending fractures), plate-screw fixation (22%, 30 of 134 cases; 23 pathologic and 7 impending fractures), or a combination of these techniques (0.75%, 1 of 134 cases; 1 pathologic fracture). Cement was used in 7 of 57 intramedullary nailing cases (12%), in 1 case after curettage of the tumor, and in 6 cases to create a strong construct for the proximal interlocking screws in the humeral head. Cement was used in 25 of 30 plate-screw fixations (83%); an osteoarticular allograft was used in combination with plate-screw fixation after proximal humeral resection in 1 patient with renal cell carcinoma (3.3%, 1 of 30 cases). Endoprosthetic reconstruction was used for 46 (34%, 46 of 134 cases; 43 pathologic and 3 impending fractures) proximal humeral lesions after resection of the humeral head (17 humeral head hemiarthroplasties) or proximal humeral (29 modular tumor prostheses). Five of the 17 (29%) humeral head replacements were combined with a proximal intercalary allograft (3 renal cell carcinomas, 2 breast carcinomas). Cement was used in 43 of 46 (93%) endoprosthetic reconstruction cases.

Diaphyseal lesions were treated by uncemented intramedullary nailing (69%, 91 of 131 cases; 70 pathologic and 21 impending fractures), plate-screw fixation (30%, 39 of 131 cases; 28 pathologic and 11 impending fractures), or a combination of these techniques (0.76%, 1 of 131 cases; 1 impending fracture). Cement was used in 19 of 39 (49%) plate-screw fixation cases. Six patients (2 renal cell carcinomas, 1 breast carcinoma, 1 lung carcinoma, and 2 multiple myelomas) underwent a segmental resection of the humeral shaft followed by intercalary allograft placement and plate screw fixation (15%, 6 of 39 cases).

Distal lesions were mainly treated by plate-screw fixation (97%, 29 of 30 cases; 26 pathologic and 3 impending fractures); cement was used in 24 cases (83%). The remaining case (3.3%; 1 pathologic fracture) was treated with an uncemented intramedullary nail.

The type of operation, as outlined before, varied on the basis of the location of the lesion ($P < .001$, by Fisher exact test) and the type of fracture ($P = .037$, by Fisher exact test).

All intramedullary nails were interlocking and inserted in an antegrade fashion. Postoperative care and