



Grand Rounds from HSS

MANAGEMENT OF COMPLEX CASES

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FROM THE EDITOR



Hospital for Special Surgery is recognized as the leading center for the diagnosis and treatment of musculoskeletal conditions. Achieving the highest level of care is the result of collaboration between specialists dedicated to innovative research, relevant patient centered outcome measures and rendering the most effective techniques of care. The editorial intent of *Grand Rounds from Hospital for Special Surgery/ Management of Complex Cases* is to not only highlight sound principles in musculoskeletal care, but also to emphasize the close collaboration of exceptional specialists that is essential to successful outcome.

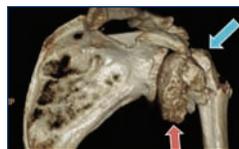
In this volume, David Dines describes a case of reverse total shoulder arthroplasty for proximal humerus fracture with underlying osteoarthritis. Dr. Dines' radiology colleagues provided computed tomography with 3-D reconstruction to fully demonstrate the complexity of this injury and develop a successful surgical plan. In the second case, Tom Sculco worked closely with medical colleagues, radiologists and biomedical implant design specialists to perform a custom total hip replacement in a patient with severe polycystic fibrous dysplasia, enabling this 59-year-old man to walk free of pain.

The anesthesiologists at HSS are unrivaled in their innovations and clinical skills. The success of thousands of surgical procedures each month, from the routine to the most challenging, ultimately depends on superbly managed anesthesia. However, understanding the unique physiological variations in each individual patient, these specialists are constantly vigilant for the unexpected. Bill Urmey's case of idiosyncratic reaction to propofol after hip arthroscopy describes a rare unforeseen challenge arising from "routine" anesthesia.

You may view this publication on www.hss.edu/complexcases, where you will find additional images and references as well as links to related articles. We hope you find these cases to be of interest and the principles presented informative. Comments are always welcome at complexcases@hss.edu.

— Edward C. Jones, MD, MA, Assistant Attending Orthopaedic Surgeon

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Reverse Total Shoulder Arthroplasty for Proximal Humerus Fracture with Underlying Osteoarthritis

Case presented by David M. Dines, MD, Samuel A. Taylor, MD, Joshua S. Dines, MD, and Dean G. Lorich, MD

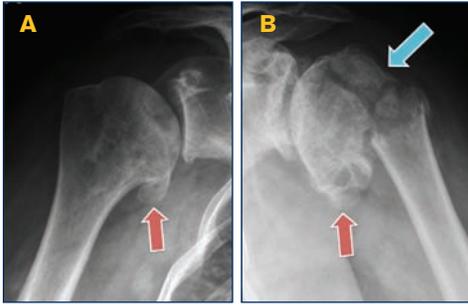


Figure 1A and 1B: AP right shoulder (A) demonstrating degenerative inferior osteophyte (red arrows) and cystic changes. AP left shoulder (B) with degenerative changes, poor bone quality, and significantly comminuted tuberosities (blue arrow).



Figure 2: CT with 3-D reconstruction demonstrating degenerative changes (red arrow) and comminuted tuberosities (blue arrow).



Figure 3: Suture repair of the tuberosities.



Figure 4: Primary non-cemented reverse total shoulder prosthesis improves functional outcome in the setting of significant risk factors for tuberosity healing.

CASE REPORT: A 70-year-old right hand dominant woman presented to HSS for management of a left proximal humeral fracture. The injury was sustained 10 days prior to presentation when she fell down a flight of stairs. Concomitant injuries were limited to facial lacerations. Of note, the patient reported bilateral shoulder pain prior to the fall with progressively decreasing range of motion and a grinding sensation in the joints.

Physical examination revealed significant resolving swelling and ecchymosis about the left shoulder as well as dependent edema in the left upper extremity. Range of motion was full in the ipsilateral elbow and wrist, but pain limited motion in the shoulder. The patient was neurovascular intact distally. Axillary nerve function was preserved. Examination of the contralateral shoulder was significant for severely limited forward flexion and external rotation, as well as harmonic crepitus.

