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SPECIALTY UPDATE

What's New in Orthopaedic Trauma

William M. Ricci, MD, Andre Spiguel, MD, Christopher McAndrew, MD, and Michael Gardner, MD

This update presents a synopsis of the most clinically relevant high-quality studies related to orthopaedic trauma from the past twelve months. Key methods (◆), results (➤), and take-home points (★) for these studies are presented.

Shoulder Girdle Fractures

A number of comparative and cohort studies presented data on alternative methods of clavicular and proximal humeral fracture fixation. Comparative functional outcome data from these studies are presented in Table I.

Clavicular Fractures

Open Reduction and Internal Fixation Versus Nonoperative Treatment

- ◆ Sixty patients with displaced midshaft clavicular fractures were randomized to either nonoperative treatment (n = 32) or open reduction and internal fixation (ORIF) (n = 28)¹.
- The rate of nonunion was 24% in the nonoperative group and 0% in the ORIF group. However, there were no differences in the Constant score, Disabilities of the Arm, Shoulder and Hand (DASH) score, or pain at one year (Table I).
- ★ Nonoperative treatment of displaced clavicular shaft fractures is associated with a higher nonunion rate than ORIF, but the outcomes in terms of function and pain are similar.

Outcomes After Hook Plating of Lateral Fractures

- ◆ Thirty-six patients who were managed with hook plates for the treatment of lateral clavicular fractures were evaluated after a median duration of follow-up of twenty-eight months².

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- Ninety-five percent of the fractures healed, and ninety-two percent of the patients required reoperation for plate removal. The Oxford and Constant shoulder scores improved after plate removal, and improvement was greater if plate removal was performed prior to six months (Table I).
- ★ Lateral clavicular fractures that are treated with a hook plate have high union rates, and plate removal prior to six months is recommended.

Proximal Humeral Fractures

Hemiarthroplasty Versus Nonoperative Treatment

- ◆ A prospective randomized trial in the Netherlands compared hemiarthroplasty with nonoperative treatment for patients with four-part proximal humeral fractures³. Twenty-five patients were included in each group.
- No differences could be found in Constant and Simple Shoulder Test scores at three and twelve months (Table I). Patients who had nonoperative treatment had better abduction strength at three and twelve months and worse pain scores at three months.
- ★ There was no clear benefit in association with the use of hemiarthroplasty as compared with nonoperative treatment for patients over the age of sixty-five years with four-part proximal humeral fractures.

Hemiarthroplasty Versus Reverse Shoulder Arthroplasty

- ◆ With use of data from the New Zealand Joint Registry, fifty-five patients who were managed with reverse shoulder arthroplasty were compared with 313 patients who were managed with hemiarthroplasty for the treatment of a proximal humeral fracture⁴.
- There were some differences between the groups in terms of demographic characteristics, with the patients in the reverse shoulder arthroplasty group

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TABLE I Data from Studies on Clavicular and Proximal Humeral Fracture Fixation

Study/Treatment	Fracture/Treatment (No. of Patients)	Duration of Follow-up*	Outcome Score*		
			Constant	DASH	Oxford
Virtanen et al. ¹ Nonoperative (n = 32) ORIF (n = 28)	Clavicular shaft	12 mo	86.1	7.1	
			86.5	4.3	
Good et al. ² Hook plate (n = 36)	Lateral clavicular	28 mo	83.8		43.8
Boons et al. ³ Hemiarthroplasty (n = 25) Nonoperative (n = 25)	4-part proximal humeral	12 mo	64		
			60		
Boyle et al. ⁴ Hemiarthroplasty (n = 313) Reverse shoulder arthroplasty (n = 55)	Proximal humeral	5 yr			32.3
					41.5
Konrad et al. ⁵ ORIF (n = 83) Intramedullary nail (n = 58)	Proximal humeral	12 mo	≈75		
			≈78		
Spross et al. ⁶ ORIF (n = 22) Hemiarthroplasty (n = 22)	Proximal humeral	30 mo	65.2		
			59.4		

*The values are given as the mean.

being older and more often female. There were no differences between the groups in terms of the revision rate or the one-year mortality rate, but the reverse shoulder arthroplasty group had better five-year Oxford shoulder scores (Table I).

