I'm not robot

reCAPTCHA

Continue

Right femoral condyle

Surgical Technique Volume 16 • June 2015 A Novel Technique for Fixation of a Medial Femoral Condyle Fracture using a Calcaneal Plate Eric C. Loesch, BS, Ankur B. Bamne, MBBS, MS, John Y. Kwon, MD Disclosure Information John Y. Kwon, MD Paragon 28: IP royalties Trimed: IP royalties ©2015 by The Orthopaedic Journal at Harvard Medical School PDF Open reduction and internal fixation using conventional and locked plates is the standard of care for femoral condylar fractures in an attempt to restore articular congruity. We report the use of a calcaneal plate as a novel technique for the fixation of a large medial collateral ligament avulsion fracture associated with a medial femoral condyle fracture. A calcaneal plate can be easily contoured to fit the femoral condyle, allows for fixation of fracture fragments by providing a washer effect and allows a wide array of screw placement options. Unicondylar fractures of the distal femur are rare injuries accounting for less than 1% of all femoral fractures1, 2 and are partial articular fractures. The intact condyle is in continuity with the femoral metaphysis.3 These unusual injuries may be overlooked in the acute trauma setting considering they are often associated with other injuries in the ipsilateral extremity. Open reduction and internal fixation of unicondylar femur fractures is the accepted treatment of choice and provides overall excellent long-term results.4 Multiple fixation techniques have been advocated for fixation for articular fractures of the distal femur. Dynamic condylar screws, lag screw fixation as well as conventional and locked plates are the modalities commonly used for supracondylar fractures and fractures of the lateral femoral condyle. Most of the currently available femoral condylar plates are pre-contoured to the lateral femoral condyle. Hence fixation of medial femoral condyle fractures is amenable only to screw fixation or by the use of various plate options not specifically designed for this purpose. We present a case of medial femoral condylar fracture,(AO [Arbeitsgemeinschaft für Osteosynthesefragen] classification 33-B2) fixed with a calcaneal plate. The patient provided written informed consent for print and electronic publication of the case report. The patient is a 24 year old male who sustained an accident on a jet ski while on a cruise vacation injuring his right knee. He was subsequently transferred to our institution for further care. He complained of isolated knee pain, difficulties with range of motion and was unable to bear weight. Physical examination revealed a swollen, tender right knee with extensive ecchymosis. Range of movement could not be ascertained because of pain and he was neurovascularly intact. Radiographs revealed a fracture of the medial femoral condyle (Figure 1). Given the diagnosis of a displaced, intra-articular fracture of the distal femur, the decision was made to proceed with operative reduction and fixation. (A) AP and (B) Lateral radiograph demonstrating medial femoral condyle fracture All Rights Reserved. Permission For Use Required. The patient was taken to the operating theatre and placed in the supine position. He was prepped and draped in normal sterile fashion. An antero-medial approach to the distal femur was performed. The vastus medialis was elevated anteriorly. The fracture hematoma was irrigated. The displaced medial femoral condyle was reduced and provisionally fixed in place with multiple 1.6mm K-wires after confirming articular reduction clinically and radiographicaly. K-wire joysticks were used to help guide the reduction, and a large pointed tenaculum was used to anatomically reduce and compress the primary fracture line. The medial femoral condyle was fixed using three 4.0mm partially threaded cancellous lag screws (Figure 2). Intraoperatively, a large sleeve of bone on which the medial collateral ligament was attached was identified that was not well appreciated on preoperative radiographs (Figure 3). Lateral radiograph of medial femoral condyle fixation using three 4.0mm partially threaded cancellous lag screws All Rights Reserved. Permission For Use Required. AP view of the knee demonstrating medial femoral condyle avulsion fragments All Rights Reserved. Permission For Use Required. The medial avulsion fracture, which was comminuted into several fragments, was reduced and fixed in place with K-wires. In order to get a washer type of buttressing effect, a Synthes calcaneal locking plate (West Chester, PA) was contoured to sit flush against the medial femoral condyle. Excessive tabs were removed and the plate was fixed with multiple 4.0mm cancellous screws (Figure 4). After fixation was completed, ligamentous stability of the knee was assessed and there was no medial gapping noted with valgus stress. The wound was irrigated and closed in layers. Calcaneal locking plate utilized for fixation of medial femoral condyle avulsion fragments All Rights Reserved. Permission For Use Required. At six-month follow-up, the patient was weight-bearing as tolerated with knee range of motion from 0-100 degrees. He was doing well but reported stiffness to flexion and radiographs revealed the presence of heterotopic bone in the area of the MCL (Figure 5). A knee manipulation under anesthesia was performed shortly thereafter, and range of motion at final followup was 125 degrees of flexion with no extension lag. At 1-year follow-up he had no pain, had knee motion symmetric to the normal side and was able to perform recreational activities without difficulty. He reported no problems with the plate or plate prominence. (A) AP and (B) Lateral radiographs demonstrating a healed fracture but with heterotopic bone formation medial soft tissues All Rights Reserved. Permission For Use Required. Open reduction and internal fixation is the treatment of choice for displaced distal femoral fractures. The primary goals of surgery are to restore articular congruity and anatomic alignment. Stable fixation of articular fragments allows for early knee motion which prevents stiffness and facilitates recovery. In the absence of specific implants for the fractures of the medial femoral condyle, we used a calcaneal plate which appears to be a viable option for this kind of fracture pattern. Advantages of the calcaneal plate for this application include plate strength yet malleable nature, low profile and easy contour ability. This allows the calcaneal plate to be easily applied in a buttress fashion to the femoral condyle reducing the chance of prominent hardware. Multiple screw holes of the calcaneal plates allow various options of screw placement depending upon the fracture pattern. Hohman et al. described 2 cases in which calcaneal plates were utilized for the fixation of both medial and lateral condylar fractures.5 This technique of fracture fixation however is only indicated in unicondylar fractures. Complete articular fractures and those with metaphyseal comminution require different methods of fixation. 1. McCarthy JJ, Parker RD. Arthroscopic reduction and internal fixation of a displaced intraarticular lateral femoral condyle fracture of the knee. Arthroscopy. 1996 Apr;12(2):224-7. 2. Smith EJ, Crichlow TP, Roberts PH. Monocondylar fractures of the femur: a review of 13 patients. Injury. 1989 Nov;20(6):371-4. 3. Manfredini M, Gildone A, Ferrante R, Bernasconi S, Massari L. Unicondylar femoral fractures: therapeutic strategy and long-term results. A review of 23 patients. Acta Orthop Belg. 2001 Apr;67(2):132-8. 4. Ostermann PA, Neumann K, Ekkernkamp A, Muhr G. Long term results of unicondylar fractures of the femur. J Orthop Trauma. 1994;8(2):142-6. 5. Hohman DW, Affonso J. Calcaneal plate fixation of distal femoral fractures. Am J Orthop (Belle Mead NJ). 2012 Mar;41(3):140-3. Page 2Surgical Technique Volume 16 • June 2015 Technical Tip for Prosthesis of Antibiotic-Loaded Acrylic Cement (PROSTALAC) Use for Infection after Shoulder Arthroplasty Robert Spang, MD, Brandon Beamer, MD, Amit Sood, MD, Jon J.P. Warner, MD Disclosure Information Jon J.P. Warner, MD American Shoulder and Elbow Surgeons: Board or committee member Arthrex, Inc: Other financial or material support Arthrocare: Other financial or material support Breg: Other financial or material support DJ Orthopaedics: Other financial or material support IMASCAP COMPANY: Stock or stock Options Journal of Shoulder and Elbow Surgery: Editorial or governing board Mitek: Other financial or material support Orthospace: Stock or stock Options San Diego Shoulder Institute: Board or committee member Scientific Advisory Board of Steadman-Phillipon Institute: Board or committee member Smith & Nephew: Fellowship Support: Other financial or material support Tornier: IP royalties; Paid consultant Tornier: Royalty on Rotator Cuff Implant: Other financial or material support ©2015 by The Orthopaedic Journal at Harvard Medical School PDF BACKGROUND Shoulder arthroplasty procedures have generally excellent clinical outcomes, but infection following shoulder arthroplasty continues to be a difficult problem both diagnostically and therapeutically. Two-stage reimplantation with use of a temporary Prosthesis of Antibiotic-Loaded Acrylic Cement (PROSTALAC) (DePuy, Warsaw, Indiana) is the standard treatment for chronic infection. Optimizing surgical technique regarding cement spacer is a priority, but detailed technical descriptions are sparse. METHODS The senior author's original technique for creation of a PROSTALAC implant for shoulder infection following arthroplasty is outlined and illustrated. This includes the use of a custom 44-mm hemispherical mold and a 3.5-mm limited contact dynamic compression plate pre-bent to 125 degrees to mimic the anatomic neck-shaft angle of the humerus. A new technical tip is presented whereby a standard culture tube is injected with antibiotic laden cement followed by plate insertion into the cement-filled