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Dear Colleague,

Welcome to the Fall 2012 issue of Orthopaedic Insights from Cleveland Clinic's Department of Orthopaedic Surgery. We bring you this newsletter twice yearly to update you on clinical and research initiatives we hope will spark interactions about how we can jointly advance orthopaedic care for patients around the nation and beyond.

Advancing care in that way involves a certain measure of leadership, and I am pleased that the contributions to this issue demonstrate leadership across a wide swath of orthopaedic practice. On pages 3 and 12 we spotlight some leading-edge work we are doing with three-dimensional preoperative planning software — in one case in conjunction with a transfer device to improve glenoid guide pin placement, and in the other case to enhance the precision of radioulnar deformity correction. On page 6 we share Cleveland Clinic’s pioneering use of iPad technology to change the trajectory of concussion care in sports medicine — along with our hopes to deploy the technology for broader use across the country. And on page 25 we announce our unique collaboration with Elsevier to update the Musculoskeletal System volume of the iconic Netter Collection of Medical Illustrations.

These are just a few of the examples of diverse leadership in research, education and clinical practice you will find in these pages. I believe this ethic of leadership was an important factor in Cleveland Clinic's ranking as one of the top 3 orthopaedic programs in the nation in U.S. News & World Report’s “America’s Best Hospitals” survey — the top-ranked program in Ohio.

While on the topic of leadership, I am proud to recognize two of our department members for recently taking on crucial leadership roles within the Cleveland Clinic health system. In 2011, Brian Donley, MD, was appointed President of Cleveland Clinic’s Lutheran Hospital; and earlier this year Mark Froimson, MD, was named President of Cleveland Clinic’s Euclid Hospital. Although our department has a bit less of their time for their clinical expertise (in foot and ankle reconstruction in Dr. Donley’s case, and in arthroplasty in Dr. Froimson’s case), our loss is more than made up for by our health system’s tremendous gain from their demonstrated leadership and vision.

My colleagues and I are mindful that an essential component of leadership is good listening, so I invite you to share with us your comments, questions and ideas in response to anything you see here. Look for our authors’ contact information at the end of their articles, and feel free to contact me with your thoughts as well. Enjoy the issue.

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Combining 3D Planning Software with Use of a Transfer Device to Improve Glenoid Guide Pin Positioning

By Joseph Iannotti, MD, PhD; Justin Baker, PhD; Eric Rodriguez, BS; John Brems, MD; Eric Ricchetti, MD; Mena Miseha, MD; and Jason Bryan, MS

Inaccurate or improperly placed implants shorten implant survival and decrease performance, putting patients at risk for suboptimal outcomes. Technologies such as patient-specific instruments and computer-guided surgery seek to improve the accuracy of implant placement.

At Cleveland Clinic, we have developed an alternative approach to these two technologies that incorporates the information derived from a three-dimensional (3D), software-generated preoperative plan for arthroplasty procedures into a patient-specific bone model that then contains the information needed to execute the surgical plan. In our unique approach, a reusable and adjustable tool is placed over the guide wire and the anatomic model to record the orientation from the software and then transfer it to the surgical site (Figure 1). We recently tested this approach for surgical navigation to significantly improve glenoid implant placement and compared the results with standard-of-care surgical methods in pathologic patient bone models. We share an overview of our results here.

OUR STUDY DESIGN
We tested this new technology using a preclinical surgical model that we have validated to reflect clinically relevant pathology and surgical exposure. Each of nine pathologic scapula models was shrouded to allow exposure of only that portion of the glenoid typically seen at the time of surgery. Three surgeons of varying surgical experience in shoulder arthroplasty placed a guide pin in each of the specimens using one of three methods:

1. Mark leg contact point on patient
2. Transfer to patient
3. Drive pin, remove device, compare trajectory

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CONTINUED ON NEXT PAGE

Figure 1. Overview of how the guide pin location and trajectory information from the 3D preoperative planning software is transferred to the patient using the transfer device. The information is output from the software by printing a 3D model of the patient’s bone. The transfer device is set on the model and loaded with the correct leg lengths, after which it is ready for transferring the exact location and trajectory from the model to the patient/sawbone.
This preclinical trial provides evidence and justification for a randomized clinical trial of this new technology, which we have begun.

- Standard-of-care instrumentation alone (standard method [SM])
- Standard-of-care instrumentation plus use of the 3D preoperative planning software (SM+3D)
- Use of the software-smart surrogate-adjustable instrument technology (experimental method [EM])

All scapula models underwent CT scanning after pin placement, and the results are reported as the deviation (in millimeters or degrees) from the desired pin position.

**RESULTS: EXPERIMENTAL APPROACH OUTPERFORMS BOTH STANDARD METHODS**

Compared with standard surgical care alone (SM; n = 54), standard surgical care plus the 3D planning software (SM+3D; n = 54) improved guide pin version deviation by an average of 4.5° (± 1° standard deviation) (P < .001).

Additionally, compared with the SM approach, the SM+3D approach was associated with a 70 percent lower risk of deviation of version angle by more than 10° (P = .005) and with an average improvement in inclination angle by 3.3° (± 1.3°) (P = .013). There was also an improvement of 0.4 mm (± 0.2 mm) in implant placement with SM+3D relative to SM alone (P = .042).

Compared with the SM approach, the software-smart surrogate-adjustable instrument technology (EM; n = 89) improved guide pin version by 8.2° (± 0.9°) (P < .001), improved inclination by 11.4° (± 1.2°) (P < .001), and improved implant placement distance by 1.7 mm (± 0.2 mm) (P < .001). Moreover, the EM approach significantly increased the accuracy of implant placement compared with the SM+3D method in terms of version, inclination and distance (P < .001) (Figure 2).

The table details the average absolute deviation from implant placement plan for each of the three methods.

<table>
<thead>
<tr>
<th>Table. Average Absolute Deviation from Plan for Implant Placement</th>
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<tr>
<td><strong>Version</strong></td>
</tr>
<tr>
<td>Experimental method (EM) (software-smart surrogate-adjustable instrument technology)</td>
</tr>
<tr>
<td>Standard method plus 3D planning (SM+3D)</td>
</tr>
<tr>
<td>Standard method (SM)</td>
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*Mean ± standard deviation
CONCLUSIONS AND NEXT STEPS
Our novel concept for the transfer of preoperative data to a surgical site using software-smart surrogate-adjustable instrumentation showed substantial improvement in the accuracy of glenoid guide pin placement compared with standard methods. This surgical method can be applied to other arthroplasty applications. Our preclinical study provides a basis for performing a clinical trial in shoulder arthroplasty to determine the ability of this novel technology to improve surgical outcomes. The development of this new technology, together with the data from this preclinical trial, provides evidence and justification for a randomized clinical trial. We have started this clinical study.

This method of surgical planning and guide pin placement is applicable to other surgical procedures and anatomic sites.

ABOUT THE AUTHORS
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Dr. Miseha, formerly a resident in orthopaedic surgery at Cleveland Clinic, is currently a fellow on the shoulder and elbow service at Harvard School of Medicine.