Preoperative imaging studies included both plain radiographs of bilateral shoulders (Figure 1) and computed tomography with 3-dimensional reconstruction (Figure 2) of the injured side demonstrating a comminuted 4-part left proximal humeral fracture with significant underlying glenohumeral osteoarthritis represented by cystic degenerative changes and large inferior humeral osteophytes. Of particular importance was the substantial comminution of the proximal humeral tuberosities and poor bone quality.

The patient was treated at two weeks following her trauma with an early primary reverse total shoulder arthroplasty and tuberosity repair (Figures 3 and 4). She did well postoperatively, returning to her previous level of activity including caring for her grandson. Follow-up examination at six months demonstrated painless forward flexion, abduction, and external rotation 140, 120, and 55 degrees respectively. The patient was so happy with her results that she subsequently underwent a standard total shoulder replacement (TSR) on the contralateral side with similarly pain-free function at early follow-up.

DISCUSSION: This patient's underlying glenohumeral arthritis and significant tuberosity comminution guided the decision to perform a reverse total shoulder arthroplasty for the proximal humerus fracture. In a patient such as this, the surgeon faces two main treatment decisions: (1) open reduction with internal fixation (ORIF) versus arthroplasty for fracture and (2) if arthroplasty is chosen, hemiarthroplasty versus reverse total shoulder arthroplasty. Standard TSR requires an intact rotator cuff. In this patient's case, the tuberosity comminution was such that there was a high risk of tuberosity nonunion which would in turn result in rotator cuff insufficiency, hence, standard TSR was not considered.

When considering ORIF or arthroplasty, it is important to choose the surgical procedure most likely to yield the best results and bearing in mind that the first operation has the best chance of success. This is particularly relevant in patients with underlying symptomatic glenohumeral osteoarthritis. ORIF, even for the most skilled surgeons, fails to address pre-injury degenerative symptomatology while simultaneously making a future arthroplasty intervention more challenging secondary to scar, anatomic distortion, and hardware placement. Primary arthroplasty (at less than four weeks) yields superior functional results when compared with delayed secondary arthroplasty (1, 2). Delayed arthroplasty for malunion yields suboptimal results and has high complication rates (3-5). In a study of 71 patients with proximal humeral malunions treated with shoulder replacement, the authors concluded that greater tuberosity osteotomy was the most significant contributor to poor functional outcome (3).

Tuberosity healing in an anatomic position to the humeral shaft enables rotator cuff function and is also critical to patient satisfaction and functional outcome following primary shoulder hemiarthroplasty for fracture. Boileau and colleagues (6) reported that final tuberosity malpositioning occurred in 50 percent of patients with hemiarthroplasty

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Total Hip Replacement for Fibrous Dysplasia

Case presented by Thomas P. Sculco, MD, and Lazaros A. Poultsides, MD, MSc, PhD



Figure 1: Preoperative AP pelvis (A), AP (B) and lateral (C) views of the left femur demonstrate osteoarthritis in both hips. On the left, there is a Shepherd's crook deformity with varus femoral neck shaft angle and elongated expansile lesions with 'ground glass' matrix.

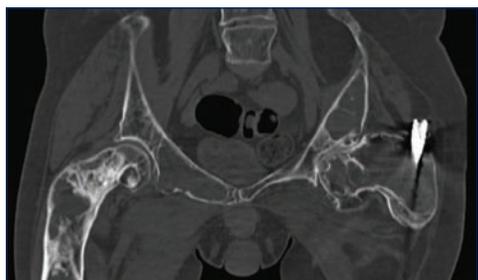


Figure 2: CT scan (coronal plane) demonstrates bilateral coxa vara deformity, diffuse expansile lesions with homogeneous matrix in the iliac wings, sacrum, acetabulum, and femurs, consistent with polyostotic fibrous dysplasia.

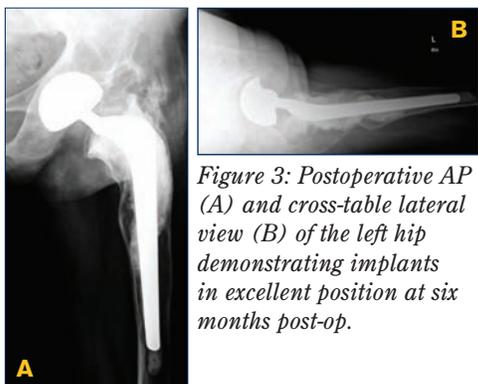


Figure 3: Postoperative AP (A) and cross-table lateral view (B) of the left hip demonstrating implants in excellent position at six months post-op.

