What's New in Orthopaedic Trauma

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The treatment of musculoskeletal trauma continues to evolve at a rapid pace, with ongoing advances in our understanding of the pathophysiology of trauma and the biology of fracture-healing and the soft-tissue response to injury, the continual introduction of new implants and surgical techniques, and clarification of the role of nonoperative treatment of certain injuries. The current emphasis on evidence-based management continues, with the orthopaedic literature containing an increasing number of randomized clinical trials, meta-analyses, and systematic reviews.

For the purpose of summarizing advances in orthopaedic traumatology within the past year, we reviewed all issues of The Journal of Bone and Joint Surgery (American Volume and British Volume), Journal of Orthopaedic Trauma, Journal of Trauma, Clinical Orthopaedics and Related Research, and Injury. Selected articles from other journals were also included. Finally, presentations from the annual meetings of the Orthopaedic Trauma Association (OTA) and the American Academy of Orthopaedic Surgeons (AAOS) were reviewed. All articles and presentations that represent Level-I and II evidence are reviewed herein, along with other articles of clinical importance (in the opinion of the authors).

**Fracture-Healing**

Research on fracture-healing can be broadly grouped into two areas: biophysical stimulation of fractures and the use of growth factors and other bioactive peptides to promote healing. With respect to biophysical stimulation, several recent studies have evaluated the effect of low-intensity pulsed ultrasound therapy and electromagnetic stimulation on fracture-healing. First, an in vitro study demonstrated that alkaline phosphatase activity, osteocalcin secretion, the expression of osteoblast-related genes, and the mineralization of human fracture hematoma-derived progenitor cells were significantly higher when low-intensity pulsed ultrasound was applied to human fracture hematoma. Two systematic reviews of the use of low-intensity pulsed ultrasound for the treatment of acute fractures were published during the last year, with somewhat conflicting results. One review concluded that low-intensity pulsed ultrasound accelerated healing, particularly at the sites of acute fractures of the tibia and radius that were treated nonoperatively with cast immobilization. The second review noted that three trials showing a benefit of low-intensity pulsed ultrasound at the sites of fresh fractures were of low quality, whereas one study of moderate quality showed no benefit for the treatment of fresh fractures of the clavicle. The authors of the latter review noted that the current literature regarding low-intensity pulsed ultrasound is of low quality and provides conflicting conclusions and concluded that large clinical trials evaluating patient-centric outcomes are needed. Finally, a meta-analysis evaluating the use of electromagnetic stimulation in long-bone lesions demonstrated that the current evidence neither supports nor refutes the benefits of electromagnetic stimulation therapy.

There is great interest in the use of peptides to promote the healing of problematic fractures. Two bone morphogenetic proteins are currently available in the United States: rhBMP-2 (INFUSE; Medtronic Sofamor Danek, Memphis, Tennessee) and rhBMP-7 (OP-1; Stryker Biotech, Hopkinton, Massachusetts). A third potential source of bioactive proteins is platelet-rich plasma, which can be obtained from the patient’s own blood. A randomized clinical study in which rhBMP-7 was compared with platelet-rich plasma for the treatment of fracture nonunion demonstrated that patients managed with rhBMP-7 had greater union rates than those managed with platelet-rich plasma (86.7% compared with 68.3%; p = 0.016). A series of four cases highlighted the potential development of substantial heterotopic ossification following use of BMPs.

Bone void fillers are also commonly used. Several recent studies demonstrated that calcium phosphate bone cement is superior to autogenous bone graft for the filling of subarticular

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cavitary defects in patients with unstable tibial plateau fractures, resulting in significantly less subsidence and reducing the risk of loss of reduction.

Outcomes

The Lower Extremity Assessment Project (LEAP) study group reported several new findings from their large observational study of patients with limb-threatening lower extremity trauma. First, the patients had a large number of complications, including wound infections, nonunion, wound necrosis, and osteomyelitis. Nonunion (31.5%) and wound infection (23.2%) were the most common complications in the salvage group, whereas wound infection (34%) was the most common complication in the primary amputation group. Furthermore, the late amputation group had the highest complication rate (68%), mostly due to wound infection. Another report indicated that no injury severity scoring system was predictive of functional recovery in patients with successful limb reconstruction after high-energy trauma to the lower extremity; therefore, caution should be employed when using these scores to predict potential recovery from injury. Finally, it was noted that physical function, pain, and the presence of depression were the factors that were most predictive of patient satisfaction two years after a high-energy lower extremity injury. Interestingly, no information that was known preoperatively, such as patient demographic factors, injury type or severity, or treatment characteristics, could be used to predict patient satisfaction two years after the injury.

Several studies evaluated the impact of musculoskeletal trauma on patients and their families. A review of 1290 patients with orthopaedic injuries indicated that self-reported pain-related disability in the week before the injury, not finishing high school, pain at the time of discharge from acute care, and being eligible for compensation were predictors of moderate or severe pain six months after the injury. Another study explored ethnic differences in the risk of posttraumatic stress disorder and demonstrated that Hispanic patients who sustained musculoskeletal injury were nearly seven times more likely to demonstrate symptoms of posttraumatic stress disorder than were white patients. Finally, a survey of caregivers to patients with musculoskeletal injuries demonstrated that a majority of the caregivers themselves experienced stress, financial drain, and employment difficulties, emphasizing the importance of referring both patients and caregivers to the appropriate services to further improve outcomes.