Mr. Bryan is an employee of ImageIQ, Cleveland, and was formerly a member of the research staff at Cleveland Clinic’s Lerner Research Institute.
The management of concussion in young athletes too often follows a scenario like this:

An athlete sustains a blow to the head in a Friday night game. He's taken out of the game but “shakes it off” without going to the emergency room. He's assessed for concussion by an on-site athletic trainer, but not in a well-documented way. What documentation there is rarely makes it to the electronic medical record. A few days later, the athlete's mother is troubled that he's “still not quite right,” so they go to a physician who must piece together conflicting recollections of what happened. The physician puts the athlete through a battery of tests three days after the injury. Without baseline data, it's difficult to know the extent and focus of the patient's impairment or how much recovery has taken place. Management is hampered by this uncertainty, and the patient's family grows dissatisfied, bouncing from one provider to another. Even worse, the athlete may be cleared prematurely because even though his functional test scores may look good, there is no way to know if he has fully returned to normal function.

Cleveland Clinic has a vision of how to change this model of sports concussion care, and we are extending the benefits of this vision to nearly 12,000 young athletes in Northeast Ohio. The vision centers on our proprietary concussion application (app) for the Apple® iPad® 2, a collaboration among our Concussion Center, Department of Biomedical Engineering and Center for Sports Health. We believe it can change the trajectory of concussion care by enabling objective, affordable, point-of-care assessment of the multiple symptoms associated with concussion and providing this information to clinicians in a meaningful manner on a device that allows for interaction with the data.

WHY AN IPAD APP?

When we began exploring a software-based model to monitor concussions, we knew that measurement of motion and acceleration would be key. When the iPad 2 came along, with a built-in gyroscope and accelerometer, it fit the bill.

The Cleveland Clinic Concussion (C3) app works by collecting position and time-series data, along with linear and angular acceleration data, to assess balance and concussion symptoms while an athlete performs clinical balance tests with an iPad attached to the waist (see photo). The app analyzes data to provide objective and specific measures of cognitive and motor function as well as balance and postural stability. Validation studies have shown that the app measures balance and postural stability with an accuracy equivalent to that of the system considered the gold standard for such testing (but which is expensive, large and nonportable). The concussion-related factors assessed by the app include:

- Information processing
- Reaction time (both choice and simple)
- Working memory
- Dynamic visual acuity
- Postural stability
- Visual memory

INTO THE CLINIC AND ONTO THE FIELD

After the validation studies, we systematically evaluated the C3 app for use in the performance of a clinical balance test often used in concussion: the Balance Error Scoring System (BESS). During BESS testing, subjects stand on varying surfaces and in varying postures to allow assessment of their processing of visual information, somatosensory (tactile) information and vestibular information from the inner ear. Whereas the traditional BESS test depends on a clinician's subjective judgment, our study showed that the C3 app enables highly objective, quantitative BESS scoring that is also more sensitive than scoring by clinical observation alone, allowing greater discrimination between various concussive conditions. This study is in press.
Next came a preliminary field study using the C3 app to gather baseline postural stability and functional data from 120 Cleveland-area high school and college athletes. The aim was to provide a benchmark to compare against if any of them later sustained concussion. Twelve of these athletes suffered concussions during the season studied. We have learned from these 12 cases that concussion appears to leave a distinct “fingerprint” in different individuals in terms of the functions most affected. For instance, some individuals have substantial impairment in dynamic visual acuity while others have none, and some individuals suffer major balance impairments while balance is unaffected in others. We are also examining the rate of recovery of these affected functions over time to see how that fits into the broader concussive fingerprint. A manuscript on this study is in development.

PERFORMANCE POLYGON GUIDES CLINICAL MANAGEMENT

Our studies of functional return following concussion are facilitated by a method of data visualization we call the “performance polygon.” It plots an individual’s scores in nine performance domains (Figure) on the first post-concussion iPad assessment and periodically thereafter to allow easy visual monitoring of recovery to baseline levels (outer trace in Figure) over time. Depicting all domains in a single view makes the relative impairments in — and rates of recovery of — various domains readily apparent. This is valuable to clinicians for pinpointing the functional domains of concern and guiding the most appropriate therapy, and it helps patients easily understand what the treatment priorities are and why.

The clinical utility of this polygon tool underscores the importance of obtaining the athlete’s baseline assessment as well as assessments immediately after the injury and then frequently thereafter to monitor recovery.

Equally important is complete documentation of what happened at the time of injury, which the C3 app enables by providing the athletic trainer with a comprehensive questionnaire that elicits essential information about the incident and initial symptoms, which may later be valuable to a treating physician. It does so systematically, using drop-down menus and numeric coding to allow direct integration into the electronic medical record. The data are also integrated into Cleveland Clinic’s Knowledge Program interactive clinical database, which promotes management using our Concussion Carepath, an online evidence-based protocol designed to reduce variability of care across the health system and improve patient outcomes.

CURRENT AND NEXT STEPS

In 2012, Cleveland Clinic has used the C3 app to complete baseline functional assessments for nearly 6,000 young athletes who play contact sports (e.g., football, men’s and women’s soccer) at the more than 50 high schools and colleges across Northeast Ohio that have Cleveland Clinic certified athletic trainers. We are using these baseline data to realize our vision for optimal care should any of these athletes sustain a head injury. We are also making the C3 app available for post-injury assessment among an additional 6,000 young athletes who are managed by our trainers but who play noncontact sports or have not yet been scheduled for baseline assessment.

Our next aim is to explore broader deployment of the app, together with our Concussion Carepath, for coordinated use by schools and hospitals across the country. Together these highly transferable tools have the potential to take much of the guesswork out of concussion assessment and care, allowing physicians to make safer return-to-play decisions.

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Diabetic patients with ankle fractures represent a distinct patient subset characterized by multiple comorbidities, greater surgical pitfalls and a well-accepted increased rate of complications. Nevertheless, successful treatment of ankle fracture in the diabetic patient is attainable by adopting an aggressive, multifaceted treatment approach that addresses the major causes of failure.

**AN INCREASINGLY COMPLEX PROBLEM**
Diabetic patients possess a long list of characteristics that can complicate ankle fracture treatment. Increased prevalences of peripheral vascular and coronary artery disease, obesity and peripheral neuropathy all contribute to a higher incidence of malunion and problems with wound healing. Charcot neuroarthropathy can exist at the time of ankle fracture or develop during treatment. In either case, profound deformity and loss of fixation after ORIF commonly result.

The challenges are even greater in the increasing number of diabetics who undergo gastric bypass surgery or kidney-pancreas transplantation. Gastric bypass patients often have profound osteopenia that contributes to more comminuted injury patterns and more difficult fixation. Transplant patients require powerful immunosuppressive medications that increase the risk of infectious complications after surgery.

**RISK REDUCTION, NOT RISK ELIMINATION**
There is no way to completely eliminate the risk of serious complications in the diabetic patient with a fractured ankle. Although nonoperative treatment may appear attractive in the diabetic patient with multiple comorbidities, even non-surgical treatment can be extremely problematic. Lack of protective sensation and inability to avoid weight bearing can result in loss of reduction and skin breakdown with cast treatment, particularly in unstable fractures.

Unstable ankle fractures are best treated surgically, even in the complex diabetic population. Achieving a stable anatomic reduction facilitates union, simplifies cast changes and radiographic monitoring, and gives the patient the best possible chance to return to an acceptable level of function. However, a number of technique alterations should be considered in the diabetic patient to minimize the risk of complication.

