Journal Scan

Highlights of Australian Orthopaedics

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The following 10 papers have been chosen to represent recent highlights of Australian orthopaedics. With so many quality papers to choose from, the decisions were difficult and arbitrary. The papers selected are not intended to represent the top 10, although all are excellent, but to present a breadth of material. Notably absent from the publication list, but a definite highlight of Australian orthopaedics, is the Australian Orthopaedic Association National Joint Replacement Registry (www.aoa.org.au/jointregistry.asp). The registry began collecting data in September 1999. As of December 2006, data have been collected for 332,700 hip or knee arthroplasties performed in 271,188 patients. The information from this registry undoubtedly will provide invaluable information regarding the effectiveness of different types of joint replacement prostheses and surgical techniques.

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Bone Biology

The anabolic and catabolic responses in bone repair.

Little DG, Ramachandran M, Schindeler A. *J Bone Joint Surg Br.* 2007;89:425–433.

Context: Traditional descriptions of fracture repair offer rich narrative information, but would be improved by a biological categorization of the steps that would explain failures or guide logical decision making.

Study Design and Results: This review paper summarizes the current literature on fracture repair but at the same time proposes a new model that describes bone and fracture repair processes in terms of the simultaneous and balanced anabolic (bone forming) and catabolic (remodeling) responses. The authors also propose a classification system for failure of bone repair in terms of either anabolic deficiency, catabolic excess, or a combination of both. Various anabolic and ant-catabolic remedies were reviewed.

Conclusions: Anabolic deficiency is characterized by disruption of local bone and soft tissue, compromised vascularity, and damage to potential local osteoprogenitor cells. Excess catabolism may result from stress shielding (from rigid fixation) and reduced loading and is typified by fracture callus observed on early radiographs which then disappears. As the authors note: “Boosting anabolism, reducing early catabolism, or influencing both the responses can influence outcome positively.”

Comment: This is an important and enlightening paper that marks a definite shift in the thinking of many researchers and clinicians working in this area. The system proposed, although requiring further refinement, successfully incorporates mechanical and biological concepts to allow us to classify bone repair and its deficiencies.

Pearl: Anabolism and catabolism are intrinsically linked, and targeting only one response may not always be

optimal. The ideal strategy for bone repair might be to promote a robust anabolic response with control of catabolism until union is achieved.

Trauma

Biomechanical considerations in plate osteosynthesis: the effect of plate-to-bone compression with and without angular screw stability. Stoffel K, Lorenz KU, Kuster MS. *J Orthop Trauma*. 2007;21:362–368.

Context: Locking screws and plates have become popular although their biomechanics are not completely understood, and in turn their indications relative to traditional compression techniques have not been completely defined. This study aimed to examine the strength, stiffness, and load to failure for compression plating, internal fixation, and a combination thereof for metaphyseal and segmental diaphyseal fractures.

Study Design and Results: This laboratory study compared the biomechanical stability of bone-plate constructs using a compression plate (CP), an internal fixator (IF), and a combination plate (CP/IF). Two fracture models were used: shaft fractures with a segmental defect were simulated in composite bones ($n = 60$) and intraarticular distal femur fractures with a comminuted supracondylar zone were created in fresh frozen cadaveric femurs ($n = 36$). These then were stabilized by compression plating, internal fixation, and a combination (compression/internal fixation) plate. Construct stiffness, plastic deformation, and fixation strength were measured under axial compression and torsion using a biaxial testing machine. In comminuted shaft fractures loaded under axial compression, only internal fixator implants provide significant resistance to varus collapse, whereas under torsion, compression plating provides better stiffness, plastic deformation, and load to failure parameters than internal fixator implants.

Conclusion: A combination of these principles, namely compression and internal fixation, produced a more stable construct in torsion and bending.

Comment: There are a few obvious limitations with this study, such as the nonphysiologic loading and failure conditions and the unassessed contribution of the materials to the ultimate result. Nonetheless, this paper makes a major contribution to the understanding of the biomechanical properties of a combination plate.