- * Five-year functional outcomes appear to favor reverse shoulder arthroplasty over hemiarthroplasty for the treatment of acute proximal humeral fractures.

Plate Versus Intramedullary Nail

- ◆ In a prospective study from twenty-five European centers, plate fixation (n = 83) was compared with intramedullary nailing (n = 58) for the treatment of three-part proximal humeral fractures⁵.
- The complication rates, Constant scores, and Neer scores were similar between the groups at one year. Most complications were related to the surgical technique rather than to the implant.
- * Similar results can be expected after nail and plate fixation of three-part proximal humeral fractures, and complications can be reduced with precise surgical technique.

Locked Plate Versus Hemiarthroplasty

- ◆ Twenty-two patients who were managed with a locked plate were compared with twenty-two patients who were managed with a hemiarthroplasty for the treatment of proximal humeral fractures⁶.

- The complication rates were similar for both groups (63.6% for the plate group and 77.2% for the hemiarthroplasty group). There were more revision procedures in the plate group (n = 10) as compared with the hemiarthroplasty group (n = 11). There were no differences in terms of the Constant score or the Short Form-36 (SF-36) score (Table I).
- * High complication rates but reasonable functional outcomes were shown for patients managed with either locked plates or hemiarthroplasty for the treatment of a proximal humeral fracture.

Glenoid Neck Fractures: Does the Glenoid Medialize?

- ◆ Two studies used computed tomography (CT) scans that included injured and uninjured shoulders. The first study included eighteen patients with extra-articular glenoid neck fractures⁷, and the second included seventy patients with a variety of scapular fractures⁸.
- The results of both studies indicated that the injured glenoid tends to lateralize (average, 9.8 mm in the first study⁷ and 6.0 mm in the second study⁸) relative to the midline rather than to medialize. Medialization only occurred in four of the eighteen patients.
- * Medialization of the glenoid seen on radiographic evaluation of scapular fractures actually represents lateralization of the scapular body relative to the glenoid. The glenoid tends to translate laterally, not medially, relative to the axial skeleton.

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Elbow Injuries**Posttraumatic Elbow Stiffness and Bracing**

- ◆ Sixty-six patients with posttraumatic elbow stiffness were enrolled in a prospective randomized control trial to evaluate elbow function⁹. Thirty-five patients were managed with a static progressive splint, and thirty-one were managed with a dynamic splint.
- There was no significant difference between the two cohorts in terms of the elbow flexion arc at any time point, and there was no significant difference in DASH scores. Major gains in motion were made during the first few months after trauma or surgery, yet patients continued to have improvement until six to twelve months later.
- ★ There is no difference between static progressive and dynamic splinting protocols in terms of posttraumatic elbow stiffness. Improvement in motion with exercises and splinting can occur for a period of six to twelve months.

Treatment of Displaced Radial Head Fractures

- ◆ Fifty-nine patients with isolated Mason Type-2 radial head fractures were retrospectively reviewed¹⁰. Twenty-four patients were managed with radial head excision, and thirty-five were managed with ORIF.
- The results in terms of residual elbow and wrist pain, elbow and wrist motion, and maximum grip strength were all significantly better after ORIF. The functional rating score and the DASH score were significantly higher in the ORIF group as well. Moderate to severe osteoarthritis was found in nine patients in the excision group and in only two patients in the ORIF group. Proximal radial migration was observed in twenty-three of twenty-four patients in the excision group and in none of the patients in the ORIF group.
- ★ Patients managed with ORIF of displaced radial head fractures had greater strength, less residual pain, and greater elbow motion, a lower prevalence of posttraumatic arthritis, and improved DASH and functional scores than those managed with radial head excision. ORIF is the treatment of choice for Mason Type-2 radial head fractures.
- ◆ Forty-two patients with unilateral, isolated, closed, displaced, or comminuted (Mason Type-2 and 3) radial head fractures who underwent excision were retrospectively reviewed¹¹.
- At the time of the latest follow-up, thirty-six patients had no pain and six had occasional or mild pain. According to the Broberg and Morrey clinical score, eighteen patients had an excellent outcome, twenty-two had a good outcome, and two had a fair outcome. According to the DASH score, thirty-six patients had

an excellent outcome and six had a good outcome. Eighteen patients presented with degenerative changes in the elbow; fourteen patients had Grade-1 changes, and four had Grade-2 changes. An increased positive ulnar variance was noted on radiographs of the wrist in eight patients. Radiographic findings did not correlate with lower clinical scores at the time of follow-up.