**PREOPERATIVE MANAGEMENT**
Preoperative management is the first consideration. Ankle fracture surgery should be delayed in the diabetic patient to allow for preoperative medical optimization and resolution of swelling. The soft-tissue envelope should be as quiescent as possible before surgical treatment proceeds. Fracture blisters, if present, should be re-epithelialized, and skin wrinkles should be present. A delay of two weeks is not atypical for ankle fracture in a diabetic patient. This approach mirrors the one routinely used in treating pilon and calcaneus fractures in the nondiabetic population.

However, a delay before surgery is feasible only if a successful and well-done closed reduction and splinting is performed. While mild residual talar subluxation after closed reduction may be well tolerated in the young, healthy, nondiabetic patient, a suboptimal reduction can lead to severe soft-tissue breakdown in the diabetic patient. Thus, the goal of closed reduction in the diabetic patient must be near-anatomic reduction of the talus beneath the tibia.

Post-reduction splinting must also be performed to an exacting standard. The splint must be molded appropriately to maintain the reduced talus within the mortise. The splint should be well padded over the malleoli but not so padded that a reduction cannot be maintained. Bulky Jones cotton, while useful as postoperative cast padding, is not ideal for maintaining a closed reduction, as it inhibits proper molding of the plaster.

**AN AGGRESSIVE SURGICAL APPROACH**
At Cleveland Clinic, we have adopted an aggressive surgical approach to the diabetic ankle fracture. This may seem counterintuitive in the medically complex, at-risk diabetic patient. But precisely because these patients possess so many risk factors for failure, internal fixation must be employed in a manner aggressive enough to counter these risks.

The goal of surgical treatment is to maximize ankle stability (Figure 1). To this end, posterior malleolar fractures are routinely reduced and stabilized with posterior buttress plating through a posterolateral approach. Applying the fibular plate to the posterior or posterolateral surface of the fibula using this same posterolateral incision further enhances construct...
Figure 1. (A, B) Injury radiographs showing ankle fracture in a diabetic patient with a history of gastric bypass surgery and kidney-pancreas transplantation on immunosuppressive medications. (C, D) Aggressive and comprehensive internal fixation was performed, including placement of a posterolateral fibular locking plate, posterior and medial buttress plates and a supplementary syndesmotic screw.

Figure 2. (A) Severe supination-adduction fracture dislocation in a 61-year-old diabetic female with a history of Charcot neuroarthropathy on the contralateral side. (B) Successful stabilization with a transarticular screw and an Ilizarov external fixator.

CONTINUED ON NEXT PAGE
The number of total knee replacements (TKRs) performed annually in the United States doubled from 1999 to 2008 and is projected to rise by an additional 600 percent by 2030. Consistent with this trend, the volume of TKR procedures performed at Cleveland Clinic has risen 30 percent over the last five years. These increases are attributable to an expansion of indications to younger and more active patients as well as to the burgeoning population of aging baby boomers. These patients are demanding more from their joint replacements than ever before.

**THE QUEST TO SATISFY PATIENT DEMANDS**

The rising expectations of today’s TKR patients have spurred the pursuit of improvements in the design, delivery and execution of TKR. A recent technological focus is patient-specific positioning guides, which are custom guides made to match an individual patient’s anatomy, potentially allowing the surgeon to more efficiently and accurately perform TKR.

Most of the major orthopaedic implant manufacturers offer versions of this technology, all of which are based on the mechanical axis. CT or MRI scanning with or without a long-leg radiograph is used to build the custom cutting blocks. Many facilities within the Cleveland Clinic health system are equipped with the imaging protocols required by the device manufacturers to facilitate production of these guides, enabling patients to be accommodated with minimal inconvenience.

**SPECIAL CIRCUMSTANCES**

The diabetic ankle fracture in the setting of severe peripheral neuropathy or early Charcot neuroarthropathy requires an equally aggressive but different approach. Patients with these conditions are often identified by their lack of pain and lack of protective sensation. At Cleveland Clinic, these patients have been successfully treated using a combination of percutaneous transarticular screws and fine-wire external fixation.

**CONCLUSION: SUCCESS IS ATTAINABLE**

Ankle fractures in diabetic patients are becoming more common and problematic, not less. The good news is that successful treatment is still attainable using an aggressive approach that anticipates and addresses potential complications.

**ABOUT THE AUTHOR**

Dr. Berkowitz is a staff surgeon in the Department of Orthopaedic Surgery specializing in foot and ankle and lower extremity trauma surgery. He can be contacted at 216.444.7607 or berkowm@ccf.org.
GOALS OF TKR CAN BE ELUSIVE
The goals for arthroplasty are to reduce pain and restore function by way of a well-placed, durable TKR. Many laboratory investigations, finite element studies and clinical outcome trials have demonstrated that appropriate alignment is critical to achieving these objectives. Traditional cutting guides aid in the placement of components, but studies have shown that there is room for improvement. Navigation systems were developed with the hope of improving accuracy and reproducibility of TKR, although literature reports have been conflicting and emphasize concerns about increased cost, time in the operating room (OR) and complications.

PROPOSED BENEFITS OF A PATIENT-SPECIFIC APPROACH
Patient-specific cutting guides (see Figure for example) offer several potential benefits, including reduced OR time, increased efficiency in case preparation, decreased blood loss and improved outcomes secondary to improved component alignment.

This technology takes the “navigation” portion of the procedure, and all the time that it requires, out of the OR. The plan is established preoperatively and can quickly be implemented at the time of surgery. The custom guides pin onto the distal femur and proximal tibia without violating either canal. The theoretical advantages of this approach include reduced blood loss, which in turn should reduce transfusion requirements and ultimately decrease infection rates.

Customization allows the operation to be performed with fewer tools and trays, resulting in decreased turnover time and improved OR efficiency. Although the use of patient-specific guides does increase up-front costs to the hospital, it has been suggested that these costs may be offset by the reductions in OR time and by lower revision rates as a result of improvements in alignment. Early data in the literature provide some support for these claims.

A COMMITMENT TO ONGOING EVALUATION
Today’s healthcare climate dictates pursuit of technologies aimed at improving clinical outcomes while enhancing efficiency. Patient-specific instrumentation has the potential to be a technology that achieves both of these objectives. At Cleveland Clinic, we are committed to research to evaluate outcomes as we continue our use of patient-specific instrumentation.

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Ms. Klika is a research program manager for the Department of Orthopaedic Surgery and Surgical Operations.

SUGGESTED READING
Both malunion of a distal radius fracture and developmental Madelung deformity can significantly impair the function of the hand, wrist and forearm. An understanding of the anatomy, pathology and altered kinematics associated with these conditions provides a good foundation for operative correction when necessary. Historically, such correction has required extensive geometric planning, wide exposure, freehand osteotomy, provisional realignment, and maintenance of alignment while applying, drilling and securing plates with screws. The process can be time-consuming, the outcome can be uncertain and the anatomic correction can be less than precise.

Surgeons in the Upper Extremity Center at Cleveland Clinic’s Orthopaedic & Rheumatologic Institute are employing a new technology that minimizes intraoperative guesswork, eliminates the need for freehand osteotomy and correction, and adds precision to the restoration of anatomy. As a result, surgical time is reduced, operating room costs are lowered and the risk of infection is potentially decreased.