tube, thus creating an improved prosthesis with delivery of antibiotics into the humeral canal. RESULTS A new technical tip is described to improve the creation and insertion of a PROSTALAC implant for patients following infection of shoulder arthroplasty. CONCLUSION PROSTALAC implants have been successfully used for the treatment of shoulder arthroplasty infections. Implant design and surgical technique can be enhanced to potentially improve outcomes. Shoulder arthroplasty procedures have increased dramatically over the last several decades with generally excellent clinical outcomes and satisfactory long-term survival rates.1 However, infection following shoulder arthroplasty continues to be a difficult problem presenting challenges both diagnostically and therapeutically. As opposed to prosthetic infections of the hip and knee, treatment algorithms are not well defined and shoulder surgery textbooks contain little information concerning the therapy of infected shoulder replacements.2 The prevalence of infection ranges from approximately 1% to 5%, with a higher rate associated with revision arthroplasty.3-5 Two-stage revision with use of a temporary Prosthesis of Antibiotic-Loaded Acrylic Cement (PROSTALAC) (DePuy, Warsaw, Indiana) is the standard treatment for chronic infection (defined as that persisting for more than four weeks postoperatively) at the site of knee and hip arthroplasty.6 The PROSTALAC implant elutes a high concentration of local antibiotics while maintaining appropriate periarticular soft-tissue tension and preventing capsular and ligament contracture. The quality of apposition between bone-cement interfaces is important in determining the longevity and stability of an antibiotic spacer as well as a cemented prosthesis. Optimizing surgical technique regarding cement spacer creation and implantation is a priority because the prosthesis' surface properties and shape impact stability.7 Detailed technical descriptions of PROSTALAC use in the shoulder are sparse but potentially useful for the surgeon faced with treating this challenging problem. Here we share a technical tip regarding the creation of a shoulder PROSTALAC implant, illustrating an evolution of the senior author's preferred technique. The senior author's original technique used a 3.5-mm limited contact dynamic compression plate (LC-DCP) pre-bent to approximately 125 degrees to mimic the anatomic neck-shaft angle. The length was made to be similar to a broach trial. The antibiotic cement was mixed in the standard fashion and was placed in a custom 44-mm hemispherical mold (Figure 1). Cement was made with a combination of antibiotic powder (typically 2 g of gentamicin, 3 g of tobramycin, and 1 g of vancomycin per 40-g bag of cement) and Simplex cement (Stryker, Kalamazoo, Michigan) (typically three 40-g bags with four polymethylmethacrylate monomers). The pre-bent plate was then placed and held in the hemispherical mold during cement hardening. This construct was then subsequently inserted with the hemispherical spacer component articulating with the glenoid surface, and the plate inserted directly into the canal. No cement was inserted surrounding the plate within the canal, and no additional fixation of plate to bone was created (Figure 2). Placement of 3.5-mm limited contact dynamic compression plate into hemispherical mold All Rights Reserved. Permission For Use Required. AP radiograph of right shoulder PROSTALAC placement using previous technique All Rights Reserved. Permission For Use Required. While this technique has been used with success, there is the potential for an improved success rate with the addition of antibiotic cement surrounding the distal portion of the plate to improve plate coverage and possibly improve stability. This new technical tip is described here. We begin with a similar setup, creating the hemispherical spacer via custom 44-mm mold. While this cement is setting, a standard sterile culture tube is obtained. After curetting and irrigating the humeral canal, the culture tube is inserted into the canal to judge the length of the PROSTALAC stem. The tube is then marked at its top insertion point. This gives the depth of the planned cement plug. A second batch of cement is mixed. The inside surface of the culture tube is wiped with xeroform to prevent adhesion of cement, and the tube is then cut at the previously marked point. Then, while the cement still has low viscosity, it is placed into a 10-cc syringe and injected into the culture tube. The 3.5-mm plate (with attached hemispherical spacer) is then inserted into the cement-filled tube. The width of the 3.5-mm LC-DCP is the same as the inner diameter of the culture tube, creating a flush fit of the edges of the plate with the tube. Once the cement is doughy, it is then added proximally by hand to cover the entirety of the plate. Once the cement has hardened, the tube mold is incised with a 10-blade and peeled off the stem. The final PROSTALAC construct (Figures 3 and 4) is then inserted into the canal using an impactor as needed. No incidences of fracture have been noted with this gentle impaction. If the PROSTALAC implant is too large to fit within the humeral canal, a burr can be used to carefully remove small amounts of bone within the canal to allow the PROSTALAC to be fully seated. Care must be taken to avoid removing excessive bone or perforating the cortex. Intraoperative photograph of PROSTALAC spacer created using novel technique All Rights Reserved. Permission For Use Required. Postoperative (A) AP and (B) Lateral radiographs following placement of PROSTALAC spacer for right shoulder periprosthetic infection All Rights Reserved. Permission For Use Required. Studies investigating outcomes on the treatment of infection following shoulder arthroplasty are limited and do not show the generally favorable outcomes seen with treatment of infections following hip and knee arthroplasty. The use of PROSTALAC for treatment of infection following shoulder arthroplasty has been shown to be beneficial. Early studies of PROSTALAC had shown mixed results,8,9 and some have suggested that outcomes of single-stage reimplantation of reverse total shoulder replacement are equivalent to two-stage reimplantation.9 However, in the largest study on this PROSTALAC use, Jawa and Warner showed that infection was initially eradicated in twenty-three (82%) of twenty-eight patients, more than half had mild or no pain, and 43% of patients declined a second-stage procedure because of acceptable function and pain relief.10 It should be noted that this study employed the first generation technique of having antibiotic laden cement in the joint only, not in the humeral canal. In some cases rotation of the PROSTALAC implant occurred due to lack of intramedullary stability; thus our recent modification seems to give more immediate rotational stability than the prior technique used by the senior author. Prior studies share limited information of technical details. Jerosch and Schneppenheim state that "a temporary spacer was prepared using antibiotic-loaded cement and additionally stabilized (e.g. by Harrington rods or similar devices)".11 In the aforementioned study, Jawa and Warner describe and illustrate their prior technique of using PROSTALAC to create an antibiotic cement implant. In that study, three spacers were made without any additional structural support, fourteen were constructed around a one-third tubular plate, and eleven were made around a 3.5-mm limited contact dynamic compression plate. They found that PROSTALAC implants can fracture or dislocate, which was observed in four of their patients (only one of whom needed a revision).10 All three fractures occurred around implants with a one-third tubular plate, prompting a switch to a limited contact-dynamic compression plate scaffold. Antibiotics are eluted from the surface and pores of cement as well as from the microcracks within it. While elution characteristics vary by brand, the amount of antibiotic delivered also depends on the overall surface area of the implant. As such, a more fully-coated plate would be expected to elute more antibiotic. One limitation of this technique is that the same culture tube is used regardless of patient humeral canal size, and the canal was not reamed. As such there may be size mismatch between the PROSTALAC and canal. Additional studies will be important to further investigate outcomes of shoulder infections treated with PROSTALAC using this technique. Use of a PROSTALAC implant for possible two-stage reimplantation is a more conservative approach that has been well-studied and has been found to yield acceptable outcomes with hip and knee arthroplasty in terms of infection eradication and restoration of function. It may also serve as an acceptable permanent treatment. This new technical tip is important in that it achieves complete implant coverage with antibiotic cement, and may improve infection control by addressing bacteria which exist in the canal. In addition, the new construct may be more mechanically stable. This may be significant particularly for those patients for whom the PROSTALAC implant ultimately serves as their final implant. 1. Torchia M, Cofield R, Settergren C. Total shoulder arthroplasty with the Neer prosthesis: long-term results. J Shoulder Elbow Surg. 1997 Nov-Dec;6(6):495-505. 2. Rockwood C, Matsen F, et al. The Shoulder. 4th ed. Philadelphia (PA): Saunders; 1998. 2 vol. 3. Sperling J, Kozak T, Hanssen A, et al. Infection after shoulder arthroplasty. Clin Orthop Relat Res. 2001 Jan;(382):206-16. 4. Schwyzer H, Simmen B, Gschwend N. Infection following shoulder and elbow arthroplasty. Diagnosis and therapy. Orthopade. 1995 Aug;24(4):367-75. 5. Cofield R, Edgerton B. Total shoulder arthroplasty: complications and revision surgery. Orthopade. 1995 Aug;24(4):367-75. 6. Cui Q, Mihalko W, Shields J, et al. Antibiotic-impregnated cement spacers for the treatment of infection associated with total hip or knee arthroplasty. J Bone Joint Surg Am. 2007 Apr;89(4):871-82. 