- ★ Early radial head excision is a viable option for the treatment of displaced or comminuted radial head fractures.

Distal Humeral Fractures: ORIF with an Extensor Mechanism-On Approach

- ◆ Twenty-four patients with distal humeral fractures (some extra-articular, some partial articular, and some complete intra-articular) that were treated with ORIF with an extensor mechanism-on approach (no olecranon osteotomies and no triceps slide) were evaluated retrospectively at a mean of twenty-seven months¹².
- All fractures healed after the index operation. The median arc of motion of the elbow was 126°, the mean Mayo Elbow Performance Index was 91.5 points (excellent), the mean DASH score was 15.9 (mild impairment), and the median loss of triceps strength was 10% compared with the uninjured elbow.
- ★ Fixation of a variety of distal humeral fractures without disruption of the extensor mechanism yields good functional results. Without direct comparison with other techniques and without long-term follow-up, it remains unclear if this approach is beneficial when applied to intra-articular fractures.

Forearm Fractures**Hybrid Fixation of Both-Bone Forearm Fractures**

- ◆ Fifty-six skeletally mature individuals who underwent surgery for the treatment of acute both-bone forearm fractures were retrospectively reviewed¹³. Twenty-seven patients had dual plating and twenty-nine had hybrid fixation (ORIF of the radius and intramedullary nailing of the ulna).
- There was no significant difference in terms of either the time to union or the range of motion according to Grace and Eversmann scores. There was one nonunion in each group, and there were nine complications overall (five in the dual plating group and four in the hybrid fixation group).
- ★ Hybrid fixation with use of ORIF with plate fixation of the radius and intramedullary fixation of the ulna is an acceptable method for the treatment of both-bone diaphyseal fractures of the forearm.

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Corrective Osteotomy for Malunited Diaphyseal Forearm Fractures

- ◆ Twenty patients with malunited diaphyseal forearm fractures underwent a three-dimensional corrective osteotomy with use of a custom-made osteotomy template based on computer simulation¹⁴. Fourteen patients underwent an osteotomy of both the radius and the ulna, and six patients underwent an osteotomy of the radius alone.
- The average radiographic deformity, compared with the contralateral side, was 21°; this value improved to 1° postoperatively. The mean arc of supination-pronation improved from 76° preoperatively to 152° postoperatively. Forearm supination was still restricted in three patients who were younger at the time of the injury and had long-standing malunions. Painful recurrent dislocations of the distal part of the ulna or the radial head resolved or decreased in five patients. The average grip strength improved from 82% to 94% in comparison with the contralateral side.
- ★ Computer-assisted osteotomy can provide excellent radiographic and clinical outcomes for the treatment of malunited diaphyseal forearm fractures, even in adults with relatively long-standing malunions.

Pelvic and Acetabular Fractures**Lateral Compression Pelvic Ring Injuries**

- ◆ Radiographs and CT scans that were obtained after 318 lateral compression pelvic ring injuries were retrospectively reviewed¹⁵. Analysis was focused on defining the spectrum of injury and determining the fracture patterns that were associated with initial displacement.
- Eighty-seven percent of the patients had a sacral fracture, with 51% having an anterior incomplete sacral fracture, 17% having a simple complete sacral fracture, 15% having a comminuted fracture, and 13% having a crescent fracture. Bilateral rami fractures, sacral comminution, and crescent fractures were associated with the highest rates of displacement.
- ★ The data in this study indicate that at least half of all lateral compression pelvic fractures are likely to be stable. This study also emphasizes the tendency of bilateral anterior pelvic ring injuries and more complex sacral fractures to be unstable, which can help to guide treatment.
- ◆ One hundred and eighteen patients with minimally displaced (<10 mm) lateral compression sacral fractures were managed nonoperatively with immediate advancement of weight-bearing¹⁶. Patients were reviewed retrospectively and were analyzed for additional displacement during healing.
- One hundred and seventeen patients (99%) were successfully managed with this protocol and healed

uneventfully with minimum additional displacement.