**PRACTICING THE OPERATION ON VIRTUAL MODELS**

Our surgeons are working with Materialise, a Belgian company that manufactures the SurgiCase® software engineering system. This computer program uses data from a three-dimensional (3D) CT scan to create a virtual bone model that exactly replicates a patient’s deformed skeleton. Using this model and a mirrored model of the contralateral forearm, our surgeons and Materialise engineers work together to create drilling and cutting guides based on the desired correction and the geometry of the plating system that best suits the patient’s needs. These guides fit the bone exactly, ensuring accurate drilling, cutting and reduction (Figure 1).

Virtual (and plastic) models are made of the deformed limb, the normal limb and the anticipated correction. With these models, the surgeon can “practice” the operation before doing the actual surgery (Figure 2). For each case, the surgeon plays an integral role in creating the design, planning the type and degree of correction, selecting the hardware and placing the screws and plates.

During surgery, the deformity is exposed through minimally invasive incisions (Figure 3). Drill guides are applied, and the screw holes are drilled. The drilling guide is removed, the cutting guide is applied and the osteotomy is made. The plate is placed over the previously drilled distal holes, and the screws are inserted. When the screws are inserted proximally, the plate automatically corrects the deformity to the position predicted preoperatively.
Figure 2. Photos of a practice procedure showing the guides for drilling screws proximally and distally. The guide for osteotomy can be used to practice on the bone model before it is applied in the actual surgical setting.

LESS OPERATIVE TIME, MORE OPERATIVE PRECISION
This computer-assisted 3D templating has reduced the overall operative time by one-third to one-half compared with freehand cases. It has also allowed us to restore bone length and bring inclination, tilt and rotation to within 3 degrees of normal. In cases where excessive bone shortening has been encountered, precise ulnar shortening osteotomy using the same technology has afforded accurate distal radioulnar joint realignment.

Our surgeons agree that this has been a truly amazing process in which to participate. We are initiating a prospective study to evaluate the cost-effectiveness and accuracy of this technology by comparing our results with those in historical controls. It has become clear that this technology saves time in terms of drilling, cutting, alignment and even screw selection, with bone screw lengths predetermined by the engineers with “spot-on” accuracy.

We believe that the additional cost of these guides will be offset by the shortening of operating room times and that the enhanced precision and predictability of this technology will result in better patient outcomes.

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A Promising System for Predicting and Stratifying Risk of Hospital-Acquired Conditions After Elective Joint Arthroplasty

By Carlos A. Higuera, MD; Ronald Huang, MD; and Javad Parvizi, MD, FRCS

The Centers for Medicare & Medicaid Services now require a reduction in Medicare Severity Diagnosis Related Group (MS-DRG) payments for certain hospital-acquired conditions (HACs) that could reasonably have been prevented through the application of evidence-based guidelines. Some of these conditions, including catheter-associated urinary tract infection (UTI), surgical site infection (SSI) and venous thromboembolism (VTE), are potential complications after elective total joint arthroplasty (TJA). Such conditions are currently reported to drive up healthcare costs and affect quality assessment regardless of age and comorbidities.

A risk stratification system is needed to ensure appropriate quality assessment and fair payment as well as to guide development of strategies for preventing these conditions in high-risk patients. In an effort to define such a stratification system, we attempted to identify the predictors of HACs and quantify their risk in a large cohort of patients who underwent TJA in a tertiary care center.

STRATIFICATION METHODOLOGY

We retrospectively reviewed the electronic medical records of a cohort of 26,390 patients who underwent elective primary TJA to identify patients’ demographics, body mass index (BMI) and comorbidities. The incidences of UTI, SSI and VTE were established. Adjusted hierarchical stepwise multivariate regression models were used to analyze independent risk factors for these HACs. The overall incidences of these HACs were as follows:

- UTI, 1.3 percent
- SSI, 0.8 percent
- VTE, 2.1 percent

Multiple independent predictors were identified for each of the above conditions. The predictors of UTI within 90 days after surgery were female sex, urinary incontinence, anemia, ischemic heart disease, hypertension and increased Charlson Comorbidity Index (CCI) score. Independent predictors of SSI within one year after surgery were ischemic heart disease, congestive heart failure, valvulopathy, connective tissue disease, diabetes mellitus and elevated BMI. Independent predictors of VTE within 90 days after surgery were knee surgery,

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<th>Table 1. Risk Stratification Criteria for the Three Hospital-Acquired Conditions (HACs)</th>
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<td>Risk factor</td>
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<td>Venous thromboembolism (VTE)</td>
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<td>History of VTE</td>
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<td>Knee surgery</td>
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<td>Atrial fibrillation</td>
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<td>Chronic obstructive pulmonary disease</td>
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<td>Anemia</td>
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<td>Depression</td>
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<td>Charlson Comorbidity Index (CCI) score</td>
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<td>Surgical site infection (SSI)</td>
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<td>Ischemic heart disease</td>
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<tr>
<td>Sex (female)</td>
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<tr>
<td>Hypertension</td>
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<td>Charlson Comorbidity Index (CCI) score</td>
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*Point value is negative because gastroesophageal reflux disease was shown to have a protective effect.

**For body mass index values over 40, 1 additional point for every 5 units.
history of VTE, chronic obstructive pulmonary disease, atrial fibrillation, anemia, depression, increased CCI score and increased BMI. Each independent predictor was quantified with a certain number of points depending on its correlation with the risk of having the studied HAC (see Table 1). Risk for each HAC was stratified into three groups (low, medium or high) based on patients’ total points across the various independent predictors. Table 2 presents the risk stratification for each of the HACs.

A NEED TO ACCOUNT FOR DIFFERENCES IN RISK PROFILES

Our analysis revealed significant differences among patients with respect to the risk of developing HACs after TJA. These differences were based on multiple variables including gender, comorbidities and BMI. These findings suggest it would be inappropriate to assume that all patients should be considered equal when assessing risk of developing HACs after TJA.

There is a need for risk stratification when assessing the quality of care surrounding TJA procedures and determining reimbursement for those procedures. The predictors we have identified for HACs may be used to develop such a risk stratification system. We believe this study developed the foundation for a risk stratification system for HACs following TJA and may be useful for assessing the quality of — and determining reimbursement for — such procedures.

VALIDATION UNDER WAY, PROSPECTIVE STUDY TO FOLLOW

We are now conducting an external validation of the models and the risk stratification here at Cleveland Clinic. Increasing the body of data will strengthen the models’ validity. Additionally, once validation of the models is finished, a prospective study using the stratification criteria will be implemented to measure patients’ risk of developing HACs. Identification of the most significant predictors may guide potential interventions to modify such predictors and reduce risk.

ABOUT THE AUTHORS

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Dr. Huang and Dr. Parvizi are with the Rothman Institute at Thomas Jefferson University Hospital, Philadelphia.