7. Crowninshield R. Femoral hip implant fixation within bone cement. Operative Techniques in Orthopaedics 2001 11(4):296-299. 8. Coste J, Reig S, Trojani C, et al. The management of infection in arthroplasty of the shoulder. J Bone Joint Surg Br. 2004 Jan;86(1):65-9. 9. Cuff D, Virani N, Levy J, et al. The treatment of deep shoulder infection and glenohumeral instability with debridement, reverse shoulder arthroplasty and postoperative antibiotics. J Bone Joint Surg Br. 2008 Mar;90(3):336-42. doi: 10.1302/0301-620X.90B3.19408. 10. Jawa A, Shi L, O'Brien T, et al. Prosthesis of antibiotic-loaded acrylic cement (PROSTALAC) use for the treatment of infection after shoulder arthroplasty. J Bone Joint Surg Am. 2011 Nov 2;93(21):2001-9. doi: 10.2106/JBJS.J.00833. 11. Jerosch J, Schneppenheim M. Management of infected shoulder replacement. Arch Orthop Trauma Surg. 2003 Jun;123(5):209-14. Epub 2003 Apr 26. Page 3Surgical Technique Volume 16 • June 2015 Failure of Consolidation of a Peri-Articular Distal Tibial Bone Cyst Post Curettage due to Communication with the Ankle Joint Eric C. Loesch, BS, Ankur B. Bamne, MBBS, MS, John Y. Kwon, MD Disclosure Information John Y. Kwon, MD Paragon 28: IP royalties Trimed: IP royalties ©2015 by The Orthopaedic Journal at Harvard Medical School PDF Curettage and bone grafting is the standard of care for benign cystic bony lesions. We report a case in which bony consolidation of a peri-articular bony cyst failed to occur because of a communication with the ankle joint and seepage of synovial fluid into the cyst. We also describe a method to manage such a case. Peri-articular benign bone cysts may fail to consolidate following curettage and bone grafting due to communication with a joint. It is important to remove this communication with the joint to ensure adequate healing of the cyst. Tumors of the foot and ankle region are rare and constitute 1-2% of all bone tumors.1 Benign bone tumors are more common than malignant tumors with a ratio of 4:1.2 Benign lesions are slow growing and often present as an incidental finding. Curettage and bone grafting has been the standard of care for benign lesions if operative treatment is required. In some instances, peri-articular lesions may communicate with the joint making treatment much more difficult. Non-invasive modalities like CT and MRI are often used to assess such a possibility.3 We present the case of failed consolidation of a peri-articular benign cystic lesion due to communication with the ankle joint. The cyst was subsequently managed by osteotomy, excision of the communicating tract, bone grafting and fixation. A 25 year old female who initially sought consultation for an ankle sprain was diagnosed with a benign bony lesion in the right medial malleolus. She was treated with curettage and bone grafting at an outside institution, along with bracing and non-steroidal anti-inflammatory drugs (NSAIDs) post-operatively. Biopsy revealed a benign lesion. Several months after her surgery, the patient's pain persisted. Her symptoms were aggravated by standing and walking, with partial relief during rest. She subsequently underwent a second similar procedure but reported continued pain. She was referred to our institution due to persistent daily pain, disability, and difficulties with activities of daily living. On physical examination, she had a well-healed scar over the postero-medial aspect of her right ankle and tenderness over the antero-medial joint line of the same ankle. Both sensation and perfusion to the extremity were intact. Plain radiographs revealed a radiolucent lesion in the medial malleolus (Figure 1). Advanced imaging demonstrated a communication with the ankle joint through a bony defect in the subchondral bone of the distal tibia (Figure 2). The cyst cavity was incompletely consolidated. Mortise radiograph demonstrating distal tibial peri-articular bone cyst All Rights Reserved. Permission For Use Required. Coronal CT image demonstrating communication between the bone cyst and the tibiatalar joint space All Rights Reserved. Permission For Use Required. A routine ankle arthroscopy was performed first using standard antero-medial and antero-lateral portals. Mild synovitis was present. Over the medial aspect of the tibial plafond, there was fissuring noted of the cartilage. A defect was confirmed with a probe, which was consistent with findings on multiple imaging studies. It was determined that the cyst cavity was communicating with the joint through this defect in the articular cartilage and subchondral bone (Figure 3). Arthroscopic image demonstrating fissuring in the articular surface. Bent portion of the probe is within the communication. All Rights Reserved. Permission For Use Required. Before the medial malleolar osteotomy, a K-wire was drilled under fluoroscopic guidance from the proximal aspect of the medial malleolus into the joint to meet the probe at the level of the joint. This was the site of the osteotomy, which was planned in order to remove the communication between the cyst and the joint (Figure 4). Next, the osteotomy was hinged open, taking care to maintain the continuity of the deltoid ligament. The cyst cavity was curetted out with incomplete consolidation of previous bone graft material noted. Infection was ruled out via intra-operative frozen section. Autologous cancellous bone graft was then harvested from the proximal tibia, mixed with demineralised bone matrix and packed into the cyst cavity. The osteotomy was reduced and provisionally fixed with K-wires. Intra-articular reduction and articular congruity was confirmed by arthroscopy. Final fixation was done using a contoured one-third tubular plate and two 3.5mm cortical screws inserted across each fragment. Although the distal most screw appeared close to the ankle joint on intraoperative fluoroscopy, direct arthroscopic examination of the plafond revealed the screw to be extra-articular. Closure was performed in layers and a splint was applied. The patient remained non weight-bearing for 3 months following the procedure. Fluoroscopic image demonstrating the arthroscopic probe in place and a K-wire directed towards this communication for the planned osteotomy All Rights Reserved. Permission For Use Required. At her 6-month follow-up visit the patient was bearing full weight on the affected extremity and did not complain of any pain. She was able to resume her daily activities without any restrictions. On examination, there was no tenderness around the ankle and her range of motion was noted to be from 10 degrees dorsiflexion to 40 degrees plantarflexion. Radiographs revealed that the cyst was well-consolidated (Figure 5). (A) AP and (B) Lateral radiographs demonstrating a healed fracture but with heterotopic bone formation medial soft tissues All Rights Reserved. Permission For Use Required. Curettage and bone grafting is the standard of care for benign bony lesions. In such cases, the cyst is packed with bone graft in an attempt to consolidate the bony cavity. Less clear, however, is the management of a bone cyst communicating with the adjacent joint. In our case, perforation of the subchondral bone led to seepage of synovial fluid into the cavity. Synovial fluid is known to contain anti-angiogenic factors which inhibit bony healing.4 Whether the defect was a result of surgical trauma or secondary to the cyst perforating the joint is not known. Buchler et al. reported five cases of intra-osseous ganglion cysts communicating with the ankle joint via a chondral flap.5 In their series, they probed all of the lesions and each of the five cysts healed without complication. In our case, it was critical to obliterate the communication between the cyst and the joint in order to ensure adequate healing of the cyst. This was accomplished by executing the osteotomy in a way that removed this defect. Arthroscopic guidance of our k-wire allowed for a precise cutting guide for our planned osteotomy directly towards the lesion. Knowing that the defect was approximately 2 mm in diameter based on preoperative imaging and arthroscopic conformation, a saw blade with a 2 mm width was selected. When directed at the lesion, the removal of bone by the saw blade removed the defect and resulted in two congruent edges upon closure of the osteotomy. The articular congruity was ensured by arthroscopy and stable fixation of the osteotomy was achieved with internal fixation. In summary, the key to managing a peri-articular bone cyst is to identify the subchondral defect and communication with the joint, plan the osteotomy in such a way so as to remove the defect, check the articular congruity using arthroscopy, and ensure stable internal fixation. Advanced imaging such as CT or MRI (+/- arthrogram) is recommended and thin-cuts or 3-Tesla imaging may be required to identify suspected lesions. If lesions without known intra-articular communication fail to heal but no communication is visualized on advanced imaging, arthroscopy should be strongly considered to allow for direct visualization of the articular surface. 1. Mercuri M, Casadei R. Tumours in the foot. Foot Ankle Surg. 2002;8(3):175-190. doi:10.1046/j.1460-9584.2002.00322.x. 2. Ozdemir HM, Yildiz Y, Yilmaz C, Saglik Y. Tumors of the foot and ankle: analysis of 196 cases. J Foot Ankle Surg. 1997 Nov-Dec;36(6):403-8. 3. Battistelli JM, Djian JC, Lambrinidis M. [Demonstration of a communication between the ankle joint and the subchondral synovial cyst of the tibial medial malleolus. Contribution of noninvasive imaging]. Ann Radiol (Paris). 1995;38(3):145-9. 4. Banks HH. THE HEALING OF INTRA-ARTICULAR FRACTURES. Clin Orthop Relat Res. 1965 May-Jun;40:17-29. 