- ★ This study indicates that with careful assessment and determination that the pelvis is minimally displaced (<10 mm on any view) and stable (sacral fracture compression without comminution), early weight-bearing and rehabilitation is a safe and effective treatment.
- ◆ One hundred and nineteen patients with unstable lateral compression pelvic ring injuries were managed operatively and were retrospectively reviewed at a minimum of one year to determine which factors correlated with functional outcome as assessed with Short Musculoskeletal Function Assessment (SMFA) scores¹⁷.
- Posterior pelvic reduction was within 5 mm in 83% of patients. The injury pattern and the demographic characteristics of the patients did not affect the outcome. Many patients had some degree of persistent disability, and SMFA scores were frequently driven by pain levels (a visual analog scale [VAS] score of ≥4) at the time of the latest follow-up.
- ★ The importance of this study is that excellent surgical reductions can be achieved and maintained. Reduction quality was not a factor in outcomes, but the majority of patients in this series had near-anatomic reductions. This should also be used to counsel patients in terms of expectations following an unstable lateral compression pelvic fracture.

Anteroposterior Compression Pelvic Ring Injuries

- ◆ One hundred and forty-eight patients with plate fixation of the pubic symphysis were reviewed retrospectively at a minimum of twelve months of follow-up¹⁸. The factors that were analyzed included fracture pattern, mode of fixation, rate of fixation failure, and subsequent interventions.
- Fixation typically involved six-hole small fragment plates. Implant breakage occurred in sixty-three patients (43%). All but two of the patients were asymptomatic. Five patients underwent revision surgery.
- ★ Physiologic symphyseal motion leads to a high rate of eventual implant fracture or subtle dissociation. The rates of reduction loss and symptoms are extremely low. Implant failure alone should not trigger revision surgery.

Hip and Femoral Fractures**Hip Hemiarthroplasty With and Without Cement for Fracture**

- ◆ Two randomized trials^{19,20} and one prospective observational study²¹ analyzed hip hemiarthroplasty with and without cement for the treatment of femoral neck fracture.

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- One hundred and sixty subjects were randomized to hip arthroplasty with or without cement²⁰. There were no differences between the groups in terms of operative variables, pain, or mortality. The rates of fracture and subsidence were higher after procedures that were performed without cement. The six-week Oxford hip score and the results of the six-month and one-year Timed Up and Go (TUG) test were better after procedures performed with cement.
- One hundred and thirty subjects were randomized to hip arthroplasty with or without cement¹⁹. There were no differences between the groups in terms of operative variables, complications, mortality, function in activities of daily living subscales, or the Energy/Fatigue score.
- Over six years, 8639 arthroplasties were performed with cement and 2477 were performed without cement²¹. Differences were observed in terms of the rates of intraoperative death, cardiac arrest, and respiratory failure (all of which were higher in association with procedures performed with cement) as well as the rate of intraoperative fracture (which was higher in association with procedures performed without cement). The group that underwent arthroplasty without cement had a relative risk of 2.1 for reoperation.
- ★ There is not a clear answer regarding the use of cemented or cementless stems. The risk of catastrophic intraoperative complications associated with cemented stems (<1%) should be balanced against the variable increase in early function and the decrease in late reoperation.

Contralateral Hip Fracture After Treatment of Femoral Neck Fracture

- ◆ The records of 1177 patients who underwent closed reduction and screw fixation or arthroplasty for the treatment of a femoral neck fracture were retrospectively analyzed for differences in the rate of subsequent contralateral hip fracture²².
- The overall rate of contralateral hip fracture rate was 7.5%, with rates of 10.10% in the fixation group and 5.57% in the arthroplasty group. Logistic regression identified fixation, age, diabetes, and bisphosphonate use as predictors of contralateral hip fracture.
- ★ Patients undergoing screw fixation for the treatment of femoral neck fracture are at increased risk for subsequent contralateral hip fracture compared with those undergoing arthroplasty.