A study that was performed to evaluate when patients had recovered sufficiently to drive an automobile after lower extremity fractures showed that a patient’s brake travel time, an indicator of one’s ability to operate the foot controls of a car, returned to baseline levels six weeks after weight-bearing had begun, which was typically twelve weeks for patients with long-bone injuries and eighteen weeks for those with articular fractures.

Infection

Two studies evaluated risk factors for surgical site infection with methicillin-resistant Staphylococcus aureus in patients with orthopaedic trauma. One study demonstrated that methicillin-resistant Staphylococcus aureus carrier status at the time of admission, hip fracture, and advancing age (with a 1.8% increase in relative risk per year) were associated with higher rates of such infection. A large case-control study demonstrated that vascular disease, chronic obstructive pulmonary disease, being admitted to an intensive care unit, having an open wound, and increased age were risk factors for the development of a deep infection with methicillin-resistant Staphylococcus aureus at the surgical site.

An interesting study identified evidence of bacterial DNA in 42% of fracture callus specimens without evidence of any other deep tissue colonization; actual bacteria were isolated in 14% of specimens from healing fractures and 35% of specimens from nonhealing fractures. The bacterial DNA was very similar to strains commonly found on the skin of the foot. Although additional research is needed, this finding raises the possibility that the source of unexpected infection complicating fracture-healing and reconstructive orthopaedic procedures may be the patient’s own skin.

Finally, the value of C-reactive protein levels in diagnosing infection after internal fixation was studied. In all patients, C-reactive protein levels increased after surgery and peaked on the second postoperative day, after which levels decreased. In uncomplicated cases, C-reactive protein levels continually decreased, whereas in cases complicated by infection, a secondary elevation in C-reactive protein level was noted beginning on the fourth postoperative day. A C-reactive protein value of ≥296 mg/L on the fourth postoperative day was found to be predictive of infection.

Polytrauma

The timing of fixation of fractures is an important variable affecting the outcome for patients with polytrauma. An observational study of patients with multisystem trauma demonstrated an approximately 50% reduction in mortality risk when definitive fixation of a femoral shaft fracture was delayed at least twelve hours after the injury as compared with treatment during the first twelve hours after admission. Also, increases in the levels of the proinflammatory cytokines interleukin-6 (IL-6) and interleukin-8 (IL-8) after the fixation of pelvic and acetabular fractures appear to be related to the magnitude of the operation as the levels were related to the degree of blood loss rather than the duration of surgery itself. Greater increases in IL-6 and IL-8 levels were seen in patients who were operatively managed early (within one or two days). Both of these findings support the current concept that, in the setting of multiple trauma, optimization of the patient’s condition is an important determinant of outcome, and even relatively short delays may allow for better resuscitation of the patient and improved outcome.
Vascular injury sometimes accompanies fracture, and in this circumstance there has been controversy regarding whether fracture repair should occur before or after revascularization. A meta-analysis of fourteen Level-III (retrospective cohort) studies indicated that there was no significant difference in the rate of amputation for patients who had the vascular repair performed first as compared with those who had the fracture fixation performed before the vascular repair. The authors noted that the duration of limb ischemia is a relative rather than an absolute predictor of amputation and that other variables such as soft-tissue and neurologic injury are more predictive of disability and amputation.

**Osteoporosis**

It is incumbent on orthopaedic surgeons to consider osteoporosis when evaluating patients who have a fracture and to refer at-risk patients for appropriate treatment. Of course, recognizing patients who should be referred for osteoporosis screening requires knowledge about osteoporosis risk factors. A study of nearly 16,000 patients demonstrated that a diagnosis of heart failure is associated with an increased risk of a future fracture, particularly a hip fracture; therefore, in addition to elderly patients with low-energy fractures, patients with heart failure should have screening and treatment for osteoporosis.

Unfortunately, identification of at-risk patients does not mean that treatment is initiated; current evidence suggests that many patients are not appropriately referred for screening after fracture. A study of 23,146 postmenopausal women who sustained a hip fracture demonstrated that only 6% were managed with bisphosphonate treatment after the injury and that only 41% of these patients continued to receive the medication at eighteen months. A prospective study demonstrated that more patients were managed with pharmacologic treatment of osteoporosis when the assessment was initiated by the orthopaedic surgeon and follow-up was conducted in a specialized orthopaedic osteoporosis clinic than was the case when patients were referred to their primary care physician for osteoporosis management (58% compared with 29%). Finally, a cost-decision model showed that tertiary care centers that hire an osteoporosis coordinator to identify patients with fragility fractures and to coordinate their care could reduce the incidence of hip fractures and could save the hospital money if as few as 350 patients were managed annually.

**Pediatric Fractures**

Recent studies have recommended early definitive fixation of supracondylar humeral fractures in children. A systematic review of Gartland type-III supracondylar fractures demonstrated that the rate of failure of closed reduction and conversion to open reduction was significantly higher (23% compared with 11%) when treatment was delayed by more than twelve hours. Furthermore, a review of children with closed, low-energy supracondylar fractures without vascular compromise who subsequently had development of compartment syndrome demonstrated that >90% of the patients had severe swelling of the elbow at the time of presentation and that all had a mean delay of twenty-two hours before treatment, emphasizing that early reduction reduces the risk of subsequent compartment syndrome.