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<table>
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<th>Risk group</th>
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<th>Events** (% of total)</th>
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*Total patients with assessable diagnoses and complete data varied for each HAC, hence the differences in cohort size among the HACs. **Number of VTEs, SSIs or UTIs in the respective risk-group breakdowns.
Pelvic Ring Injuries: Trauma from High-Energy Impact Carries High Stakes

By Damien G. Billow, MD

Pelvic ring injuries may be among the most important problems that orthopaedic surgeons manage due to the associated risk of death and potential lifelong morbidity. Pelvic ring injuries are usually secondary to high-energy mechanisms such as motor vehicle collisions or falls from significant heights. In view of the high-energy mechanism required to sustain these injuries, clinicians should routinely consider clearance of the head, chest and abdomen by the emergency department or trauma service, as associated injuries are common. Pelvic ring injuries can cause life-threatening hemorrhage, leading to hemodynamic instability requiring significant blood transfusions. Advanced Trauma Life Support protocol should be followed, beginning with the primary survey and the ABC mnemonic.

THE WORKUP
After primary and secondary surveys are complete, every workup for a patient involved in a high-energy trauma should include an anteroposterior radiograph of the pelvis (Figure 1). Physical examination and a single radiograph can diagnose an unstable pelvic ring injury and guide patient care. A patient with hemodynamic instability and a significantly displaced pelvic ring should be placed in a sheet to help control pelvic volume and aid in hemodynamic resuscitation. Two individuals should place the sheet around both greater trochanters, and the sheet should be smooth and without wrinkles to avoid any soft-tissue compromise. It is held in place with multiple clamps (Figure 2). If hemodynamic instability persists, the patient may require angiography and selective embolization.

After the patient is stabilized, further imaging studies should be obtained. These include a CT with fine cuts of the pelvis as well as inlet and outlet radiographs of the pelvis. Pelvic ring disruptions are assessed by their anterior and posterior ring injuries. Instability of the anterior ring includes symphysis disruption and rami fractures, while instability of the posterior ring includes complete disruption of the sacroiliac joints or complete fracture through the sacrum. If a pelvic ring is deemed unstable, surgery should be considered. Complete sacral fractures with associated rami fractures that are treated nonoperatively have been shown to have a higher likelihood of future displacement of more than 5 mm compared with incomplete sacral fractures that are treated nonoperatively.¹

SURGICAL CONSIDERATIONS AND TECHNIQUE
Surgical treatment has been recommended for sacral fractures displaced more than 10 mm, with less than 5 mm being considered a satisfactory reduction.² Surgical treatment is aimed at deformity correction and pain relief. Surgical treatment of the anterior ring injury can consist of plating of the symphysis, retrograde percutaneous screw fixation of the rami or placement of an external fixator. The posterior ring can be stabilized in a variety of ways, including with open plating or with iliosacral screw fixation, either after open reduction or percutaneously after closed reduction.

Percutaneous iliosacral screw fixation of the posterior pelvis has been a significant advancement in orthopaedic trauma care. The operation is performed using quality fluoroscopic imaging of a well-reduced pelvis. Images consist of inlet, outlet and lateral views of the pelvis. These images, together with knowledge of pelvic anatomy, allow for safe placement of the screws, although care must be taken not to injure the L5 nerve root on the anterior sacrum and the S1 nerve root as it courses through the nerve root tunnel. Better reductions, and thus safer screw placement, are obtained when surgery is performed earlier rather than later. Cannulated screws 7.3 mm or 7.0 mm in size are placed through a small lateral incision. Screws should be long enough to allow screw threads to penetrate the sacral body for better pullout strength (Figure 3). Percutaneous iliosacral screws have been used with low rates of infection, blood loss, nonunion and neurologic injury.³

Postoperatively, patients are managed with protected weight bearing for eight to 12 weeks, depending on whether they had a bony injury or ligamentous pelvic ring injury.

IMPORTANCE OF SPECIALIZED TRAUMA CARE
Pelvic ring injuries are among the conditions for which specialized traumatology expertise can yield important — sometimes lifesaving — payoffs for patients. Cleveland Clinic is pleased to be expanding our orthopaedic trauma services at Hillcrest Hospital, a Cleveland Clinic community hospital that is part of the Northern Ohio Regional Trauma Network.
About the Author

Dr. Billow is a traumatologist in the Department of Orthopaedic Surgery. He specializes in acute management of fractures of the pelvis, acetabulum, and upper and lower extremities. He also specializes in nonunions and malunions. He can be contacted at 216.445.4570 or billowd@ccf.org.

References


Suggested Reading

Despite the evolution of numerous surgical interventions, shoulder instability continues to be a challenging problem facing orthopaedic surgeons. Partial cap resurfacing is a promising approach to humeral bone defects in select patients with shoulder instability that has been in use at Cleveland Clinic for nearly five years, with encouraging preliminary outcomes.

A DIFFICULT PROBLEM
Shoulder instability is a multifaceted problem. Shoulder stability requires a fine balance of both soft-tissue and bony architecture. Anterior shoulder dislocations have long been known to result in a predictable pattern of pathology that includes avulsion of the anterior-inferior labrum from the glenoid, fracture of the anterior-inferior glenoid (bony Bankart lesion) and depression fracture of the posterior-superior humeral head (Hill-Sachs lesion). In a similar fashion, the less common posterior shoulder dislocation can result in analogous pathologies on the posterior glenoid and anterior humeral head (reverse Hill-Sachs lesion). Osseous defects of the humeral head play a significant and well-documented role in the pathoanatomy of chronic shoulder instability. A large defect, a young age and involvement in high-risk athletic activities predispose the patient to recurrent shoulder dislocations and worsening of the injury if not properly treated.

Surgical management options for shoulder instability vary and have been subjected to much debate in the literature and among surgeons. Arthroscopic repair of labral tears and capsule plication is a popular treatment modality. However, mounting evidence from numerous research studies shows high failure rates in patients with chronic instability and in patients with significant bony lesions. The presence of humeral head defects ranges from 65 to 71 percent in first-time dislocators and is as high as 93 to 100 percent in recurrent dislocators. Defects that are smaller than 20 percent relative to the size of the humeral head appear not to pose a significant threat to stability, whereas larger lesions result in a significant increase in recurrent instability.

SURGICAL TREATMENT OF HUMERAL BONE LOSS
Once the decision is made to surgically address humeral bone loss, there are several options to restore glenohumeral stability. Traditionally, bone grafting procedures range from osteoplasty or osteotomy correction for small defects to bony allograft reconstructions for larger lesions. Although a large allograft provides arguably the best anatomic reconstruction, its complications include graft resorption, possible disease transmission and challenges relating to graft availability. Another option is “remplissage,” in which posterior soft-tissue structures of the shoulder are anchored to the Hill-Sachs defect, but remplissage is a nonanatomic reconstruction that has been shown to decrease shoulder range of motion both in a cadaveric model and when comparing operative and nonoperative shoulders in postoperative patients.

The HemiCAP® partial humeral head resurfacing implant (Arthrosurface Inc., Franklin, Mass.) (Figure 1) is a relatively new alternative for managing both Hill-Sachs and reverse Hill-Sachs lesions in the setting of acute and chronic shoulder instability. This metallic resurfacing implant is an off-the-shelf device available in multiple sizes and multiple radii of curvature to provide a near-anatomic reconstruction while preserving native bone stock.