Preoperative Traction for Femoral Shaft Fracture

- ◆ Sixty-five patients were enrolled in a prospective randomized trial in which distal femoral skeletal traction or cutaneous traction (Buck boot) was used

for preoperative stabilization of femoral shaft fractures that were treated operatively within twenty-four hours²³.

- The time of application was shorter in the cutaneous traction group, and no differences were found between the groups in terms of VAS scores, narcotic requirements, or time to obtaining reduction in the operating room. No complications were reported.
- ★ For patients with femoral shaft fractures that will be treated operatively within twenty-four hours, cutaneous traction provides similar results with less invasive application than skeletal traction.

Tibial and Pilon Fractures**Tibial Malrotation**

- ◆ Seventy patients who were managed with intramedullary nailing for the treatment of isolated unilateral tibial shaft fractures had axial CT scans and goniometric measurement of tibial rotation and underwent functional evaluations²⁴.
- Twenty-nine patients (41.4%) had tibial malrotation of $\geq 10^\circ$, twenty-four had an external rotation deformity, and five had an internal rotation deformity. There were no significant differences between the normal rotation and malrotation groups in terms of the Lower Extremity Functional Scale (LEFS) score, the Olerud-Molander score, or the six-minute walk test.
- ★ Despite a high prevalence of tibial malrotation following locked intramedullary nailing of isolated tibial shaft fractures, there is no significant intermediate-term functional impact.

Posterior Plating of Tibial Pilon Fractures

- ◆ Nineteen patients with Orthopaedic Trauma Association (OTA) 43C pilon fractures and a displaced posterior malleolar fragment were managed with either a posterior approach followed by a staged anterior approach (n = 9) or a standard anterior approach alone (n = 10)²⁵.
- Forty percent of the patients who were managed with an anterior approach alone had >2 mm of joint incongruity, and 70% had radiographic evidence of joint-space narrowing. In comparison, none of the patients who were managed with a posterior approach followed by a staged anterior approach had joint incongruity and 33% had evidence of joint-space narrowing. No significant difference was noted between the two groups in terms of ankle motion or complications. The posterior plating group had significantly higher American Orthopaedic Foot & Ankle Society (AOFAS) and Maryland Foot scores.
- ★ The use of a posterior approach followed by a staged anterior approach for the treatment of pilon fractures

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with a displaced posterior malleolar fragment allows the anterior components to be secured to a stable posterior malleolus. This technique improved the ability to obtain an anatomic articular reduction and to preserve joint space and correlated with improvements in clinical and functional outcome scores.

Foot and Ankle Fractures**Malleolar Ankle Fractures**

- ◆ Eighty-one patients with an isolated fibular fracture and a positive external rotation stress test (medial clear space, ≥ 5 mm), were randomized to operative fixation or to closed reduction, cast treatment, and protected weight-bearing²⁶. The patients were followed for at least one year.
- No differences were found between the groups in terms of functional outcomes at one year. At the time of the latest follow-up, eight patients (20%) in the nonoperative treatment group had talar subluxation with a medial clear space of ≥ 5 mm and eight (20%) had delayed union or nonunion.
- ★ Although ankle fractures occur along a spectrum of instability, cast treatment of some unstable stress-positive lateral malleolar fractures may not effectively maintain the reduction. Although no differences in functional outcomes were seen at one year between the groups, this time point may be too early to identify the chronic effects of subtle talar subluxation.
- ◆ Fifty-one patients who underwent operative fixation of an unstable ankle fracture were randomized to general anesthesia or popliteal block²⁷. Oral narcotics were administered as needed, and postoperative pain was assessed in the first forty-eight hours.
- Over the first twelve hours, patients who had general anesthesia had significantly more pain. However, between twelve and twenty-four hours, those who received a popliteal block had significantly more pain.
- ★ This study highlights the effectiveness of regional anesthesia in the first twelve hours but emphasizes the phenomenon of “rebound” pain, which might be an appropriate target for novel and directed analgesia protocols that account for rebound pain.