**Clavicular Fractures**

Whether or not to repair clavicular fractures has been a topic of interest in previous years, with the focus on identifying which fractures (and patients) benefit from surgery. Two studies evaluated outcomes following intramedullary nail fixation of the clavicle with a titanium elastic nail inserted through the medial aspect of the clavicle. The first study was a retrospective review of thirty-one cases in which there was a 100% union rate and excellent cosmetic and functional results, although protrusion of the nail occurred in seven cases, requiring shortening of the nail in five patients. Open reduction was required in half of the cases, and the nails were removed from all but two of the patients. The second study was a randomized clinical trial of sixty adult patients in which titanium elastic nailing was compared with nonoperative management. All fractures in the titanium elastic nailing group healed, whereas the nonoperative group had a 10% nonunion rate. Two patients in the nonoperative group underwent subsequent surgery to correct a symptomatic malunion. Outcome and disability scores favored the titanium elastic nailing group even at the time of the two-year follow-up, although the greatest differences were seen in the first eighteen weeks. Finally, patients in the titanium elastic nailing group had less shortening and were more satisfied with their cosmetic appearance and the overall outcome.

**Proximal Humeral Fractures**

A matched-control series of displaced greater tuberosity fractures (defined as those with >5 mm of displacement) that were treated operatively revealed a 100% union rate, with 80% of the patients having a good to excellent functional outcome score; these results were significantly better than those for patients who had been managed nonoperatively. A retrospective study of forty elderly patients with three and four-part proximal humeral fractures demonstrated that open reduction and internal fixation with a locked plate was associated with better clinical results as compared with a technically optimal hemiarthroplasty, and the authors noted that it should be considered as a viable option for the treatment of these fractures. A retrospective series emphasized the technical difficulties and complications encountered in association with the use of angular stable (locking) plates. Although the patients in that series had a 95% rate of fracture union, only half of the patients had a good or excellent result, 33% had failure of reduction and fixation, and 21% had development of humeral head osteonecrosis. The majority of these complications occurred in patients older than sixty-five years of age with type-C fractures.
Unfortunately, complications are common after the surgical repair of proximal humeral fractures. In elderly patients with three and four-part proximal humeral fractures, the risk of complications appears to be influenced by the initial direction of humeral head angulation. In one series, the complication rate was 79% for varus fractures, compared with 19% for valgus fractures. In an analysis of 1027 proximal humeral fractures, the prevalence of nonunion was 1.1% among those that were treated nonoperatively, and metaphyseal comminution and translation of the humeral head by >33% were factors that increased the nonunion rate. Furthermore, a delay of more than six months in the operative treatment of a nonunion resulted in a significant deterioration in overall glenohumeral function, leading the authors to suggest that the operative fixation of a nonunion should occur no later than three months after the fracture.

Finally, a systematic review of early hemiarthroplasty in elderly patients who had a proximal humeral fracture was conducted. A total of sixteen studies involving 810 arthroplasties in 808 patients were included; the mean age of the patients was sixty-eight years, and the mean duration of follow-up was 3.7 years. Most injuries were four-part fractures or fracture-dislocations. Complications related to tuberosity healing occurred in 11% of the cases. Although most patients had no or mild pain, most had marked limitation of function, with an average Constant score of 57.

### Humeral Shaft and Elbow

A prospective randomized trial comparing antegrade with retrograde locked intramedullary nailing of midshaft humeral fractures demonstrated that both techniques resulted in similar rates of union. Antegrade nailing resulted in a longer time for the recovery of shoulder function, whereas retrograde nailing resulted in a longer time for the recovery of elbow function; the eventual functional outcome in both groups was similar.

A prospective randomized trial of patients older than sixty years of age who had a displaced, comminuted distal humeral fracture demonstrated that patients who were managed with semiconstrained total elbow arthroplasty had superior outcome scores, a reduced reoperation rate, comparable range of motion, and more predictable outcomes as compared with those managed with open reduction and internal fixation, supporting the use of primary total elbow arthroplasty in patients with such fractures.

### Distal Radial Fractures

The ideal treatment of unstable distal radial fractures is still under investigation, with closed treatment, closed reduction and percutaneous pin fixation, external fixation (either bridging or nonbridging), and open reduction and internal fixation all considered to be reasonable treatment options. A study of the practice patterns of younger American orthopaedic surgeons, as indicated by case lists submitted to the American Board of Orthopaedic Surgery between 1999 and 2007, demonstrated that during this time there was a shift in the treatment of distal radial fractures from closed reduction and percutaneous methods (pinning and/or external fixation) to open reduction and internal fixation. This shift was not accompanied by improvement in surgeon-perceived functional outcome.