OUR EXPERIENCE WITH THE PARTIAL RESURFACING IMPLANT
Partial cap resurfacing of humeral bone defects has been used specifically in the setting of shoulder instability for nearly five years at Cleveland Clinic. Our indications for the device include the following:

- A humeral head lesion of at least 25 percent of the total area of the articulating surface
- An engaging Hill-Sachs or reverse Hill-Sachs lesion
- Continued shoulder instability despite previous arthroscopic treatment of soft-tissue structures

Shoulders with deficient glenoid bone stock also undergo a Latarjet procedure at the same time as humeral defect resurfacing (Figure 2). All operations are performed through a deltopectoral approach, except for one case in which a muscle-splitting technique was used.
Our investigations are ongoing, but results thus far are very encouraging. To date, 21 shoulders in 20 patients (mean age, 34 years; range, 17 to 72 years) have been evaluated, with a mean follow-up of 28.1 months (range, 6 to 56 months). Sixteen of the 21 shoulders have undergone partial cap placement for a Hill-Sachs lesion in anterior shoulder instability, and five have undergone a partial cap placement to treat a reverse Hill-Sachs lesion.

None of the 21 shoulders has suffered a dislocation following HemiCAP implantation. Review of patient-reported outcome scores from both the Short-Form Health Survey (SF-12) and the Musculoskeletal Review of Systems reveals statistical improvement following surgery, and more than 80 percent of patients report a return to activity levels comparable to those before their shoulder injuries. Although these are relatively generic outcomes scores, improvement on these measures indicates overall patient improvement and increased quality of life. All patients undergoing shoulder surgery at Cleveland Clinic now also complete the shoulder-specific Penn Shoulder Score, with preliminary results in our patients showing a similar trend in improvement postoperatively.

Although recurrent glenohumeral instability remains a difficult problem to treat successfully, partial resurfacing arthroplasty of focal defects appears to be a promising technique for managing humeral bone loss.

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Dr. Miniaci is a staff surgeon in the Department of Orthopaedic Surgery and Medical Director of the Cleveland Clinic Sports Health facility. He specializes in shoulder reconstruction, knee reconstruction and cartilage resurfacing, and can be contacted at 216.518.3466 or miniaca@ccf.org.
A Dual-Purpose Questionnaire for Adolescents with Lower Extremity Problems: Developed for Clinical Practice with Research Utility in Mind

By Paul Saluan, MD; Boris Bershadsky, PhD; and Ryan Goodwin, MD

Treatment of adolescents with musculoskeletal problems is a rapidly growing area, with new technologies and procedures appearing every year. Objective and clinician-collected data are critically important in selecting appropriate treatment, but patients’ perception of their well-being is vital when evaluating treatment success. Indeed, patient-reported evaluation of health-related quality of life has become a mandatory component of studying new treatments.

The most promising way to lower the cost of collecting outcomes-related data is through integration with the process of collecting clinical data. This integration requires dual-purpose questionnaires that are useful in clinical studies and clinical practice simultaneously. Yet these two characteristics — usefulness in clinical studies and usefulness in clinical practice — do not necessarily overlap, as good outcome instruments may not be clinically relevant (and vice versa).

REVERSING THE USUAL QUESTIONNAIRE MODEL
Traditionally, outcome instruments are designed to support clinical research (psychometric properties) and then may be tested for their potential to support clinical practice (clinical properties). At Cleveland Clinic, we proposed reversing this process — to develop a clinically valuable tool for our population of interest (adolescents with lower extremity problems) and then test its psychometric properties.

To be clinically useful, a self-reported questionnaire for adolescents with problems in the lower extremities should be clinically relevant, brief, simple and applicable in a non-screened population. We developed such an instrument based on several broadly used questionnaires (PODCI, SF-10, CHQ, ASK, PedsQL, FAQ, GMFM, PEDI, WeeFIM). Special attention was paid to these questionnaires’ applicability in clinical practice. When analyzing these instruments, we concentrated on a few of the most clinically important domains: self-reported pain and physical limitations, perceived leg-related dissatisfaction symptoms, problem location and footedness.

INITIAL USE IN CLINICAL PRACTICE
The resulting questionnaire contains scorable and non-scorable sections (Figure). The scorable section allows us to quantify physical limitations and pain that patients experience during low- and high-demand activities (four scores). In the first version of the questionnaire, this section consisted of 15 questions. One 11-level question with four anchors (never, rarely, often, always) was used to capture the patient’s dissatisfaction with his/her physical limitations and pain. The nonscorable section (five questions) quantifies symptoms related to particular joints; it also includes a body diagram and inquires about the patient’s footedness.

Patients received blank questionnaires and completed them before seeing their doctors. Completed questionnaires were scanned, and the information was automatically extracted and loaded into a research database (to support statistical analysis) and an electronic medical record (to support clinical process).

During the past two years, the questionnaire was used in 3,445 consecutive surgical and nonsurgical patients (7,197 applications) as a part of the clinical process at Cleveland Clinic. Patient-reported data stored in the research database were combined with clinical information stored in the electronic medical record. Statistical analysis-targeted shortening of the questionnaire was implemented using a combination of cluster analysis and resampling with replacement. This demonstrated that the scorable section of the instrument could be reduced to 11 questions without compromising the stability of the instrument’s dimensional structure.

PUTTING THE TOOL TO THE TEST FOR CLINICAL STUDIES
The usefulness of a questionnaire in clinical studies can be estimated by testing its psychometric properties (validity, reliability and sensitivity to change).

Validity (face, content and construct validity) is the ability of an instrument to measure what it is intended to measure. Face validity refers to experts’ opinion that a questionnaire’s content (questions and responses) is relevant to the studied construct. Content validity can be tested by measuring the number of missing responses and counting the number of respondents who provide the best and worst possible combinations of responses (ceiling and floor effects). Construct validity can be estimated by testing the questionnaire against predefined hypotheses. Most often these hypotheses are
formed to test convergent and divergent validity in comparison with other functional or clinical measures.

Reliability (internal consistency and stability over time) refers to the accuracy of measurement in cross-sectional and longitudinal studies. Internal consistency estimates the similarity between items that represent the same domains in cross-sectional studies (single measurement point). It can be quantified by Cronbach’s alpha or intraclass correlation coefficients. Testing the stability of scores in longitudinal studies requires at least two measurement points and evaluates random variation of scores in a sample that supposedly does not have a systematic change over time.

Sensitivity to change, or responsiveness, reflects an instrument’s ability to capture the systematic effects of studied interventions and is one of the most important indicators of its usefulness in clinical studies. Sensitivity to change is negatively correlated with the sample size needed to detect the effects of studied interventions. Insufficiently sensitive questionnaires require a much larger sample and lower the cost-effectiveness of studies.

Statistical analysis of data accumulated in our research database confirmed the questionnaire’s validity, reliability and sensitivity to change. This proved that our instrument designed as a clinical tool is able to support clinical outcomes research. This instrument can be viewed as a low-cost, clinically relevant add-on to the existing library of outcomes tools designed for adolescents with injury and pain in the lower extremities. We believe it can serve as an instrument of choice for large-volume data collection in nonscreened populations.

The work reported here was sponsored by a Pediatric Orthopaedic Society of North America/Orthopaedic Research and Education Foundation (POSNA/OREF) research grant.

Figure. The dual-purpose lower extremity questionnaire.