Syndesmosis

- ◆ The records for 251 patients with syndesmotic injuries that were treated operatively with clamp placement and screw fixation were retrospectively reviewed²⁸. All patients subsequently underwent intraoperative unilateral three-dimensional CT to assess syndesmotic reduction.
- In eighty-two patients (33%), malreduction of the syndesmosis was noted on the CT scan. In most cases

of malreduction, the displacement of the fibula was anterior translation and internal rotation within the incisura.

- ★ This study confirms the findings of several previous studies that demonstrated high rates of syndesmotic malreduction in association with the use of conventional reduction techniques, which negatively affects outcomes. Additional techniques are required to overcome this common occurrence.
- ◆ Ten cadaveric ankle specimens were used to systematically determine the effect of clamp position on syndesmosis reduction with varying stages of ligamentous disruption²⁹.
- Clamp orientations that were not parallel to the fibular-tibial axis consistently caused sagittal plane malreduction. Slight overcompression of the syndesmosis was extremely common in association with all clamp vectors and levels of instability.
- ★ Accurate reduction of the syndesmosis remains challenging. This study demonstrates that precise clamp positioning is necessary to ensure optimum reduction. The functional consequences of subtle overcompression of the syndesmosis remain unknown.

Geriatrics**Geriatric Trauma**

- ◆ Five hundred and ninety-seven patients with an age of sixty-five years or more who had sustained high-energy orthopaedic trauma were evaluated retrospectively³⁰.
- The overall in-hospital mortality rate was 14%. The mortality rate was 23% among elderly patients with a clavicular fracture, compared with 13% among those without a clavicular fracture, and was significantly associated with midfoot fractures.
- ★ Blunt trauma in geriatric patients is unique from that in younger patients. The interesting and unexpected associations between specific fractures and mortality in this large study may help to counsel patients and families and to direct hospital resources.

Fragility Fractures

- ◆ Three hundred and ninety-nine patients who sustained a fragility fracture and were referred to a metabolic bone disease clinic were screened for secondary causes of osteoporosis³¹.
- More than half (54%) of the patients had vitamin D deficiency or insufficiency. In addition, almost one-third (32%) of the patients had secondary causes of osteoporosis other than vitamin D deficiency.
- ★ Vitamin D deficiency in patients with fragility fractures is extremely common. However, other, secondary causes of osteoporosis are also very common,

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which should trigger the initiation of a workup for other metabolic bone pathologic conditions.

- ◆ The charts of 660 patients with an age of more than sixty years who had fragility fractures of the proximal part of the femur were reviewed³². Factors that predicted increased cost of treatment and length of hospital stay were determined.
- Body mass index and specific medical comorbidities did not contribute to the length of stay. The strongest predictor of increased length of stay was the American Society of Anesthesiologists (ASA) classification. For each increase in ASA grade, the length of stay increased by two days and the cost of treatment increased by \$9300.
- ★ In an age of strict allocation of health-care resources, determining which patient cohorts consume more resources is critical. On the basis of the data in this study, patients with increased ASA grades should be expected to have increased treatment costs.

Acetabular Fractures

- ◆ Forty-one patients with an age of fifty-five years or more who had an acetabular fracture were managed with either a traditional ilioinguinal approach (twenty-four patients) or a limited approach (lateral two windows approach) (seventeen patients)³³. The groups were compared in terms of multiple outcomes at a minimum of two years of follow-up.
- Reduction accuracy did not differ between the groups. The overall rate of conversion to hip arthroplasty was 27%, with no difference between the groups. Functional outcomes were equivalent. Blood loss and surgical time were significantly less in the limited-approach group.
- ★ This study demonstrated that quality reductions and acceptable rates of subsequent arthroplasty and fixation failure are possible with a limited anterior exposure. This approach can limit operative time and blood loss, which may be especially important in this medically frail population.