5. Büchler L, Hosalkar H, Weber M. Arthroscopically Assisted Removal of Intraosseous Ganglion Cysts of the Distal Tibia. Clin Orthop Relat Res. 2009 Nov;467(11):2925-31. doi: 10.1007/s11999-009-0771-4. Epub 2009 Mar 10. Page 4Surgical Technique Volume 16 • June 2015 The "Magneto View": A Simple Method for Obtaining Intraoperative Axial Radiographs of the Calcaneus Erik T. Newman, MD, Brian A. Kelly, MD, and Edward K. Rodriguez, MD, PhD Disclosure Information Edward K. Rodriguez, MD, PhD MXO: Paid consultant MXO orthopedics: Stock or stock Options Synthes: Research support Zimmer: IP royalties ©2015 by The Orthopaedic Journal at Harvard Medical School PDF BACKGROUND Displaced, intra-articular fractures of the calcaneus are often treated with open reduction and internal fixation, which relies on appropriate intraoperative imaging. Of particular importance is axial imaging of the calcaneus, namely the Harris view. However, obtaining the Harris view intraoperatively can be a challenge. We describe the "Magneto view," a simple method for acquiring intraoperative axial views of the calcaneus. TECHNIQUE Open reduction and internal fixation of the calcaneus is performed via a lateral approach with the patient in the lateral decubitus position. Both the x-ray source and the image intensifier of a standard C-arm are sterilely draped. To obtain the Harris view, the C-arm is rotated such that the beam is oriented parallel to the floor. With the surgeon standing in the center of the "C," the base of the C-arm is advanced towards the posterior of the patient until the heel is adjacent to the x-ray source. Optimal axial imaging may then be obtained. CONCLUSION The "Magneto View" is a simple and versatile technique for the acquisition of accurate intraoperative axial imaging of the calcaneus. Fractures of the calcaneus are the most common fractures of the hindfoot, frequently presenting in young males following a high-energy axial load such as a fall from height.1 Two early observers, Cotton and Henderson, wrote in 1916 that "the man who breaks his heel bone is 'done', so far as his industrial future is concerned."2 Fortunately, surgical and imaging techniques have improved; for patients with significantly displaced intra-articular fractures, operative treatment with open reduction and internal fixation (ORIF) now leads to superior outcomes as compared with conservative management.3,4 Accurate reduction and fixation of the calcaneus relies on appropriate intraoperative imaging. In particular, proper screw placement into the sustentaculum tali, avoidance of iatrogenic injuries to neurovascular structures at the medial hindfoot, and correction of varus deformity can be aided with proper axial imaging, namely the Harris view. However, this radiographic view can be particularly difficult to obtain intraoperatively due to positioning and overlapping structures of the foot. We present the "Magneto view," a simple alternative method for obtaining high-quality intraoperative axial views of the calcaneus when performing ORIF through a standard lateral approach. The patient is placed in the lateral decubitus position on a radiolucent table, with the affected extremity up. The well leg is placed in a straight leg position. With the use of multiple blankets or a foam pad placed on top of the contralateral limb, a stable platform is created under the operative extremity on which to perform the procedure. The knee of the operative leg can be bent so that lateral imaging avoids capturing the well leg. All bony prominences are well padded. A single large C-arm fluoroscopy unit is required to obtain the necessary views. At the beginning of the procedure, the unit may be placed in any position convenient for the surgeon, but must be able to be maneuvered to the posterior side of the patient. We suggest that the base of the C-arm be brought in diagonally from the foot of the table. The monitor can be placed at the foot of the bed or anterior to the patient. Lateral images of the calcaneus can be obtained in the usual fashion, with the beam of the C-arm oriented perpendicular to the floor. When axial imaging is needed, the C-arm is positioned posterior to the patient. The "C" is rotated 90 degrees such that the beam is oriented parallel to both the floor and the long axis of the patient, with the x-ray source towards the head of the patient and the intensifier towards the foot. Both the x-ray source and image intensifier are draped in a standard sterile fashion (Figure 1). The operating surgeon stands in the center of the "C", between the x-ray source and intensifier, while the unit is advanced towards the patient (Figure 2); care is taken to maintain sterility at all times. To obtain the Harris view, the surgeon extends the hip and flexes the knee to place the heel adjacent to the x-ray source (Figure 3). The rotation of the "C" can be adjusted to optimize the view and obtain axial images at multiple angles, ensuring proper alignment of the heel and placement of the sustentacular screw (Figure 4). Both the x-ray source and the image intensifier must be sterilely draped All Rights Reserved. Permission For Use Required. C-arm orientation Beam is parallel to both the floor and the long axis of the patient. C-arm is brought in from the posterior side of the patient; the operating surgeon stands in the center of the "C". All Rights Reserved. Permission For Use Required. With the heel adjacent to the x-ray source, the C-arm may be rotated to adjust the angle of the axial view All Rights Reserved. Permission For Use Required. Sample intraoperative images demonstrating screw position All Rights Reserved. Permission For Use Required. High-quality intraoperative imaging is essential in the fixation of intra-articular calcaneal fractures. Of particular importance is the sustentaculum tali, which is typically maintained in an anatomic position with respect to the medial talus. Fluoroscopic visualization of this so-called anteromedial "constant" fragment with the Harris view allows for accurate placement of screws and avoidance of medial penetration which puts neurovascular structures at risk. Additionally, a quality axial image confirms correct alignment of the heel. The Harris view was first described in 1948 by Harris and Beath, as a method of assessing for the presence of a talocalcaneal bridge in a rigid flat foot deformity.5 An axial view of the calcaneus is obtained with the x-ray source posterior to the heel and tilted caudally ~45° with respect to the long axis of the foot. As applied to calcaneal fractures, the Harris view allows for assessment of subtalar joint displacement, angulation of the tuberosity fragment, increase in heel width, and residual calcaneal varus after reduction. However, adjustment of projector angle in acquiring Harris views may be necessary intraoperatively. Essex-Lopresti noted in his initial classification of calcaneal fractures that reliance on a single axial view may not allow for accurate characterization of the subtalar joint: "Unless the rays strike the joint tangentially its outline will not show against the mass of spongy bone. Furthermore, if the joint is simply displaced downwards and forwards – that is, in the line of the X-ray tube – no deformity will be apparent."2 More recently, a cadaveric study performed by Gitajn et al. found that the standard 35-45 degree Harris view may be inadequate in assessing placement of lateral-to-medial sustentacular screws.6 They noted that inferior screw misplacement, which could endanger the (FHL) and neurovascular bundle, was identifiable only on 10 and 20 degree views. Several methods of obtaining axial images of the calcaneus in the operating room have been outlined. Typically, a single C-arm is used, with only the image intensifier draped. In a recent paper outlining percutaneous fixation techniques, for instance, Marsh et al. describe positioning the base of the C-arm at the foot of the bed, opposite the surgeon and at a 45 degree angle to the axis of the patient.7 To obtain Harris views in this configuration, the x-ray source is arced below the table until the beam is parallel to the floor. Abousayed et al. described a two C-arm technique for calcaneal fixation: with the patient in a lateral decubitus position, a standard C arm is utilized for lateral views, while a mini C-arm, oriented horizontally and positioned with the x-ray source just posterior to the calf, allows for variable-angle Harris views.8 Other authors have argued for the intraoperative use of three-dimensional imaging modalities.9,10 One report found that the use of a C-arm-based three-dimensional imaging device, following initial reduction and fixation with the aid of standard fluoroscopy, resulted in alteration of screw placement in 41% of cases, albeit at the expense of slightly longer operative times.10 Three drawbacks exist with this technique. First, positioning of the surgeon in between the x-ray source and image intensifier may result in slightly higher radiation exposure per fluoroscopy shot. However, we feel that this may be compensated by the decreased number of shots required given the accuracy afforded by this technique. Second, the extra maneuvering and draping necessary to position the c-arm correctly makes switching between views more time consuming, and slightly more expensive if multiple drapes are required. This can be minimized if an experienced X-ray technician is available. Additionally, we attempt to perform a majority of the procedure utilizing the lateral view, switching to the axial view to verify the heel alignment after provisional reduction has been obtained, and again after implants have been placed to ensure proper screw position. Finally, there are increased sterility concerns with the positioning of the surgeon. The surgeon and operating room staff need to be vigilant for any breaks in sterility when this method is used. We believe, however, the quality and ease of obtaining these images justifies these added risks and inconveniences. The "Magneto view" described here represents a novel technique for positioning and use of the C-arm intraoperatively. By draping both the x-ray source and the image intensifier and standing in the center of the "C," the surgeon has improved ability to adjust the angle of projection for axial views of the calcaneus, while maintaining unfettered access to the surgical field. In our experience, this is a simple way to obtain high quality images with the standard – as opposed to mini – C-arm, without the added time and expense of advanced imaging modalities. 