CASE REPORT: A 59-year-old male presented to HSS for chronic and progressive left hip pain. The patient had a history of polyostotic fibrous dysplasia (McCune–Albright syndrome) and the diagnosis was made at age six based on a biopsy of the tibia. He had multiple surgeries on his left femur for significant acquired deformity, including osteotomies and a Kuntscher intramedullary nailing at age 22. His disease has affected other skeletal areas including his left forearm where he underwent surgery for a pathologic fracture at the age of 10. He also had a left non-displaced tibial plateau fracture that healed with immobilization. The patient was diagnosed with a pituitary adenoma and acromegaly. He received irradiation with good results and was still receiving therapy for high levels of prolactin, and human chorionic gonadotropin (hCG) for hypogonadism at the time of initial consultation. Upon presentation, he walked with limp and used two axillary crutches for ambulation. He stood with a planovalgus deformity of both hindfeet, and because of leg length inequality he used a 6.5cm lift on the left side. Physical examination of the left hip revealed a flexion contracture of 30 degrees with flexion to 90°, 30° abduction, 20° adduction, 20° internal and 0° of external rotation. His neurovascular exam was normal.

Plain radiographs (AP pelvis, AP and lateral of the left femur) demonstrated osteoarthritis in both hips, severe on the left side, and a Shepherd's crook deformity with an associated varus alignment of the left femoral neck shaft angle. A Kuntscher nail was present transfixing a healed fracture deformity of the proximal left femur (Figures 1A, 1B and 1C). CT scan of the pelvis showed diffuse expansile lytic lesions of the iliac wings, sacrum, acetabulum, femurs, findings consistent with bilateral polyostotic fibrous dysplasia, with bilateral coxa vara deformity, severe on the left side resulting in a leg-length discrepancy of 6.5cm (Figure 2).

Because of the patient's severe pain and disability left total hip arthroplasty

(THA) was recommended. Given the shape of the left proximal femur, a custom femoral implant was manufactured. The patient had adequate acetabular bone for a standard acetabular component. The posterolateral approach was utilized. The IM nail was loose and was removed easily. A left 60mm Anatomic Dual Mobility (ADM) cup was placed without supplement screw fixation, in order to reduce the risk of dislocation. The proximal femoral canal was very dilated and fibrotic. A large amount of fibrous tissue was removed leaving a thin shell of bone in the greater trochanter and femoral neck area. Given the varus proximal femoral deformity, the starting reamer had to be lateralized into the greater trochanter significantly in order to ream directly into the canal. Intraoperative X-ray confirmed the correct placement of the reamers and trial broaches. The final custom-made broach demonstrated excellent fit and fill of the proximal femoral metaphysis. The custom polished stem (13.5mm X 225mm) was cemented into the femoral canal, and a 28mm/+6mm cobalt chrome head and the associated polyethylene insert (28mm ID for a 60mm shell) were assembled and placed onto the stem trunion and reduced providing excellent stability throughout the range of motion. The defect in the greater trochanter was filled with demineralized bone matrix. A standard posterior repair was performed through drill holes in the greater trochanter. Percutaneous adductor tenotomy was performed after closure to release a severely contracted adductor tendon.

Postoperatively the patient was toe-touch weight bearing for six weeks and then as tolerated. His hospital course was uncomplicated and he was discharged on POD 8. The pathology report confirmed the diagnosis of polyostotic fibrous dysplasia. He returned for his three month follow-up and was walking pain free (mild limp) using a cane. At six months he was doing very well and the follow-up X-ray demonstrated the components in excellent position (Figures 3A and 3B).

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Idiosyncratic Reaction to Propofol After Hip Arthroscopy

Case presented by William F. Urmev, MD, Bryan T. Kelly, MD, Mandip Singh Kalsi, MD, and Travis G. Maak, MD

CASE REPORT: A 19-year-old female collegiate sprinter presented with the chief complaint of right hip pain. The location of the pain was anterior, groin, and posterior; with no mechanical symptoms. She was able to walk on level ground approximately 10 minutes without pain. Physical therapy and various chiropractic manipulations had resulted in no change in symptoms. An intraarticular steroid injection provided transient pain relief followed by full return of symptoms. The patient and her family denied any hip problems as a child. There was no related trauma or significant past medical or surgical history. The patient's only medication was oral contraception.