Open Fractures, Infections, Nonunions, and Bone-Grafting**Timing to Operative Debridement of Open Fractures**

- ◆ A systematic review of the literature that included 3539 open fractures from sixteen studies investigated the association between the time to operative debridement of open fractures and infection³⁴.
- No differences in terms of the rate of infection could be identified between early and late debridement according to any of the time thresholds used in the included studies.
- ★ The historical “six-hour” rule for the debridement of open fractures has little support in the available literature.

Wound Vacuum-Assisted Closure for Open Tibial Fractures

- ◆ A retrospective review of 229 open tibial fractures that were treated with either negative-pressure wound therapy (NPWT) (72%) or conventional dressings (28%) compared infection rates³⁵.
- The infection rate was lower in the NPWT group (8.4%) than in the conventional dressing group (20.6%).
- ★ NPWT is preferred to conventional dressings for the treatment of open tibial fractures.

Infection After Internal Fixation of Fractures in HIV-Positive Patients

- ◆ The association between orthopaedic infection and human immunodeficiency virus (HIV) after internal fixation of fractures was investigated in a retrospective study of sixty-four patients³⁶.
- The infection rate was 23% in the study group, compared with 3.9% in historical controls. CD4 counts of <300 were associated with postoperative infection.
- ★ Patients with HIV and CD4 counts of <300 are at high risk for infection after internal fixation of fractures.

Morbidity of Iliac Crest Bone Graft Harvest

- ◆ The prevalence of complications at the iliac crest bone graft donor site was determined in a prospective study of ninety-two patients³⁷.
- The VAS score for pain was 3.9 at two weeks and then decreased to 1.4 at six weeks and reached 0.3 at one year. Only two patients reported a pain score of >3 at one year. There were three deep infections and no permanent sensory deficits.
- ★ Anterior iliac crest bone-grafting is a well tolerated procedure.

Iliac Crest Bone Graft Compared with Reamer/Irrigator/Aspirator (RIA) Graft

- ◆ The cellular and biochemical characteristics of bone grafts that were harvested with the RIA and from the iliac crest (each from the same patient) were compared in a prospective study of ten patients³⁸.
- The expression of mRNA was independent of age, sex, and comorbidity. RIA samples had greater expression of stem cell markers and genes associated with growth factors that act early in the osteogenic cascade.
- ★ Bone graft harvested with the RIA technique appears to have a favorable biologic profile compared with iliac crest bone graft.

Polytrauma**Stress-Induced Hyperglycemia and Infection Risk**

- ◆ A retrospective review of 187 nondiabetic orthopaedic trauma patients who were admitted to the

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intensive care unit was performed to analyze the relationship of elevated blood glucose and infection³⁹.

- Logistic regression modeling demonstrated an elevated hyperglycemia index as a risk factor for surgical site infection (odds ratio [OR], 1.8; 95% confidence interval [CI], 1.3 to 2.5).
- ★ Tight control of blood glucose in patients with orthopaedic injuries who are admitted to the intensive care unit, even those who are not diabetic, is recommended to decrease surgical site infection.

Duration of Orthopaedic Surgery in Polytrauma

- ◆ A retrospective review of 187 patients with long-bone fractures and an Injury Severity Score (ISS) of ≥ 18 was performed to analyze the relationships between the duration of surgery and both acute respiratory distress syndrome (ARDS) and mortality⁴⁰.
- When surgical time was analyzed both as a continuous variable and as a categorical variable (less than two hours, two hours or more, one to less than three hours, three to six hours, or more than six hours), the length of surgery was not a predictor of mortality ($p = 0.45$) or ARDS ($p = 0.75$).
- ★ In the setting of adequate and maintained resuscitation, the expected length of surgery alone should not be considered a reason to delay the operative treatment of fractures.

Outcomes**Knee Extensor Mechanism Injuries**

- ◆ Two cohort studies analyzed subjective outcomes, knee motion, and strength after patellar fracture⁴¹ and knee extensor mechanism disruption⁴².
- SF-36 physical component scores and Knee Injury and Osteoarthritis Outcome Scores (KOOS) were worse than population norms, and strength was decreased by 25% to 30%, more than one year after the operative treatment of a patellar fracture⁴¹.
- SF-36 scores were high and equal across comparison groups of patellar fracture, quadriceps tendon rupture, and patellar tendon rupture one year after treatment⁴².
- ★ Residual limitations persist more than one year after knee extensor mechanism disruptions, and the outcomes after tendon injuries are nearly equivalent to those after patellar fractures.