1. Mitchell MJ, McKinley JC, & Robinson CM. The epidemiology of calcaneal fractures. Foot (Edinb). 2009 Dec;19(4):197-200. doi: 10.1016/j.foot.2009.05.001. 2. Essex-Lopresti P. The mechanism, reduction technique, and results in fractures of the os calcis. Br J Surg. 1952 Mar;39(157):395-419. 3. Bezes H, Massart P, Delvaux D, Fourquet JP, & Tazi F. The operative treatment of intraarticular calcaneal fractures: Indications, technique, and results in 257 Cases. Clin Orthop Relat Res. 1993 May;(290):55-9. 4. Thordarson DB, Krieger LE. Operative vs. nonoperative treatment of intra-articular fractures of the calcaneus: a prospective randomized trial. Foot Ankle Int. 1996 Jan;17(1):2-9. 5. Harris RI, & Beath T. Etiology of peroneal spastic flat foot. J Bone Joint Surg Br. 1948 Nov;30B(4):624-34. 6. Gitajn IL, Toussaint RJ, & Kwon JY. Assessing accuracy of sustentaculum screw placement during calcaneal fixation. Foot Ankle Int. 2013 Feb;34(2):282-6. doi: 10.1177/1071100712467617. Epub 2013 Jan 10. 7. Marsh JL, Boyer JS, Sullivan J, Phisitkul P, & Karam MD. A percutaneous technique for reduction and internal fixation of displaced intra-articular calcaneal fractures. JBJS Essential Surgical Techniques. 2011; 1(2): e9. doi: 10.2106/JBJS.ST.K.00016. 8. Abousayed MM, Toussaint RJ, & Kwon JY. The use of dual c-arms during fixation of calcaneal fractures: a technique tip. Foot Ankle Spec. 2014 Jun;7(3):208-10. doi: 10.1177/1938640013514268. Epub 2013 Dec 10. 9. Richter M, Zech S. Intraoperative 3-dimensional imaging in foot and ankle trauma-experience with a second-generation device (ARCADIS-3D). J Orthop Trauma. 2009 Mar;23(3):213-20. doi: 10.1097/BOT.0b013e31819867f6. 10. Geerling J, Kendoff D, Citak M, et al. Intraoperative 3D imaging in calcaneal fracture care—clinical implications and decision making.J Trauma. 2009 Mar;66(3):768-73. doi: 10.1097/TA.0b013e31816275c7. Page 5Surgical Technique Volume 16 • June 2015 Novel Intraoperative Technique for Thoracic Level Localization Utilizing a Percutaneous Upper Lumbar Intrapedicular Jamshidi Needle as a Fixed Marker for Wrong Level Surgery Avoidance: Technical Note and Literature Review C. Chambliss Harrod, MD, Richard F. Rathbone, MD, Robert E. Boykin, MD, Kirkham B. Wood, MD The authors report no conflict of interest related to this work. ©2015 by The Orthopaedic Journal at Harvard Medical School PDF OBJECTIVE To introduce a novel simple, cost-efficient, safe, reproducible intraoperative thoracic-level identification technique during open or minimally invasive posterior or lateral (transthoracic) approaches with the use of a Jamshidi needle anchored as a fixed marker in the upper lumbar spine. BACKGROUND Wrong site or level surgery is an unfortunate problem in thoracic spine surgery that can compromise patient care. Likely under-reported, literature is sparse regarding risk factors and effectiveness of current protocols to prevent and decrease the frequency of wrong-level surgery. Accurate intraoperative thoracic spine level localization is often not easily achieved. Coordinating pathology on preoperative imaging with intraoperative imaging is even more difficult in patients with challenging anatomy and non-traumatic conditions. Typically, spot or live fluoroscopy with non-fixed markers (needles, instruments) is performed. Increased radiation exposure to both patient and surgeon results, and correct level identification is often difficult. Recent technological advances include radiographic placement of radiopaque embolization coils, screws, markers, or cement augmentation into the pedicle of interest. However, these techniques increase costs, require admission and increase length of stay, increase anesthetic and radiation exposure, and need additional confirmatory cross sectional imaging (CT or MRI) post-procedure. METHODS Ten patients with nontraumatic etiologies including symptomatic thoracic disc herniations, ossification of posterior longitudinal ligament, epidural abscess, and osteomyelitis underwent surgical treatment via anterolateral, posterior, or combined approaches. Using standard percutaneous techniques, a standard Jamshidi needle was placed into the most cranial lumbar vertebrae (typically L1 or L2) that can be visualized on the same lateral fluoroscopic image as the sacrum using a true AP image to serve as a fixed marker to confidently and accurately reference more cranial levels throughout the case. RESULTS Ten patients underwent successful thoracic decompressive and reconstructive procedures with correct level identification via the Jamshidi technique without complication. CONCLUSION Combined with appropriate preoperative imaging, intraoperative placement of Jamshidi needles allows confident thoracic level identification of any (non-traumatic) pathology without the need for another procedure, anesthetic, cross-sectional imaging study or the additional radiation exposure, costs, or complications associated. It is a safe, efficient, and reliable thoracic level identification technique. Wrong-level spinal surgery is an unfortunate source of frustrations for both surgeons and patients.1-3 Additional procedures, morbidity, cost, anxiety, and lack of trust frequently compromise patient care and the patient-doctor relationships, often culminating in litigation.2 Thoracic pathology requiring surgical intervention can be associated with a disproportionately high rate of wrong-level surgery in non-traumatic etiologies where a focal deformity or fracture does not readily identify correct levels. Accurate intraoperative thoracic spine level localization is often not easily achieved. Coordinating non-traumatic pathology on preoperative imaging with intraoperative imaging is even more difficult in patients with obesity or challenging anatomy. Traditionally, counting techniques using preoperative then intraoperative spot or live fluoroscopy with the use of extracorporeal radio-opaque markers such surgical instruments or needles are employed. These require increased radiation exposure to both surgeon as well as patients and can still be difficult to correctly localize levels. Other techniques include use of C7-T3 spinouts process anatomy, 2-D or 3-D fluoroscopic or computed tomography (CT)-based neuronavigation, preoperative radiographic placement of radiopaque embolization coils, cement augmentation, marking wires, or fiducial screw placements into the pedicle of interest.4-8 However, these techniques increase costs, often require admission (and increase length of stay), increase anesthetic and radiation exposure, and may necessitate additional confirmatory cross sectional imaging [CT or magnetic resonance imaging (MRI)]. To the best of our knowledge, we introduce a new cost-efficient, reproducible intra-operative thoracolumbar level identification technique. Ubiquitous to spinal surgeons due to use in both minimally invasive techniques as well as aspiration of bone marrow aspirate, we use the Jamshidi needle anchored as a fixed marker in the upper lumbar spine to definitively and confidently localize levels for thoracic spinal surgery regardless of minimally invasive or open posterior or lateral (transthoracic) approaches. Ten patients with nontraumatic etiologies including symptomatic thoracic disc herniations, ossification of posterior longitudinal ligament, epidural abscess, and osteomyelitis underwent surgical treatment via a combination of minimally invasive and open lateral, posterior, and combined approaches (Table 1). Preoperatively, we employ routine thoracic [lateral, anteroposterior (AP)] and full length 3 foot standing scoliosis [lateral, posteroanterior (PA)] radiographs in addition to both thoracic and entire spine scout T2-weighted MRI sequences to denote the level of interest counting cranially from the sacrum with careful attention to possible transitional lumbosacral levels, number of non rib-bearing (lumbar) vertebrae and identification of the twelfth (or lowest) rib. Additionally when available, scout coronal thoracolumbar CT images (in addition or in place of plain radiographs) are quite helpful in identifying the twelfth rib and the number of lumbar vertebrae. We print and displayed all images in the operating theatre to confirm the number of lumbar vertebrae, presence of transitional anatomy, morphology of the twelfth rib, and ultimate labeling of thoracic pathology. Patient demographics All Rights Reserved. Permission For Use Required. Patients are positioned on a radiolucent Jackson table either prone (with chest, hip, and thigh pads) or lateral with bolsters. The surgical field is prepped from the axilla (transthoracic approach) or cervicothoracic (posterior) junction all the way to the superior aspect of the gluteal crease below the posterior superior iliac spine. After draping, we then obtain a true AP fluoroscopic image of the uppermost (L1) lumbar (or first, non-rib bearing vertebrae) with the spinous process centered between the pedicles, whose superior border approximates adjacent superior endplate (Figure 1). Using a Kischner wire, we then mark the midpoint of the pedicle transversely followed by the lateral aspect vertically (Figure 2). If doing a transthoracic case, we utilize the ipsilateral (or "upside") pedicle for technical ease. The Jamshidi needle is then inserted on the skin surface typically 2 cm lateral to the lateral wall of the pedicle and advanced until the transverse process is palpated (Figure 3). It is then "walked" medial until the junction of the transverse process and lateral upslope of the superior articular facet is tactilely felt with fluoroscopy confirming