ABOUT THE AUTHORS

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‘Is It Cancer, Doctor?’ Vigilant Management of Enchondroma

By David Joyce, MD; Nathan W. Mesko, MD; Hakan Ilaslan, MD; Steven A. Lietman, MD; and Michael Joyce, MD

In the world of orthopaedic oncology, differentiating benign lesions from those with a more menacing natural history is important. One of the most common bone lesions discovered as an incidental finding is the benign cartilage lesion known as the enchondroma. With at least 85 percent remaining asymptomatic, these lesions are typically found on routine multimodal imaging studies during investigations of activity-related musculoskeletal complaints, such as a sports injury to the rotator cuff or knee, or arthritis of a joint. Understanding the presentation and appearance of these benign lesions is important, as it will direct future care and may help ease anxiety and quell uncertainty in the patient with a newly discovered bone lesion. Although transformation of a solitary enchondroma to malignancy is rare, any concern for possible malignancy should prompt referral to a major musculoskeletal tumor center.

A ROUTINE PRESENTATION

The enchondroma lesion itself is made up of a benign growth of hyaline cartilage. Its exact cause is unknown. It displays equal prevalence in males and females between ages 20 and 50, when it is often discovered, although enchondroma lesions may begin to grow in early childhood. There is no sex predilection, and since most enchondromas are asymptomatic, the true prevalence and most frequent age of onset are unknown. Common locations for enchondromas include the metatarsal and metacarpal bones, distal femur (Figure 1) and proximal humerus (Figure 2).

Less than 15 percent of enchondromas are symptomatic (active). Active lesions are painful and may increase the risk for pathologic fracture if associated with cortical thinning (endosteal scalloping). A patient with constitutional symptoms (e.g., night sweats, weight loss, nocturnal pain) should be evaluated aggressively for malignant transformation. Associated soft-tissue masses are indicative of either fracture hematoma or chondrosarcoma transformation.

Figure 1. Lateral radiograph showing a distal femur enchondroma. Note the marked geographic borders and lack of periosteal or cortical changes.

Figure 2. Anteroposterior radiograph showing an enchondroma of the proximal humerus. The calcification pattern largely resembles the “popcorn” appearance of the typical benign enchondromatous lesion.
RADIOGRAPHIC BASICS

Understanding the common radiographic findings for a benign lesion is important. Although extremely rare (< 1 percent incidence), malignant transformation of an isolated enchondroma has been described. A basic understanding of benign radiographic characteristics can aid in determining the possibility of malignant progression.

Plain radiographs should always be interpreted in the context of the history and physical exam. Enchondromas most commonly appear as elongated intramedullary lesions located in a centralized position of the metaphyseal and metadiaphyseal regions. They typically are solitary, well-formed lesions with a calcified matrix resembling popcorn (the exception is enchondromatosis; see below). Hand enchondromas are more commonly radiolucent but can also display punctate stippling in conjunction with cortical thinning (though rarely cortical destruction). Typically, periosteal reaction is seen only with associated pathologic fracture. A representative radiographic differential diagnosis for enchondroma should include low-grade chondrosarcoma and bone infarct. In general, after skeletal maturity, enchondromas do not grow and rarely cause pain.

Endosteal scalloping may occur with enchondromas. Anteroposterior and lateral plain film evaluation should be undertaken initially. Scalloping may be incidental or, if severe enough, may lead to undue cortical stress and, in rare instances, pathologic fracture. Soft-tissue or extracortical masses associated with an enchondroma should heighten suspicion for potential transformation to a chondrosarcoma.

ENCHONDROMAS AND MALIGNANT TRANSFORMATION

Although solitary enchondromas are largely the rule, multiple foci of enchondromas in a single patient can be found in syndromes such as Maffucci’s syndrome and Ollier’s disease (enchondromatosis). Maffucci’s syndrome is characterized by soft-tissue hemangiommas and multiple enchondromas, often in the hands but also involving long bones. Radiographic clues include calcified soft-tissue phleboliths within the hemangiomas, as well as aggressive-appearing multifocal lytic bone lesions. In both Maffucci’s syndrome and Ollier’s disease, angular and rotational deformities can be caused by lesions involving the growth plates. A sudden increase in pain and destructive cortical changes are worrisome for
malignant transformation. Both syndromes are associated with an increased risk of secondary chondrosarcoma, with incidence as high as 30 percent in Ollier’s disease and up to 50 percent in Maffucci’s syndrome.

Though it is rare in solitary enchondromas, malignant transformation must always be considered. Clues that signal a potential for malignant degeneration include greater than 50 percent endosteal scalloping, full-thickness cortical destruction (Figure 3), periosteal changes and associated soft-tissue masses. Isolated pelvic enchondromas are extremely rare, and any enchondroma-like lesion in the pelvis warrants suspicion for a potential chondrosarcoma. Beyond plain films, CT scans are helpful for evaluating the degree of endosteal scalloping, and MRI is most reliable in delineating the true extent of intramedullary or extracortical involvement in conjunction with any soft-tissue mass (Figure 4). Bone scans are largely nonspecific in diagnosing solitary enchondromas (due to a near-universal propensity for increased uptake) but may be helpful in recognizing the patient with multiple enchondromatosis.

MANAGEMENT ISSUES
Since most enchondromas are incidental findings, management usually consists of regular follow-up via serial radiographs, with observation being the treatment of choice for most lesions that are asymptomatic. Any questionable lesion-associated pain may be distinguished from periarticular pathology with a simple intra-articular injection. An adequate biopsy is indicated in lesions with associated pain and worrisome radiographic characteristics (i.e., full-thickness cortical destruction) for a low- or intermediate-grade chondrosarcoma. Definitive diagnosis often requires more than a needle biopsy, with a clear-cut diagnosis often depending on the permanent pathology. As in the management of all sarcomatous lesions, the surgeon who will be doing the definitive surgery should be involved early, with the patient referral made prior to biopsy. Intralesional curettage and use of adjuvant therapy (e.g., liquid nitrogen, phenol) for low-grade extremity chondrosarcoma have produced excellent long-term results, with recurrence rates of approximately 6 percent (J Bone Joint Surg Am. 2012;94[13]:1201-1207).

‘NO, MRS. JONES, THIS IS NOT CANCER’
The incidence of benign bone lesions far surpasses the number of diagnosed sarcomas. Although the vast majority of enchondromas will remain indolent over the patient’s lifetime, every orthopaedic surgeon should be familiar with the diagnostic characteristics of common bony and soft-tissue lesions. Any concern for possible malignancy should initiate a referral to a major musculoskeletal tumor center, such as Cleveland Clinic. In the vast majority of cases, the good news you convey to the patient concerning the benign characteristics of his or her lesion will dispel uncertainty and provide reassurance. The welcome words “It’s not cancer” will reliably bring a smile to the face of patient and provider alike.

ABOUT THE AUTHORS
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Cleveland Clinic Plays Exclusive Role in Updating Musculoskeletal Volume of *The Netter Collection*

Cleveland Clinic’s Orthopaedic & Rheumatologic Institute has partnered with the publisher of *The Netter Collection of Medical Illustrations* to comprehensively update the series’ three-part *Musculoskeletal System* volume. The collaboration represents the first time a medical center has provided exclusive clinical content guidance for a volume of this iconic collection of anatomic illustrations that has educated generations of medical students. The collection is published by Elsevier.