During the last year, a number of well-done comparative clinical trials were reported, providing additional insight for clinicians who treat these common injuries. A prospective randomized trial demonstrated that the use of locked volar plate fixation led to better patient-assessed outcomes than did either external fixation or locked radial column plate fixation in the first three months, despite the finding that there were no differences in terms of strength, motion, or radiographic alignment. However, at the time of the one-year follow-up, all three techniques provided excellent functional outcomes. Another study of patients with intra-articular distal radial fractures indicated that patients who had wrist arthroscopy to repair or débride the triangular fibrocartilage complex at the same time that they underwent fluoroscopically-assisted closed reduction and percutaneous pin fixation had better functional outcomes in comparison with patients who did not have arthroscopy. Finally, with regard to the postoperative management of patients who have had volar plate fixation of a distal radial fracture, one study demonstrated that mobilization of the wrist joint within two weeks postoperatively appeared to be safe but did not result in any difference in wrist motion in comparison with immobilization for six weeks.

Several studies have evaluated the use of external fixation for the treatment of unstable distal radial fractures. First, in a study in which bridging external fixation with supplementary Kirschner wire fixation was compared with volar locked plate fixation, the volar plate fixation group had better range of motion of the wrist initially but the functional outcomes and complication rates for the two groups were similar at one year after the injury. In a retrospective study, patients managed with bridging external fixation had a six-times greater risk of dorsal malunion and a 2.5-times greater risk of radial shortening as compared with patients managed with a nonbridging external fixator, leading the authors to recommend the use of nonbridging external fixation when possible. Finally, a randomized trial demonstrated similar radiographic and functional outcomes at one year after the injury for patients managed with either a nonbridging external fixator or a dynamic bridging external fixator.

### Scaphoid Fractures

Two randomized clinical trials with long-term follow-up demonstrated similar outcomes for patients with nondisplaced scaphoid fractures that were treated operatively or nonoperatively. In both reports, most patients underwent open reduction and internal fixation with use of a volar approach. Interestingly, one study demonstrated a significant increase in the prevalence of osteoarthritis in the scaphotrapezial joint.
among patients who were managed operatively\(^7\), whereas the other study demonstrated a similar prevalence of scapho-trapezial arthritis in both groups\(^8\).

A systematic review of the treatment of acute non-displaced or minimally displaced scaphoid waist fractures was also published\(^9\). Twelve articles comparing open reduction and internal fixation, percutaneous fixation, and nonoperative management were included. The reviewers concluded that the best available evidence suggests that percutaneous fixation may result in faster union (by five weeks) and earlier return to work and sport (by seven weeks) as compared with cast treatment.

There were no differences in these parameters when open reduction and internal fixation was compared with cast treatment. Although open reduction and internal fixation resulted in a higher union rate than cast treatment did, this outcome needs to be balanced with the 30% rate of minor complications that was found following open reduction and internal fixation. Finally, the review indicated that manual workers are off from work significantly longer than nonmanual workers, regardless of how they are managed.

**Spine Trauma**

Two general categories of studies on the spine were published during the period of this review: (1) articles on excluding spinal injury and (2) articles on treatment. Two new studies addressed so-called clearance of the cervical spine in patients with blunt trauma. Many patients with blunt injury are either clinically unevaluable or have suspicious symptoms but have normal findings on plain radiographs of the cervical spine. How to “clear” the cervical spine in these cases (i.e., how to exclude a cervical spine injury) has always been a dilemma. One meta-analysis of five Level-I diagnostic studies demonstrated that in this trauma population a normal magnetic resonance imaging scan of the cervical spine can conclusively exclude a cervical spine injury and should be established as the gold standard for clearing the cervical spine in this subset of patients\(^10\). Second, a retrospective review of 121 patients who had been positively diagnosed with cervical spine injuries showed that a multidetector-row computed tomography scan correctly diagnosed 100% of the injuries (including those in nine patients requiring surgical intervention who had false-negative radiographs)\(^11\). In contrast, plain radiographs had a sensitivity of only 61%, leading the authors to conclude that standard radiographic views of the cervical spine provide no clinically important advantage over computed tomography for the diagnosis of cervical spine injury.

Regarding treatment, an ongoing area of controversy has been the issue of whether to administer corticosteroids to patients with acute spinal cord injury. A study of patients who were admitted with a spinal cord injury demonstrated no difference between patients who were managed with and without methylprednisolone with regard to the incidence of mortality in the intensive care unit or the level of neurologic function at the time of discharge from the intensive care unit\(^12\). However, the methylprednisolone group had a significant increase in infections and an increase in hyperglycemia as compared with the no-methylprednisolone group. Finally, a study of patients in the National Trauma Data Bank who had a spinal fracture that underwent surgical fixation demonstrated that those who had the procedure performed within three days after the injury had similar mortality but a significantly lower rate of complications (17.5% compared with 30%) than did those who had the procedure performed after three days\(^13\).

**Pelvic and Acetabular Fractures**

Single-leg-stance radiographs are considered a valuable method to assess for chronic instability of the pelvic ring; however, data have been lacking regarding what constitutes a normal amount of motion. Two studies shed light on this topic. First, a study of uninjured patients demonstrated that as much as 5 mm of motion is physiologic at the pubic symphysis in men and nulliparous women, with multiparous women demonstrating a greater physiologic range of pubic translation\(^14\). Furthermore, in patients with a suspected diagnosis of chronic pelvic instability, standing anteroposterior and single-leg-stance pelvic radiographs are more helpful for confirming the diagnosis than radiographs made in the supine position\(^15\).