appropriate starting point. This technique avoids iatrogenic injury of a lumbar facet joint or capsule. Additionally, use of true AP imaging for marking the upper lumbar vertebrae can reliably identify correct levels even in the face of coronal or sagittal plane deformities so long as preoperative planning correlates number of non-rib bearing lumbar vertebrae with correlation to thoracic pathology. Anteroposterior (AP) fluoroscopic image with Kirschner wire marking the midpoint of the L1 pedicles All Rights Reserved. Permission For Use Required. Intraoperative photograph demonstrating midpoint and lateral borders of the L1 and L2 pedicles All Rights Reserved. Permission For Use Required. AP fluoroscopic image demonstrating percutaneous placement of Jamshidi needle with correct docking at the right L1 transverse process and upslope of the facet. This starting point allows avoidance of iatrogenic facet violation. All Rights Reserved. Permission For Use Required. We then advance the Jamshidi needle via mallet impaction typically 15-20 mm but always stopping prior to reaching the medial border of the pedicle (Figure 4A). A lateral fluoroscopic image is then obtained with the Jamshidi and the lumbosacral junction visualized in a single image to confirm the appropriate marking level (Figure 4B). Similarly, the fluoroscope is moved cranially and typically T8 (+/- one level) can be visualized and definitively counted from the Jamshidi marking level (typically L1, occasionally L2) (Figure 5). If the desired level is more cranial, the steps are repeated for placement of a thoracic Jamshidi in similar fashion as above with the only caveat being slightly more care taken to avoid incidental medial displacement of the needle towards the canal due to the orientation of thoracic transverse processes when obtaining an initial starting point. The definitive level(s) are then marked for a lateral or posterior case with subsequent operation performed. We leave the Jamshidi needle in the upper lumbar vertebrae until the end of the case serving as a continual fixed reference point once deep exposure of the levels has been performed for a repeat counting for final level confirmation prior to undertaking any definitive decompressive or reconstructive procedure (Figure 6). It also allows final images to be obtained when constructs are utilized in reconstructive procedures. (A)AP and (B) Lateral fluoroscopic images of entire lumbar spine with visualization of the sacrum and L1 Jamshidi needle in single fluoroscopic images. All Rights Reserved. Permission For Use Required. (A) AP and (B) Lateral fluoroscopic images demonstrating L1 Jamshidi marker with subsequent identification of T8 pedicle cannulation for the definitive procedure All Rights Reserved. Permission For Use Required. (A) Lateral and (B) Dorsal intraoperative photographs demonstrating placement of Jamshidi marker at L1 with gearshift preparing for transpedicular anchor fixtion at T10 All Rights Reserved. Permission For Use Required. All ten patients underwent correct thoracic level identification, exposures and subsequent decompressive and/or reconstructive procedures using the above technique without complication. In addition to expected and appropriate clinical response, postoperative imaging included full-length postoperative scoliosis radiographs to visualize entire thoracolumbar spine prior to discharge to ensure accurate levels compared with preoperative imaging. Routine use of postoperative CT or MRI was not employed. The Joint Commission (JC) broadly defines "wrong site surgery" as any surgery performed on the wrong site or patient or performance of the wrong procedure.9 Wrong level "exposure" involves surgical exposure on an unintended level but not implying incorrect surgery performed. In a prospective study of 100 lumbar discectomies, Ammerman et al. report a 15% rate of inappropriate exposure.10 Wrong level "surgery" involves performing surgical procedures (essentially, decompression or fusion/instrumentation) at the wrong level or part.11 Wrong level surgery commonly results in complex medical, legal, social, and emotional issues for both the patient and physician involved.12 Although seemingly rare (0.09 to 4.5 per 10,000 surgeries performed), about half of spine surgeons will experience a wrong-level surgery during their career.2, 13, 14 The American Association of Orthopaedic Surgeons (AAOS) in 1997 advocated patients place initials on the operative site.15 The North American Spine Society (NASS) advocated the "Sign, Mark, and Radiograph" protocol in 2001 with a similar JC protocol issued in 2003 in an effort to reduce incidence of wrong-level operations.16, 17 However, Wong et al. reported a rise in wrong site surgery events after instituting the JC Universal Protocol although it was not known if there was a true increase in wrong site surgery versus increased awareness and reporting.18 A paucity of high-quality literature exists; however, a multitude of risk factors have been proposed. Most notably, failure to use fixed site markings, inappropriate positioning, inadequate preparation/preoperative planning, emergent operations, and anatomical anomalies are often cited. In addition to following the above protocols, Devine et al. in a systematic review of the wrong-level surgery most strongly recommended intraoperative imaging after exposure and marking of a fixed anatomic structure that can be directly compared with preoperative studies to determine the correct site for spine surgery.2 In particular, thoracic procedures are disproportionately at risk for wrong-level operation as multiple anatomical challenges including distance away from known reference points (lumbosacral junction or C2), ribs complicating counting techniques, lumbar vertebrae variability (number, presence of transition anatomy), and difficulty imaging due to obesity. A key step in preventing wrong-level surgery is meticulous scrutiny of preoperative imaging with the surgeon understanding and documenting his own method of level derivation that can be reproduced with certainty in the operating theatre with the use of radiographs or fluoroscopy. Each surgeon must have his own method of definitively determining the pathological level. As described above, we always begin with plain radiographs (thoracic, scoliosis) in addition to cross sectional imaging (thoracic and entire spine scout MRI with or without CT) as we will be directly correlating intraoperative fluoroscopic radiographs to our preoperative radiographs during surgery. When CT is indicated (OPLL, understanding disk calcification, fractures), it is immensely helpful in identifying the twelfth rib and the number of lumbar vertebrae. Correlating the official radiologist interpretation and accepting or rejecting (with documentation reasoning) eliminates surgeon confusion on the date of surgery as well as provides solid reasoning if one labels the level of pathology different from the radiologist. Once more, we recommend physically printing and displaying these images in the operating theatre for continual referencing in the OR and as a backup if portable disks or internet-based imaging is unable to be retrieved. Other level identification methods have evolved over time as technology has improved. Prior to the advent of fluoroscopy, posterior counting techniques required more extensile exposures so that the first non-rib bearing (C7 or L1) vertebrae can be identified (nearly always caudally referenced from L1) or counted from C7-T3 spinous process anatomy.4 Currently, intraoperative imaging is the standard of care with radiation exposure to both patient and surgeon previously quantified depending on both location (lumbar > cervical) and modality (CT > fluoroscopy or radiographs).19, 20 Most commonly, counting techniques utilize fluoroscopy with the use of extracorporeal radio-opaque markers such surgical instruments or needles are employed. These require increased radiation exposure to both surgeon as well as patients and can still be difficult to correctly localize levels. Other techniques include use of 2-D or 3-D fluoroscopic or CT-based neuronavigation, preoperative radiographic placement of radiopaque embolization coils, cement augmentation, marking wires, or fiducial screw placements into the pedicle of interest.4-8 However, these techniques increase costs, often require admission (longer length of stay), increase anesthetic and radiation exposure, and may necessitate additional confirmatory cross sectional imaging (CT or MRI). A need remains for a cost-efficient, safe, simple, reproducible intraoperative thoracic level identification technique by which any thoracolumbar level may be easily identified regardless of pathology or deformity. Avoidance of additional radiological or interventional procedures with possible complications and increased radiation exposure (to both patient and operator) is possible with our technique using a percutaneous upper lumbar Jamshidi needle placement to serve as a fixed marking anchor by which all cranial levels can be confidently labeled. Although we did not experience any complications, strict adherence to the above technique is recommended to avoid inadvertent facet violation and potential slippage of Jamshidi needle with injury to adjacent structures. Lastly, premature removal of the Jamshidi marker at any point during the operation could increase risk for wrong-level operation. Combined with appropriate preoperative imaging, intraoperative placement of Jamshidi needles allows confident thoracic level identification of any (non-traumatic) pathology without the need for another procedure, anesthetic, cross-sectional imaging study or the additional radiation exposure, costs, or complications associated. It is a safe, efficient, and reliable method of localizing thoracic spine levels intraoperatively that utilizes technique familiar to all spinal surgeons. 