The effort will help complete the second edition of the nine-volume collection, marking the first revision since its mid-20th-century introduction by revered physician and medical illustrator Frank H. Netter, MD. The second edition is available in electronic format, as well as in print with the hallmark covers that have led the collection to be affectionately known as the “Green Books.”

Co-editors of the second edition’s *Musculoskeletal System* volume are Joseph P. Iannotti, MD, PhD, Chairman of Cleveland Clinic’s Orthopaedic & Rheumatologic Institute, and Richard D. Parker, MD, Chairman of the Department of Orthopaedic Surgery. They enlisted the assistance of 50 Cleveland Clinic staff — mostly from the Orthopaedic & Rheumatologic Institute, but also with contributions from the Neurological Institute and Lerner Research Institute.

Their charge was to update and refresh the volume’s text, add modern imaging where appropriate, organize the content in keeping with modern practice and medical instruction, and guide illustration updates where needed. The latter were carried out by a team of medical illustrators working in the Netter style. Dr. Netter died in 1991.

“Our publishing partner, Elsevier, wanted to ensure that the updated volume had the appeal it’s always had,” says Dr. Parker. “So we shared a mutual commitment to the same precision, clarity and proficiency in presenting complex concepts simply that made the first edition of *The Netter Collection* such an institution in medical education.”

That shared commitment made the collaboration a natural one, Dr. Parker adds. “*The Netter Collection* is part of the core education of almost every medical student in America, if not worldwide,” he explains. “Cleveland Clinic has the same mission of educating future and current medical providers both domestically and internationally. So it made sense to partner on this and co-brand the volume to each of us. We are honored that Cleveland Clinic is the first institution to contribute in an exclusive way to this universally recognized educational and reference text, and we are delighted that the Orthopaedic & Rheumatologic Institute was able to play a key role.”

The *Musculoskeletal System* volume (volume 6) consists of three parts: *Upper Limb* (Part I), *Spine and Lower Limb* (Part II) and *Biology and Systemic Diseases* (Part III). Part I is being released in November 2012, with Parts II and III following in February and March 2013.
Orthopaedic Residency Update 2012

By Thomas E. Kuivila, MD

Reflecting on the quality and remarkable accomplishments of our orthopaedic surgery residency graduates this past June, I took some measure of pride and comfort in the maxim of Aristotle: “The sign of a great teacher is that the accomplishments of his students exceed his own.” By then applying the somewhat intuitive algebraic symmetric property of equality (if $a = b$, then $b = a$), I realized this implied that since our residents were stellar and would indeed likely exceed our own accomplishments, then we, as an orthopaedic faculty, were great teachers.

Wait, what is it that’s written about pride? “Pride goes before destruction, a haughty spirit before a fall.” Exactly. I adjusted my perspective quickly. While I believe we do a good job of educating the residents and preparing them for careers as surgeons, no craftsman carves a masterpiece from mediocrity or materials. So let’s be honest: These young men and women are academic stars before we even meet them. And we will meet our new stars as we say good-bye to the old ones.

A FOND FAREWELL TO OUR RESIDENCY GRADS

At our residency graduation dinner in June, we said adios to seven outstanding young physicians:

Michael Bloomfield, MD, a graduate of the six-year orthopaedic residency track, is a fellow in adult reconstructive surgery at the Rothman Institute at Thomas Jefferson University in Philadelphia. He has been recruited to return to Cleveland Clinic and will do so next August.

Jarrod Dumpe, MD — or, more appropriately, Maj. Jarrod Dumpe, USAF, MC — who arrived in Cleveland from the Medical College of Georgia, has returned to the sunny Southern United States as a staff surgeon at Wilford Hall Medical Center at Lackland AFB, Texas, where he will take care of our fighting elite and their dependents.

Mark Kayanja, MD, PhD, has remained in the Cleveland Clinic fold as a fellow in our combined neurosurgery and orthopaedic spine fellowship. The pediatric spine group eagerly anticipates his visits to the scoliosis operating theater.

Michael Mariscalco, MD, headed to the land of the Scarlet and Gray to begin his fellowship in orthopaedic sports medicine at The Ohio State University.

Mena Mesha, MD, also a graduate of the six-year orthopaedic residency track, will augment his upper extremity know-how as a shoulder and elbow fellow in the Harvard combined program.

Aaron Potts, MD, seeking a change of venue from the Midwest for a year, is at the San Diego Sports Medicine Center as a fellow in orthopaedic sports medicine.

Chris Utz, MD, has taken his talents to the University of Cincinnati as he too is a fellow in orthopaedic sports medicine.

Because I was, if nothing else, a procrastinator in penning this article, I have the chance to announce that all seven successfully completed Part I of the ABOS exam in July. Congratulations and best wishes for continued success!

INTRODUCING OUR SIX NEW RESIDENTS

Like the cost of college (anyone have a clue what keeps me up nights?) the number of applicants for our six residency positions climbs annually. Last year we topped 700 applications. Through a laborious but enjoyable culling process, we interviewed 72, ranked 60 and were delighted to match six outstanding individuals from our top nine ranking spots. The orthopaedic residency class of 2017 includes:

- David Brigati, MD, University of Texas – San Antonio
- Vahid Entezari, MD, Iran University of Medical Sciences
- Maggie Glenn, MD, University of South Alabama
- Patrick Marinello, MD, Albany Medical College
- Daniel Mesko, DO, Michigan State University
- Michael Silverstein, MD, Florida State University

If their past accomplishments and academic credentials — far too numerous to recount here — are any gauge of future success, we are in good shape indeed.

SOME HOMECOMINGS TOO

Finally, we recently welcomed back two former residents, both from the class of 2011, as staff physicians. Carlos Higuera, MD, who completed his fellowship in adult reconstructive surgery at Jefferson, will equally split his time between his clinical arthroplasty role and outcomes research. Damien Billow, MD, who completed a fellowship in orthopaedic traumatology at Vanderbilt University, will lend his expertise in the management of trauma at both our main campus location and in the expanding orthopaedic service at Cleveland Clinic’s Hillcrest Hospital.

Orthopaedics continues to be an exciting surgical specialty, and we are grateful that the education of new surgeons is truly a two-way street in which their challenge is to keep us on top of our game. Remaining in the vanguard as new technologies and strategies emerge is critical for our collective future success, as reflected in Alvin Toffler’s observation that “the illiterate of the 21st century will not be those who cannot read and write, but those who cannot learn, unlearn and relearn.”

ABOUT THE AUTHOR

Dr. Kuivila, a pediatric orthopaedic and scoliosis surgeon, is also Vice Chairman for Education in the Orthopaedic & Rheumatologic Institute as well as the Orthopaedic Residency Program Director. He can be contacted at 216.444.2741 or kuivilt@ccf.org.
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Orthopaedic Insights is published by Cleveland Clinic’s Department of Orthopaedic Surgery to inform musculoskeletal specialists about advances in diagnosis, medical and surgical management, and research.

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At the Orthopaedic & Rheumatologic Institute, our physicians, scientists and engineers pursue excellence and innovation in the care of patients with joint, bone, muscle, connective tissue and immune disorders. The Orthopaedic & Rheumatologic Institute is one of 26 institutes at Cleveland Clinic, a nonprofit academic medical center ranked among the nation’s top hospitals (U.S. News & World Report), where nearly 3,000 physicians in 120 specialties collaborate to give every patient the best outcome and experience.

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