The diagnosis of lateral compression injuries of the pelvic ring has received some new scrutiny. A review of the anatomic computed tomography scan findings in a series of 100 pelvic ring disruptions classified as lateral compression-1 fracture demonstrated that they in fact constitute a wide spectrum of injury with more high-energy posterior injury patterns than previously described\(^16\). Approximately half of these injuries were associated with complete disruption of the sacrum or some degree of sacral comminution. The authors concluded that existing schemes for the classification of these injuries do not adequately account for the wide spectrum of possible injury and cannot be used to guide treatment. These findings were corroborated by another study of sixty patients with lateral compression fractures in which three-dimensional computed tomography analysis of fracture displacement also demonstrated complex patterns\(^17\). In fact, the authors were able to place the injuries into five distinct groups on the basis of their pattern of rotation and translation, which may explain the variations in outcome associated with this injury pattern.

A particular area of controversy regarding acetabular fractures is the treatment of the small (<50%) posterior wall fracture. Moed et al. reported on three methods of measuring the size of the posterior wall fragment, including two previously described methods and a modification of one of those methods\(^18\). None of the methods were able to reliably predict stability in all cases, although the determination of wall size with the method advocated by the authors reliably predicted hip stability when fragments involved <20% of the wall and predicted instability when fragments involved >50% of the wall. The authors stated that dynamic fluoroscopic stress ex-
amination with the patient under general anesthesia is the preferred method for determining hip stability status after posterior acetabular wall fractures.

There were several new studies regarding complications that may arise following pelvic and acetabular fractures. First, in a matched case study of hemodynamically unstable patients with pelvic ring injuries, direct retroperitoneal packing was compared with early pelvic angiography. Pelvic packing was accomplished at a median of forty-five minutes after the time of admission, and this group had a significant decrease in the number of blood transfusions during the next twenty-four hours, required fewer embolization procedures, and had no deaths due to uncontrolled hemorrhage. In contrast, angiography was not begun for a median of 130 minutes, and 10% of the patients died as a result of acute bleeding. With regard to the prevention of heterotopic ossification associated with acetabular fractures, a systematic review of studies comparing indomethacin with radiation therapy was performed. Only five studies of varying quality were identified. The prevalence of heterotopic ossification was significantly lower for patients managed with radiation therapy (3%) than for those managed with indomethacin (9%). Another study reviewed the long-term complications of the placement of vena cava filters in patients with pelvic or acetabular fractures who had development of a deep-vein thrombosis preoperatively. In 102 consecutive patients, the placement of a filter did not result in any serious complications (recurrent deep-vein thrombosis or pulmonary embolism), and the authors concluded that the placement of an inferior vena cava filter in patients with pelvic trauma is not associated with the same long-term complications as are observed in patients with thrombosis associated with medical comorbidities.

Proximal Femoral Fractures
As befits a topic that is always of great interest to orthopaedic surgeons, a large number of important studies were published or presented last year regarding hip fractures. Several studies addressed the prevention, outcomes, and perioperative treatment of these fractures. Regarding prevention, a health technology assessment sponsored by the Canadian government evaluated the protective effect and cost-effectiveness of hip protectors in the elderly, demonstrating that hip protectors appear to be effective for reducing the risk of hip fractures in long-term-care facility residents (relative risk, 0.77) and are cost-effective for women over the age of seventy years who live in long-term-care facilities.

The perioperative management of the elderly patient who has a hip fracture is always complex. One study demonstrated that troponin T levels were elevated in 39% of patients with an age of more than sixty-five years who were admitted with a femoral neck fracture and that those patients had increased morbidity, increased mortality, and longer hospital stays than those with normal troponin T levels. The authors noted that heart failure or myocardial infarction were the principal causes of early death in those patients and that cardiac ischemia was often silent; they recommended that the troponin T level be measured in all patients with an age of more than sixty-five years who are admitted with a femoral neck fracture in order to identify those with increased cardiovascular risk and to allow appropriate medical optimization. A multicenter study evaluated the Estimation of Physiologic Ability and Surgical Stress (E-PASS) scoring system, which was designed to assess postoperative risk in patients undergoing surgery. In 813 consecutive patients with hip fractures, this scoring system proved to be accurate for estimating postoperative risk and medical expenses.

The timing of surgery for the treatment of a hip fracture has been a continued source of controversy. A study of patients older than fifty years of age with acute hip fractures demonstrated that those who underwent surgery within twenty-four hours after the injury were more likely to return to independent living, had a reduced risk for the development of pressure ulcers, and had a shortened hospital stay in comparison with those in whom surgery was delayed more than thirty-six hours. A common cause of surgical delay is medication that patients are taking preoperatively; this is especially true for the antiplatelet agent clopidogrel. One study of patients with hip fractures who were taking clopidogrel demonstrated that the drop in preoperative to postoperative hemoglobin was 1.3 g/dL less when surgery was delayed for at least five days compared to when surgery was done within five days. However, the delayed surgery group had a significant increase in thromboembolic events that could be attributed to the delay in treatment. Two presentations at the 2008 annual meeting of the Orthopaedic Trauma Association indicated that early surgery is safe for patients taking clopidogrel. In one, Nydick et al. presented a case-matched series of fifty-seven patients requiring nonelective orthopaedic surgery; twenty-five patients were receiving clopidogrel, and thirty-seven age and injury-matched controls were not. These authors were unable to find any difference in transfusion rates, wound drainage, or overall complications between the two groups. In another study, Collinge et al. reviewed 447 patients older than sixty years who had an operation for the treatment of a hip fracture. In that group, thirty-eight patients were taking clopidogrel, seventy-nine were taking aspirin alone, and 330 were not taking any anticoagulants. No patient in any group had a delay of surgery, and there were no differences between the groups with regard to any bleeding parameter or the complication rate after surgery.