1. Mayer JE, Dang RP, Duarte Prieto GF, Cho SK, Qureshi SA, Hecht AC. Analysis of the techniques for thoracic and lumbar-level localization during posterior spine surgery and the occurrence of wrong-level surgery: results from a national survey. Spine J. 2014 May 1;14(5):741-8. doi: 10.1016/j.spinee.2013.06.068. Epub 2013 Sep 5. 2. Devine J, Chutkan N, Norvell DC, Dettori JR. Avoiding wrong site surgery: a systematic review. Spine (Phila Pa 1976). 2010 Apr 20;35(9 Suppl):S28-36. doi: 10.1097/BRS.0b013e3181d833ac. 3. Marquez-Lara A, Nandyala SV, Hassanzadeh H, Sundberg E, Jorgensen A, Singh K. Sentinel Events in Lumbar Spine Surgery. Spine (Phila Pa 1976). 2014 Jan 29. [Epub ahead of print] 4. Paolini S, Ciappetta P, Missori P, Raco A, Delfini R. Spinous process marking: a reliable method for preoperative surface localization of intradural lesions of the high thoracic spine. Br J Neurosurg. 2005 Feb;19(1):74-6. 5. Ahmadi SA, Slotty PJ, Schröter C, et al. Marking wire placement for improved accuracy in thoracic spinal surgery. Clin Neurol Neurosurg. 2014 Apr;119:100-5. doi: 10.1016/j.clineuro.2014.01.025. Epub 2014 Jan 28. 6. Upadhyaya CD, Wu JC, Chin CT, Balamurali G, Mummaneni PV. Avoidance of wrong-level thoracic spine surgery: intraoperative localization with preoperative percutaneous fiducial screw placement. J Neurosurg Spine. 2012 Mar;16(3):280-4. doi: 10.3171/2011.3.SPINE10445. Epub 2011 Nov 4. 7. Young RM, Prasad V, Wind JJ, et al. Novel technique for preoperative pedicle localization in spinal surgery with challenging anatomy. J Neurosurg Spine. 2014 Apr;20(4):400-3. doi: 10.3171/2013.12.SPINE13477. Epub 2014 Feb 7. 8. Slotty P Jr, Kröpil P, Klingenhöfer M, et al. Preoperative localization of spinal and peripheral pathologies for surgery by computed tomography-guided placement of a specialized needle system. Neurosurgery. 2010 Apr;66(4):784-7. doi: 10.1227/01.NEU.0000367450.79418.5B. 9. A follow-up review of wrong site surgery. Sentinel Event Alert. 2001 Dec 5;(24):1-3. 10. Ammerman JM1, Ammerman MD, Dambrosia J, et al. A prospective evaluation of the role for intraoperative x-ray in lumbar discectomy. Predictors of incorrect level exposure. Surg Neurol. 2006 Nov;66(5):470-3; discussion 473-4. 11. Patient safety first alert--implementing a correct site surgery policy and procedure. AORN J. 2002 Nov;76(5):785-8. 12. Goodkin, R. and L.L. Laska. Wrong disc space level surgery: medicolegal implications. Surg Neurol. 2004 Apr;61(4):323-41; discussion 341-2. 13. Jhawar BS, Mitsis D, Duggal N. Wrong-sided and wrong-level neurosurgery: a national survey. J Neurosurg Spine. 2007 Nov;7(5):467-72. 14. Mody MG, Nourbakhsh A, Stahl DL, Gibbs M, et al. The prevalence of wrong level surgery among spine surgeons. Spine (Phila Pa 1976). 2008 Jan 15;33(2):194-8. doi: 10.1097/BRS.0b013e31816043d1. 15. Canale, ST. Wrong-site surgery: a preventable complication. Clin Orthop Relat Res. 2005 Apr;(433):26-9. 16. Norton, E. Implementing the universal protocol hospital-wide. AORN J. 2007 Jun;85(6):1187-97. 17. Dettori JR, Norvell DC, Dekutoski M, et al. Methods for the systematic reviews on patient safety during spine surgery. Spine (Phila Pa 1976). 2010 Apr 20;35(9 Suppl):S22-7. doi: 10.1097/BRS.0b013e3181d70494. 18. Wong DA, Watters WC 3rd. To err is human: quality and safety issues in spine care. Spine (Phila Pa 1976). 2007 May 15;32(11 Suppl):S2-8. 19. Simpson AK, Whang PG, Jonisch A, Haims A, et al. The radiation exposure associated with cervical and lumbar spine radiographs. J Spinal Disord Tech. 2008 Aug;21(6):409-12. doi: 10.1097/BSD.0b013e3181568656. 20. Biswas D, Bible JE, Bohan M, Simpson AK, et al. Radiation exposure from musculoskeletal computerized tomographic scans. J Bone Joint Surg Am. 2009 Aug;91(8):1882-9. doi: 10.2106/JBJS.H.01199. Page 6 Young Investigators Corner Volume 16 • June 2015 Patient Perception of Trustworthy Sources for Injury Research Elizabeth J. Bennett, Shannon E. Hogan, Nicholas H. Page, Mark S. Vrahas, MD Disclosure Information Mark S. Vrahas, MD AO Foundation: Board or committee member AOPOC inc: Paid consultant Clinical Orthopaedics and Related Research: Editorial or governing board ©2015 by The Orthopaedic Journal at Harvard Medical School PDF BACKGROUND The advent of accessible online health information has increased the frequency with which patients research their diagnoses and treatment options. Understanding how patients determine trustworthy information and where to find such information is crucial to physicians as they adapt to the new dynamic in the patient-physician relationship. This study was designed to investigate how undergraduate students, acting as potential patients faced with an orthopaedic injury, research their injuries and how that research influences their treatment decisions. METHODS A panel of researchers (three undergraduate students) were presented with a profile of a patient with a fractured clavicle. They were instructed to research the fracture as though they were the patient in order to determine a preferred treatment. The on-line sources utilized were initially sorted into the following categories: trustworthy background sources, trustworthy decision sources, or untrustworthy sources. Findings and the rationale behind their choice of treatment were presented to a panel of orthopedists who assisted in evaluating the students' decision-making process. RESULTS Most of the research yielded what was considered trustworthy background sources, which included websites written for the lay audience. Trustworthy decision sources ultimately included scholarly sources and textbooks. Untrustworthy sources predominantly consisted of blogs or sources that demonstrated clear bias. CONCLUSION It is important for physicians to understand patients' perceptions of the sources they read and the information they obtain about their diagnoses. What may be considered layman sources may be more trustworthy than young adult patients might have previously believed. Physicians should acknowledge the pre-existing information a patient might have and be prepared to address the discrepancy between professional opinion and the patient's research. LEVEL OF EVIDENCE Level V Patients are becoming increasingly involved in researching treatment options for their orthopaedic diagnoses. As patients utilize various resources to supplement their knowledge of their condition, the patient-physician relationship has evolved such that patients may give considerable weight to the information from external sources. Up to 79% of orthopedic patients have access to the Internet, the majority of which uses this means to research their medical conditions and diagnoses.1 Because of its availability and patient's use of health information websites, it may be beneficial for physicians to learn what types of medical sources patients are using to educate themselves, as not all sources offer the same quality of information.2 Patients can find information about their diagnoses by performing a web-based search online (i.e. "Google search"), in textbooks, in academic journals, and through word of mouth. After researching their conditions, but prior to consultation with a physician, patients begin to formulate a decision for treatment based on resources they deem trustworthy. The physicians' goals are to understand how to better communicate with and help their patients make informed decisions regarding their treatment. Thus, the objective of our study was to examine how patients conduct research about their orthopaedic diagnoses, the sources they use, and how these sources affect their decisions. A panel of orthopedic physicians presented a panel of researchers (three undergraduate students) with a profile of a patient with a clavicle fracture (Figure 1) The theoretical patient was a 20 year old male who fell while practicing ballet. Additional information included his symptoms: pain and swelling, but neuro and vascular intact, and additional characteristics: healthy college student who is interested in medicine. Subjects based their research on this information. They were instructed to research this fracture from the perspective of a patient and decide how they would want to be treated. Consulting medical professionals with orthopaedic expertise was not allowed. All other avenues of research including books, general web-based searches, as well as scientific databases were allowed. All sources were archived in real time and categorized to document if the information/source was used to develop a treatment algorithm. Criteria for what was considered a trustworthy sources were: A. No obvious or potential bias B. Scholarly or educational C. From a well-known or reputable institution D. Concrete evidence or references Based on these criteria, sources were divided into three categories: 1) Trustworthy Decision Sources: Sources used for both background information and to make an ultimate decision (met at least 3 criteria) 2) Trustworthy Background Sources: Sources used only to elucidate the background information (met at least 2 criteria) 3) Untrustworthy Sources: Sources used for neither background information nor to make a decision (met less than 2 criteria) AP x-ray of the clavicle of the theoretical patient All Rights Reserved. Permission For Use Required. The fracture was researched using trustworthy sources (as described above) and a treatment algorithm was determined based on this research. The research and treatment algorithm was then presented to a panel of orthopaedic surgeons. The chosen sources were discussed with the surgeons so that they might better understand the thought process and research of a potential patient. Research was presented to the panel (Table 1). The researchers reviewed a total of 14 sources. Several sources came from peer-reviewed journals or sites, including NCBI, orthobullets.com, hopkinsortho.org, orthoinfo.aaos.org, and emedicine.medscape.org. Six of the sources were textbooks; the other eight were online sources. When placed into the three categories of trustworthiness, seven