Subsequent evaluation revealed physical findings consistent with a labral tear in the right hip which was confirmed on Magnetic Resonance Imaging. Arthroscopic evaluation and treatment was proposed.

Hip Arthroscopy, Intra and Postoperative Course

The patient received a combined spinal-epidural anesthesia with intravenous sedation. The spinal was administered using 60mg of Mepivacaine, and an epidural dose of 10cc of 2% lidocaine was injected 30 minutes before transfer to the PACU.

Intravenous sedation consisted of 5mg of midazolam, a propofol bolus of 70mg (10mg/ml) with infusion of 25 to 30ml/hr over the duration of the procedure. She also received a total of ketamine 50mg and dilaudid 2mg. Hip arthroscopy and labral repair was uneventful with an approximate surgical duration of 2.5 hours. Estimated blood loss for the procedure was minimal and the patient received 800 cc of IV lactated ringers solution intraoperatively. At completion of surgery, patient remained sedated; however, upon transfer to the PACU, the patient was awake and responsive.

Ninety minutes after arrival in the PACU, the patient developed tonic-clonic movements and was unable to follow commands. Vital signs were stable and blood glucose levels were normal. Forty-five minutes later, the patient responded appropriately to her parents, yet continued to drift off to sleep. An hour later, during the orthopaedic fellow post-operative

assessment, the patient once again displayed dystonic reactions and myoclonic movements. Vital signs continued to remain stable, and all labs were within normal limits.

Further workup and evaluation consisted of a neurology consult and a negative head CT scan. The medical intensive care team followed the patient closely with continuous EEG monitoring. Overnight, the patient remained stable, sleeping, and awakening to verbal stimuli with increasing responsiveness and orientation. There were no further myoclonic or dystonic episodes. The following morning, the patient was alert, fully oriented with normal neurological exam and discharged home. Subsequent recovery was uneventful with no further neurological symptoms.

DISCUSSION: Initial differential diagnosis for this patient's symptomatology focused on underlying neurologic, metabolic/electrolyte abnormality, and medication related etiology. Possible neurological causes for the patient's symptomatology included undiagnosed seizure disorder, status epilepticus, post-ictal state, cerebrovascular accident, and spontaneous intracranial bleed. The patient's physical exam and negative head CT ruled out many of these diagnoses. Continuous EEG monitoring was considered to rule out underlying seizure disorder, but was felt unwarranted by neurology given the clinical presentation. Metabolic disorders and electrolyte abnormalities were considered and ruled out with normal laboratory findings. Medication related etiologies considered included ketamine emergence phenomenon, local anesthetic toxicity, and opioid overdose. Because the doses were significantly below toxic levels, these diagnoses were effectively ruled out.

A propofol neuroexcitatory reaction was also strongly considered and felt to be the most likely diagnosis given the waxing and waning nature of the symptoms, the negative imaging, laboratory workup, negative past medical neurological history, and, most importantly, evaluation by an attending anesthesiologist who had seen a similar presentation in a patient with propofol neuroexcitatory reaction.

Propofol's dominant neurological effect is neuro-suppressive. However, propofol can also induce neuroexcitatory reactions including seizures, convulsions, unconsciousness, and dystonia, which most often manifest during induction or emergence (1). While the mechanism for these neuroexcitatory reactions is unknown, it has been suggested that it may be due to increased potency at subcortical centers, producing an imbalance in excitatory-inhibitory effect, resulting in inhibition of calcium channels that may reduce transmitter release from inhibitory neurons. The patient population most affected by these propofol induced neuroexcitatory reactions is young, female and day-surgery patients (2).