With respect to outcome data, 18,817 patients entered into the Scottish Hip Fracture Audit database were studied; the thirty-day and 120-day mortality rates were 7% and 18%, respectively. The authors evaluated a number of prognostic variables, which they grouped into patient-derived “case-mix” variables (age, anesthesia risk, sex, fracture type, prefracture residence, and mobility) and “management” variables (time to treatment and the seniority of the surgeon and anesthetist).
Their data showed that the patient-specific variables predicted early mortality, whereas the management variables did not; unfortunately, the case-mix factors cannot be modified by preoperative medical intervention. Another study involving the same database not surprisingly showed that patients with an age of more than ninety-five years who had a hip fracture more commonly presented with poor health status, were less likely to be independent, and were more likely to be living in a nursing home at the time of injury than were those in a comparison group of patients with an age of seventy-five to eighty-nine years. However, even after statistically controlling for their worse health status, these “extremely elderly” patients had higher mortality than the younger patients did. Perhaps the most striking difference was in the ability to return to the preinjury level of function; only 2% of the extremely elderly patients who had walked unaided preoperatively were able to do so at 120 days postoperatively, compared with 22% of those in the control group. The same authors reported the results of a separate but otherwise similar study in which younger patients (patients who were less than sixty-five years old) who had a hip fracture were compared with the exact same cohort of patients who were seventy-five to eighty-nine years old. As one might expect, the younger patients were healthier, were more likely to be independent, and were more likely to live in their own home at the time of the injury as compared with the patients in the older control group. Interestingly, pathologic fractures were more common in the younger cohort. The younger patients also were more likely to walk independently and were more likely to return home as compared with the patients in the older control group. Finally, although the mortality rate after the surgical treatment of a hip fracture was lower in the group of younger patients than in the comparison group of older patients, it was higher than that expected in the general population of individuals less than sixty-five years of age. Finally, a study of 3686 patients undergoing surgery for the treatment of a hip fracture demonstrated a 2.3% rate of surgical site infection. The length of stay, the cost of treatment, and the predischarge mortality rate all significantly increased in association with the presence of a deep wound infection; in addition, the one-year mortality rate was significantly higher for patients who had a surgical site infection than for those who did not (50% compared with 30%).

With regard to specific injuries of the hip or the proximal part of the femur, orthopaedic surgeons need to be aware of the presentation of an irreducible femoral head fracture-dislocation without an associated acetabular posterior wall fracture. These patients present with the injured extremity locked in slight, but fixed, flexion at the hip, the leg in neutral rotation, and an obvious limb-length inequality. Plain radiographs demonstrate apposition of the fractured, cancellous surface of the dislocated femoral head against the lateral cortex of the ilium above the acetabulum, with no posterior wall acetabular fracture. For patients with this injury, closed re-
duction should not be attempted and urgent open reduction and internal fixation is recommended instead.

Several studies have compared the outcomes associated with different treatment modalities for femoral neck fractures. A study comparing the outcomes for patients who had internal fixation of a nondisplaced femoral neck fracture with those for patients who had hemiarthroplasty of a displaced femoral neck fracture demonstrated that the internal fixation group had shorter operating time, decreased hospital stay, fewer perioperative complications, less pain, less reduction in mobility, and a lower one-year mortality rate but that the internal fixation group had a higher reoperation rate than the hemiarthroplasty group (17% compared with 6%). The authors concluded that internal fixation is the treatment of choice for nondisplaced femoral neck fractures. A study evaluating patients who had undergone fixation of isolated intracapsular hip fractures with cancellous screws demonstrated that a large percentage of these fractures (66%) healed in a shortened position and that some (39%) healed with varus collapse. Furthermore, shortening of the femoral neck was the largest factor adversely affecting the Short Form-36 physical functioning score, leading the authors to conclude that healing at the site of a hip fracture should not be regarded as a successful result without an assessment of the functional outcome. A study of Pauwels type-3 vertical (>70°) femoral neck fractures demonstrated a trend toward more frequent nonunion for fractures treated with cannulated screws than for those treated with fixed-angle devices such as a sliding hip screw or a cephalomedullary nail (19% compared with 8%).

With regard to arthroplasty, a systematic review of the literature demonstrated no difference with regard to the postoperative mortality rate, overall complication rate, or pain between patients with femoral neck fractures who had a hemiarthroplasty with cement and those who had a hemiarthroplasty without cement. A study based on the Norwegian Hip Fracture Register demonstrated that 95% of nondisplaced femoral neck fractures were treated with screw fixation, whereas 83% of basicervical fractures and 84% of intertrochanteric fractures were treated with a compression hip screw. However, there was a lack of consensus with regard to the treatment of displaced femoral neck fractures, 52% of which were treated with a bipolar hemiarthroplasty. In another study based on the Norwegian Hip Fracture Register, elderly patients in whom a displaced femoral neck fracture was treated with a bipolar hemiarthroplasty had less pain, were more satisfied with the result of surgery, and had higher quality-of-life scores than those managed with screw fixation. It will be interesting to see if the publication of these data will lead to more uniform treatment of displaced femoral neck fractures. Finally, an examination of the trends in the surgical treatment of femoral neck fractures in the United States between 1990 and 2001 demonstrated that there has been greater utilization of hemiarthroplasty but a surprising decrease in the utilization of total hip arthroplasty when one compares the period from
1990 to 1993 with the period from 1998 to 2001\textsuperscript{80}. The authors were not able to explain the latter finding, which was consistent across all categories of patient age, hospital volume, and surgeon volume.