Early Prediction of Function After Hip Hemiarthroplasty

- ◆ A prospective cohort study of sixty-two subjects who underwent hemiarthroplasty for the treatment of femoral neck fracture examined the correlation between the TUG test, Lower Extremity Measure (LEM) scale, and independent walking⁴³.

- More than half (54%) of the patients required an aid for walking at two years after surgery, and the results of the three-week TUG test correlated indirectly with LEM scores and the ability to walk without aid.
- ★ The TUG test, administered within weeks after a femoral neck fracture, can predict two-year function and can be used to advise patients and their families.

Combat Nerve Injuries

- ◆ A retrospective cohort study of 213 type-III open tibial fractures resulting from combat injuries analyzed the incidence of and recovery from nerve injury⁴⁴.
- Thirty-two patients had forty-three associated tibial and/or peroneal nerve injuries (incidence, 22%), with 50% of motor nerve injuries and 27% of sensory nerve injuries demonstrating improvement over the twenty-month follow-up period.
- ★ Similar to previous data regarding civilian injury⁴⁵, peripheral nerve injury associated with open tibial fractures resulting from combat injuries should not heavily influence the decision to amputate a limb because of the high rate of recovery of nerve function.

Basic Science**Segmental Bone Defects**

- ◆ A critical-sized bone defect was created in rat femora and was stabilized with external fixators⁴⁶. This model was used to determine the effects of stiffness and the timing of dynamization on bone healing in the presence of bone morphogenetic protein (BMP)-2.
- ★ "Reverse dynamization" (changing from low stiffness to high stiffness after fourteen days) markedly increased the healing compared with constant low, medium, or high-stiffness fixators.
- ★ Much attention has been paid to biological adjuvants to augment the healing of segmental bone defects. This study highlights the importance of the mechanical environment in these situations as well as potential therapeutic targets.
- ◆ After the creation of a segmental femoral defect in rats, the experimental group received cultured bone marrow-derived endothelial progenitor cells on a gelfoam scaffold and immunohistochemistry was performed to analyze various isoforms of vascular endothelial growth factor (VEGF)⁴⁷.
- At multiple early healing time points, three isoforms of VEGF were significantly greater in the endothelial progenitor cell-treated group as compared with the control group, although the peak levels of each isoform varied slightly.
- ★ The importance of VEGF in the fracture-healing cascade is well known, but research continues to characterize its sources, specific activity, and required

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cofactors. VEGF is a promising possible substance for osteogenesis enhancement.

Muscle Injury

- ◆ A rabbit model of acute fracture with blunt soft-tissue injury was used⁴⁸. In the experimental group, a VEGF-coated collagen sponge was placed at the injury site.
- After forty days of healing, the VEGF-treated group demonstrated 22% greater muscle force than the control group. Histologically, the VEGF group had greater muscle tissue and less connective tissue.
- ★ Muscle injury inevitably occurs following blunt trauma and associated fracture. Very few potential targets are available to enhance muscle recovery, but VEGF may improve vascularity and enhance muscle recovery.

Osteoporosis and Fracture-Healing

- ◆ The FREEDOM trial, a large multicenter randomized trial, compared denosumab, a RANK ligand inhibitor, and placebo in patients with osteoporosis. A subanalysis of the FREEDOM trial data analyzed the outcomes of patients who sustained fractures during the study⁴⁹.

- Of the 7808 patients in the study, 667 sustained a total of 851 nonvertebral fractures (including 386 in the denosumab group and 465 in the placebo group). Seven patients (two in the denosumab group and five in the placebo group) had delayed healing.
- ★ The antiresorptive effects of medications to treat osteoporosis have led to a theoretical concern of interference with the fracture-healing process on a cellular level. This large study demonstrated no clinical evidence to substantiate the risk of delayed fracture-healing with RANK ligand inhibitor therapy.

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