of these were considered trustworthy background sources, two were considered untrustworthy, and five were considered trustworthy enough to inform a decision for treatment. In general, the panel of researchers agreed with the treatment choices picked by the researchers and that textbooks are a trustworthy source to use. However, they disagreed with some the criteria for a trustworthy decision source. Their opinion was that the general, broader layman's websites are trustworthy decision sources. They also considered the scholarly sources used to be less trustworthy than the researchers had previously thought.21 All Rights Reserved. Permission For Use Required. The criteria used to differentiate a trustworthy or untrustworthy source stemmed from previous academic experience that resulted in the perception that scholarly sources may be more credible than what may be considered layman's sources (i.e. Wikipedia and WebMD). Well-known sources, based on name recognition within the general population4, 5, 6, 7, 8, 12 were considered to be trustworthy. Therefore, the students based their research on the sources that fit those criteria and based treatment decisions on the information from those sources deemed as trustworthy. In contrast, the panel of physicians stated that they valued the layman's websites more and the scholarly sources less. The physicians explained that layman's websites were more similar to textbooks, as both were a consolidation of information amassed from a large quantity and variety of resources. Their argument was that the authors of these sites22, 23 have likely utilized multiple sources24 and drawn conclusions based on information from several sources they deem trustworthy. Therefore, to our orthopaedic surgeon panel, the information in these sources represented the most understandable and complete overview to allow patients to understand their orthopaedic problem. Of note, the researchers initially rejected these websites for anything other than background information because of their broad-based approach to a given question or topic. While some of the sites are indeed basic, physicians suggested that often that is all that is necessary. For example, Medscape is a website that offers thorough yet straightforward and accurate descriptions of treatment options. This website was originally thought to be too broad and elementary, but the panel of orthopaedists found it to be a good example of a patient-friendly and trustworthy website.21 In contrast, the physicians noted that some of the scholarly journal articles were too specific and not indicative of typical or successful outcomes due to small sample sizes. For example, much of the literature cited by the researchers indicated that the use of a “figure 8 brace” was the best option. However, during discussion with the physicians, it was learned that while this particular brace is theoretically promising, its well-repute is based on studies of very specific cases and small sample sizes.21 Uninformed orthopedic trauma patients may not recognize these issues, and could be misled to choose inappropriate or less than optimal treatment options. There are several limitations to this study that should be addressed. As undergraduate students, the panel of researchers was not representative of the population at large. Though limited by their instructions from the panel of physicians that prohibited seeking advice from any orthopedic professional, access to relevant textbooks was much simpler than would be found in the general population. The study had a very small sample size with three researchers acting as one patient which limits the general applicability of our results. No validated objective metric was utilized to determine the “trustworthiness” of sources nor was interobserver reliability (on the part of the students or physicians) assessed. Furthermore, the appropriateness of the researcher’s treatment choice was the opinion of three orthopaedic surgeons. Additionally only one orthopaedic condition was examined. All these factors contribute to the difficulty in extrapolating these findings to broader populations. However, as this study sought to mimic a young adult’s research on clavicle fractures from a patient’s standpoint, it shed light on the sources a patient might use to learn about their injury. Based upon the discussion with a panel of orthopaedic surgeons it was shown that there is a tendency for young adults to trust scholarly sources, but that broader sources are typically more pertinent and provide sufficient information for patients to make informed decisions. Due to the limitations of this study, we propose that future studies include larger sample sizes, a broader demographic, and examine information for disciplines outside of orthopaedic trauma. We thank Michael Weaver, MD, Colin Heinle, MD for their analysis of our treatment decision and for participating in this study. We also thank Suzanne Morrison, MPH, Robert Lucas, and Jordan Morgan for the opportunity to participate in this study, and for their input. Supported by the Harvard Medical School Orthopedic Trauma Initiative. The authors should be commended on their work to better elucidate internet sources that young patients may utilize when researching an orthopaedic condition. While there are methodologic shortcomings, some of which are addressed in the discussion section, the authors demonstrate that various websites offer differing levels of information about clavicle fractures and conclude that a provider’s understanding of these internet sources may be helpful during the physician-patient interaction. A goal of OJHMS is to promote research endeavors within the Harvard orthopaedic community and to support our young researchers as they develop the skills, knowledge and most importantly the passion to seek out answers. We hope that this project as well as their internship with the Harvard Orthopaedic Trauma Initiative sparks a lifetime of “answering questions”. John Y. Kwon, MD 1. Fraval A, Chong YM, Holcdorf D, Plunkett V, Tran P. Internet use by orthopaedic outpatients - current trends and practices. Australas Med J. 2012;5(12):633-8. doi: 10.4066/AMJ.2012.1530. Epub 2012 Dec 31. 2. Dy CJ, Taylor SA, Patel RM, Kitay A, Roberts TR, Daluiski A. The effect of search term on the quality and accuracy of online information regarding distal radius fractures. J Hand Surg Am. 2012 Sep;37(9):1881-7. doi: 10.1016/j.jhsa.2012.05.021. Epub 2012 Aug 1. 3. Johns Hopkins Orthopaedic Surgery: Johns Hopkins Sports Medicine Patient Guide to Clavicle (Collarbone) Fracture [Internet]. Baltimore, MD: The Johns Hopkins University, The Johns Hopkins Hospital, and Johns Hopkins Health System; c2011 [cited 2014 Jun 30]. Available from: . 4. Hillen RJ, Burger BJ, Poll RG, de Gast A, Robinson CM. Malunion after midshaft clavicle fractures in adults. Acta Orthop. 2010 Jun;81(3):273-9. doi: 10.3109/17453674.2010.480939. 5. Paladini P, Pellegrini A, Campi F, Porcellini G. Treatment of Clavicle Fractures. Transl Med UniSa. 2012 Jan 18;2:47-58. Print 2012 Jan. 6. Pecci M, Kreher JB. Clavicle Fractures. Am Fam Physician. 2008 Jan 1;77(1):65-70. 7. S Thyagarajan D, Day M, Dent C, Williams R, Evans R. Treatment of mid-shaft clavicle fractures: A comparative study. Int J Shoulder Surg. 2009 Apr;3(2):23-7. doi: 10.4103/0973-6042.57895. 8. van der Meijden OA, Gaskill TR, Millett PJ. Treatment of clavicle fractures: current concepts review. J Shoulder Elbow Surg. 2012 Mar;21(3):423-9. doi: 10.1016/j.jse.2011.08.053. Epub 2011 Nov 6. 9. Abassi, D. Orthobullets: Clavicle Fractures [Internet]. Cambridge, MA: Lineage Medical LLC; c2004 [updated 2014 May 4; cited 2014 Jun 30]. Available from: . 10. Rockwood C, Matsen F, et al. The Shoulder. 4th ed. Philadelphia (PA): Saunders; 1998. 2 vol. 11. Bucholz RW, Heckman JD, eds. Rockwood and Green’s Fractures in Adults: Volume 1. 5th ed. Philadelphia, PA: Lippincott Williams & Wilkins; 2002. 12. Kleinhenz B, author; Young, CC, chief editor; Brilliant, LC et al., contributors. Medscape: Clavicle Fractures [Internet]. New York: WebMD LLC; c1999-2015 [updated 2014 Dec 10; cited 2015 May 23]. Available from: . 13. Hoppenfeld S, deBoer P, Buckley R. Surgical Exposures in Orthopaedics: the Anatomic Approach. 4th ed. Philadelphia, PA: Lippincott WIlliams & Wilkins; 2009. 14. Bernstein J, eds. Musculoskeletal Medicine. 1st ed. Rosemont, IL: American Academy of Orthopaedic Surgeons; 2003. 15. Schatzker J, Tile M. The Rationale of Operative Fracture Care. 2nd ed. Berlin: Springer; 1996. 16. Einhorn TA, O’Keefe RJ, Buckwalter JA, eds. Orthopaedic Basic Science: Foundations of Clinical Practice. 3rd ed. Rosemont, IL: American Academy of Orthopaedic Surgeons; 2007. 17. Zaidi, M. Anatomy. In: Internal Medicine Discussion. [place unknown]: Doctors Hangout; 2011 May 8 [updated 2011 Jun 8; cited 2014 Jun 30]. Available from: . [about 2 screens] 18. Orthopaedic Trauma Association. Clavicle Fracture (Broken Collarbone) [Internet]. Chicago: AAOS; c1995-2015 [updated 2011 Jan; cited 2014 Jun 30] Available from: . 19. Etemad, A. About Collarbone (Clavicle) Fracture [Internet]. Minneapolis, MN: Patients Crossing Oceans Blog; 2012 Mar 19 [cited 2014 Jun 30]. Available from: . 20. Bedi, A. Broken Collar Bone (Clavicle Fracture) [Internet]. Easton, CT: Sportsmd Media Inc.; c2010-2015 [updated 2014; cited 2014 Jun 30] Available from: . 21. Communication with: Mark Vrahas, MD, Michael Weaver, MD, Colin Heinle, MD (Partners Orthopaedic Trauma Service, Harvard Medical School, Boston, MA) 2014 Jul. 22. Wikipedia. [place unknown]: Wikimedia Foundation; c2001 [cited 2015 May 23]. . 23. WebMD [Internet]. New York, NY: WebMD LLC; c2005-2014 [cited 2015 May 23]. Available from: . 24. Lenza, M; Faloppa, F. Surgical interventions for treating acute fractures or non-union of the middle third of the clavicle. Cochrane Database Syst Rev. 2015 May 7;5:CD007428. [Epub ahead of print] Page 7Table of Contents Volume 16 • June 2015