Several recent studies have evaluated the treatment of intertrochanteric fractures with a sliding hip screw as compared with an intramedullary device. A randomized study in which a sliding hip screw was compared with the Holland nail (a long trochanteric nail with two screws that can be placed into the femoral neck and head) demonstrated that the use of the Holland nail allowed patients to be mobilized to a greater extent than did the sliding hip screw, with less risk of implant failure\textsuperscript{81}. However, a study of 43,659 Medicare beneficiaries who were more than sixty-five years old showed that those who were managed with an intramedullary device had a slightly greater rate of revision surgery in the first year, an increased length of hospital stay, and higher hospital costs in comparison with those who were managed with a sliding hip screw, leading the authors to not support the routine use of intramedullary nail fixation for the routine treatment of intertrochanteric femoral fractures\textsuperscript{82}. Another randomized study of 208 patients with unstable pertrochanter hip fractures demonstrated that the long gamma nail and the sliding hip screw had similar outcomes\textsuperscript{83}. Finally, in a randomized study in which the Percutaneous Compression Plating System (Gotfried PCCP; Orthofix, McKinney, Texas) was compared with the sliding hip screw in sixty-six patients (mean age, seventy-seven years), compression plate fixation was associated with a shorter operative time and improved functional outcome although the healing rates were comparable between the two groups\textsuperscript{84}.

**Femur**

A recent study in which the piriformis starting portal was compared with the trochanteric starting portal for antegrade femoral nailing demonstrated that both groups had approximately the same time to union as well as nearly equal functional outcome scores\textsuperscript{85}. However, heterotopic ossification was present in 47% of the patients in the piriformis group as compared with 31% in the trochanteric group, with a higher prevalence of severe (grade-III or IV) heterotopic ossification in the piriformis group than in the trochanteric group (18% compared with 7.7%). Also, although the differences were not significant, the patients in the trochanteric group showed a trend toward improved function, increased gluteus medius strength, and increased tensor fasciae latae strength.

**Tibia**

Intramedullary nail fixation of the tibia is a common treatment for tibial shaft fractures; according to a survey, 80% of Canadian orthopaedic trauma surgeons treat tibial fractures operatively\textsuperscript{86}. In 2008, several studies evaluated the outcomes associated with various treatments for tibial shaft fractures. First, the results of the SPRINT trial were published\textsuperscript{87}. In that multicenter study, 1319 adults with a tibial shaft fracture were randomized to treatment with intramedullary nailing with or without reaming. The primary outcome was reoperation, which was needed in 11% of patients with closed tibial fractures that were treated with nailing with reaming and 17% of patients with closed fractures that were treated with nailing without reaming. No significant differences in reoperation rates were seen among the patients who had open fractures. Furthermore, the study demonstrated that delaying reoperation for the treatment of tibial nonunion for at least six months may substantially decrease the need for reoperation. A second study demonstrated that patients who were managed with an intramedullary nail for the treatment of a stable, isolated tibial fracture had significantly better results than those who were managed with casting in terms of the rate of return to work (76% compared with 39%), ankle dorsiflexion and plantar flexion, and Short Musculoskeletal Function Assessment scores three months after injury\textsuperscript{88}. A study of patients who had intramedullary nail fixation of isolated tibial fractures (with a median duration of follow-up of fourteen years) demonstrated that although the function of the patients was comparable with population norms, there were persistent sequelae, including moderate knee pain (73%), persistent quadriceps and calf muscle atrophy (27% each), objective evidence of venous insufficiency (15%), and radiographic evidence of osteoarthritis (35%)\textsuperscript{89}. Furthermore, an eight-year follow-up study of patients who were randomized to either transtendinous or paratendinous intramedullary nail fixation of the tibial shaft demonstrated that the rate of anterior knee pain was the same in both groups (29%)\textsuperscript{90}. It should be noted that a majority (62%) of the patients who had reported anterior knee pain at some time after surgery had no anterior knee pain eight years later, demonstrating that anterior knee pain does seem to resolve irrespective of which surgical technique is used.

**Tibial Plafond and Ankle**

A study of tibial plafond fractures that were treated either with temporary external fixation and then formal open reduction and internal fixation or with temporary external fixation, articular reduction, and continuing bridging external fixation demonstrated that although there was no difference in the quality of the articular reduction immediately postoperatively between the two groups, the internal fixation group had fewer delayed unions or nonunions in comparison with the external fixation group (19% compared with 42%)\textsuperscript{91}. Also, the functional outcome scores were better in the internal fixation group at six months, but no difference was noted between the two groups at twelve months.