Case reports of propofol neuroexcitatory reactions vary tremendously in the dose of propofol administered, the duration of the reaction and therapies utilized, with no definitive therapy as yet elucidated (3), (4). In this particular case, we were fortunate to have an attending anesthesiologist who had seen a similar presentation in a patient with propofol neuroexcitatory reaction and was confident given the negative workup that this patient's symptomatology was most consistent with propofol induced neuroexcitation. ■

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for displaced fractures and was highly associated with unsatisfactory results, prosthesis malalignment, lost range of motion, and pain. More recently, Krishnan et al (7) described improved tuberosity healing (and outcomes) in patients treated with a fracture specific humeral component (79%) compared with those treated by a conventional stem (66%).

Functional outcome following shoulder hemiarthroplasty highly correlates with tuberosity osteosynthesis, but to a much lesser degree for reverse total shoulder arthroplasty. Sirveaux et al. (8) compared outcomes for each intervention and stratified results based upon tuberosity union. If the tuberosities healed, Constant-Murley Scores were similar in the two groups, but the hemiarthroplasty group out-performed the reverse with regard to active forward flexion and external rotation. If tuberosities did not heal, however, the reverse prosthesis proved superior with regard to both constant score and active forward flexion. With this in mind, factors that influence the tuberosities' propensity for healing – such as degree of comminution and bone quality must be considered.

This case illustrates the multifactorial decision making process in a 70-year-old woman with a comminuted proximal humerus fracture in the setting of underlying glenohumeral arthritic changes and poor bone quality. In such patients, arthroplasty enables the surgeon to address the pre-existing pathoanatomy as opposed to simply fixing the fracture. The choice of prosthesis (hemiarthroplasty versus reverse total shoulder arthroplasty) remains controversial. Tuberosity healing, however, clearly impacts outcomes in patients treated with hemiarthroplasty. Therefore, one should consider the use of a reverse prosthesis in patients with significant risk factors for tuberosity nonunion. ■

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DISCUSSION: Fibrous dysplasia is a developmental anomaly of bone formation that accounts for approximately 7 percent of benign bone tumors (1). It exists in a monostotic or polyostotic form, commonly occurs in the proximal femur, and may require THA for its management in a select group of patients (2). THA not only aims to improve pain and function, but also to correct residual peri-articular deformity. Long-term fixation of the femoral component is of concern in such patients. The results of THA in patients with this disorder are significantly limited in the literature.

Sierra et al (3) reported the results of THA in patients with fibrous dysplasia, with an emphasis on the surgical technique and implants used during the primary and revision hip reconstructions. The study group was comprised of seven men and four women (one bilateral) with an average age at primary THA of 44

years (range, 23-66 years), and an average follow-up of 15.7 years (range, 2-30 years). Four patients had the monostotic form and seven patients had the polyostotic form. A cemented stem was used in seven hips and cementless stem in the remaining five. Seven hips in six patients were revised for loosening of components at an average of 12.5 years, and two of these were re-revised for the same reason. Fixation failure of a cementless femoral component led to early revision in three hips. The surgical outcomes for patients with monostotic were superior to those with polyostotic disease.

There has been an increasing interest in custom, cemented, non-modular femoral stems for patients with fibrous dysplasia in order to accommodate the proximal femoral anatomy, and not to rely on the local limited potential for bone ingrowth for fixation. Advances in imaging and biomedical engineering allow the accurate design and manufacture of these implants that will provide excellent fit and restore the leg length, offset and center of rotation.

An alternative highly cross-linked polyethylene-on-metal bearing surface was utilized in this case. Because of the atrophy of left abductor musculature, likely due to disuse, there was a higher risk for dislocation. Therefore, an anatomic dual mobility cup was used which offers improved hip stability and increased range of motion, because of the large diameter polyethylene insert, and the anatomic rim shape of the cup, respectively. In addition, the primary articulation at the internal bearing along with the use of a highly cross-linked polyethylene liner reduces polyethylene wear that may help to prolong the life of the implant given the patient's young age (4).

This case illustrates the challenge of managing patients with fibrous dysplasia. Preoperative planning is of paramount importance. In this case, a cemented custom implant was utilized in order to optimize femoral fixation and achieve a predictable fit, as well as restore length, offset and adjust the appropriate anteversion. Potential complications of modularity and failed cementless fixation were therefore avoided. Nevertheless, the long-term outcomes and cost-effectiveness of custom-made, non-modular femoral components in patients with fibrous dysplasia are yet to be determined. ■

References continued on back page



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CASE 2 CONTINUED

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