The recommendation that a 7-cm skin bridge is the minimum safe distance between skin incisions when fixing a tibial plafond fracture was recently challenged in a study of forty-six fractures in which the average width of the skin bridge was 5.9 cm and there was a very low rate of soft-tissue complications, potentially allowing for incisions that are closer to
each other in the surgical treatment of tibial plafond fractures. However, it should be noted that all but two of the injuries were treated in a staged fashion by very experienced surgeons.

In a study of acute ankle fractures that were evaluated arthroscopically, sixty-one (73%) of eighty-four injuries were associated with chondral lesions; a majority (61%) of these lesions involved the talar dome. Furthermore, the more severe injuries, particularly the pronation-external rotation and supination-external rotation type-IV fractures, were associated with an increased number of chondral lesions in the ankle as compared with the less severe injuries.

Miscellaneous Topics

An analysis of the busiest non-academic trauma center in the nation demonstrated that, given the appropriate payer mix and effective contract negotiations, the provision of orthopaedic trauma services is clearly in the financial best interest of the supporting hospital and that hospitals that are resistant to the establishment of an orthopaedic trauma center could stand to lose substantial income; therefore, hospitals should support their orthopaedic trauma department with adequate resources and reimbursement for care.

A study from India evaluated the five to seven-year outcomes for 173 patients with Gustilo and Anderson type-III A and IIIB open fractures who had primary closure of the wounds. This approach was only used when patients met exceedingly strict criteria, which included débridement within twelve hours after the injury, the absence of sewage or organic contamination, no skin loss, bleeding skin margins that could be approximated without tension, and no evidence of peripheral vascular disease. After an average duration of follow-up of 6.2 years, 93% of the patients had a good or excellent result, with an overall infection rate (superficial and deep) of 9%. Although these results seem to support primary closure of even the more severe open fractures, it is not clear exactly what injuries the authors treated; most North American clinicians consider a type-IIIB open fracture to be associated with skin loss (by definition) that would preclude primary closure as a treatment option. The authors still considered the advisability of primary closure of high-grade (e.g., Gustilo and Anderson type-III) open fractures to be an unresolved question.

Upcoming Educational Events Featuring Orthopaedic Trauma

The twenty-fifth Anniversary Annual Scientific Meeting of the Orthopaedic Trauma Association (OTA) will be held October 7 through 10, 2009, in San Diego, California. Please see the OTA web page (www.ota.org) for more information about the meeting schedule and registration. The OTA meets at Specialty Day during the Annual Meeting of the American Academy of Orthopaedic Surgeons (AAOS) and always plans an educational event suitable for all orthopaedic surgeons who want to learn more about trauma care. Finally, the AAOS and OTA co-sponsor annual courses on extremity trauma in the fall and pelvic and acetabular trauma in the spring; this fall, the AAOS/OTA “Strategies and Tactics in Orthopaedic Extremity Trauma” will be held on November 19 through 21, 2009, at the Learning Center in Rosemont, Illinois. Please see the OTA web page for further details about OTA courses in 2010.

Evidence-Based Orthopaedics

The editorial staff of The Journal reviewed a large number of recently published research studies related to the musculoskeletal system that received a Level of Evidence grade of I. Over 100 medical journals were reviewed to identify these articles, all of which have high-quality study design. In addition to articles already cited in this update, three additional level-I articles were identified that were relevant to musculoskeletal trauma. A list of those articles is appended to this review following the standard bibliography.

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83. The SouthEast Fraction Consortium; Obremskey WT. A prospective multicenter study of intramedullary nailing versus casting of stable tibial fractures. Read at the Annual Meeting of the Orthopaedic Trauma Association; 2008 Oct 15-18; Denver, CO.
86. Obremskey WT. Prospective cohort trial of external fixation versus internal fixation of distal tibia plafond fractures. Read at the Annual Meeting of the Orthopaedic Trauma Association; 2008 Oct 15-18; Denver, CO.
Evidence-Based Orthopaedics


Fifty-two patients with severe knee trauma randomly received femoral nerve blockade or intravenous metamizole at the accident scene, and were then transported to the hospital. Pain as assessed with a visual analog score was decreased by 50% in the nerve blockade group, and only two of the twenty-six patients who received nerve blocks were thought to have not benefited from it. The authors concluded that peripheral nerve blocks done in the field can be safely administered and improve patient care.


The authors studied a cohort of 41,331 veterans admitted to a Medicare facility with a hip fracture between 1999 and 2002 and very carefully determined the rates of readmission to any facility within thirty days. Nearly one-fifth (18.3%) of the patients were readmitted within thirty days. The one-year mortality in this subset of patients was 48.5%, which was twice the mortality rate that was observed among patients who were not readmitted (24.9%). Risk factors for readmission were primarily medical comorbidities, including fluid and electrolyte disorders, cardiac disease (arrhythmias, congestive heart failure), pulmonary disease, and renal failure. The authors discuss the implications of these findings as they related to health policy issues, including coordination of care and pay-for-performance.


The authors reported the results of a meta-analysis of the wound infection rate in 3808 patients managed with either internal fixation or arthroplasty for the treatment of closed fractures. Compared with a multiple-dose regimen of prophylactic antibiotics, the risk ratio for a single dose of antibiotics was 1.24. However, the 95% confidence interval for the risk ratio spans 1.0, so even these data are insufficient to make a definitive recommendation.