Pearls: As noted in the study above, the ideal fracture healing environment balances the anabolic and catabolic responses. Thus, a stiffer fracture construct (which presumably will stress shield more) may not necessarily be the better construct. Optimal stiffness for healing is yet to be determined.

Preinjury status: are orthopaedic trauma patients different than the general population? Gabbe BJ, Cameron PA, Graves SE, Williamson OD, Edwards ER. *J Orthop Trauma*. 2007;21:223–228.

Context: Defining patients' preinjury health-related quality of life status (HRQOL) is an essential prerequisite to measuring the quality of recovery after orthopaedic trauma; as the old joke goes, "one cannot play the piano after the cast is removed if one could not play before it was applied." The use of population norms has been advocated because of concerns regarding the influence of the traumatic event on the recollection of preinjury status; however differences between recalled HRQOL and population norms have not been investigated previously in a large cohort of patients.

Study Design and Results: This is a prospective cohort study of 1839 patients admitted to the two adult Level 1 trauma centers in Victoria, Australia with orthopaedic injuries and registered by the Victorian Orthopaedic Trauma Outcome Registry (VOTOR). The mean SF-12 physical scores were greater in the orthopaedic patients (50.9 vs 48.9; $p < 0.001$) than the population norms, particularly in males from 18 to 54 years old, as were the SF-12 mental scores (54.5 vs 52.4; $p < 0.001$), particularly among women.

Conclusions: The reliance on population norms to estimate preinjury HRQOL status in patients admitted with orthopaedic injuries may result in underestimation of the impact of injury in particular age and gender subgroups.

Comments: The establishment of large databases collecting ongoing quality data is challenging but critical to the establishment of evidence-based guidelines. The VOTOR enrolls all patients admitted to the two adult Level 1 trauma centers in Victoria (population 5 million) and currently provides 12-month outcome data on more than 80% of enrolled patients. In time, this database should be the source of many other interesting studies.

Pearls: Although orthopaedic surgeons can greatly assist in functional restoration of a traumatized patient, the patient may not be completely appreciative, as what is recognized is not the improvement relative between preoperative and postoperative states, but the decline relative to the immediate preaccident state. This study implies that this decline may be greater than we have realized, and suggests that even greater attention be paid to preemption and treatment of posttraumatic psychological depression.

Compartment syndrome

The following 2 articles are presented as a group

Context: Acute compartment syndrome is a serious and not uncommon complication of limb trauma. The condition is a surgical emergency and is associated with significant

morbidity if not diagnosed promptly and treated effectively. Despite the urgency of effective management to minimize the risk of adverse outcomes, the best management approach has not been defined. Diagnostic guidelines, such as continuous compartment monitoring of patients with tibia fractures, have been recommended but not widely practiced.

Survey of management of acute, traumatic compartment syndrome of the leg in Australia. Wall CJ, Richardson MD, Lowe AJ, Brand C, Lynch J, de Steiger RN. *ANZ J Surg.* 2007;77:733–737.

Study Design and Results: A structured survey was sent to all currently practicing orthopaedic surgeons and accredited orthopaedic registrars in Australia to assess their current practice for management of acute, traumatic compartment syndrome of the leg. Questions were related to key decision nodes in the management process, as identified in a literature review. These included identification of patients at high risk, diagnosis of the condition in alert and unconscious patients, optimal time and technique for performing a fasciotomy and management of fasciotomy wounds. Two hundred sixty-four valid responses were received, a response rate of 29% of all eligible respondents. The results indicated considerable variation in management of acute compartment syndrome of the leg, particularly in the use of compartment pressure measurement and the appropriate pressure threshold for fasciotomy. Of the 78% of respondents who regularly measured compartment pressure, 33% used an absolute pressure threshold, 28% used a differential pressure threshold, and 39% took both into consideration. The majority advocated decompression within 6 hours (96%) with 76% routinely decompressing all four compartments (There was a tendency for the older surgeons to restrict decompression to the involved compartment and to use shorter or single-incision techniques). Various options were used for postfasciotomy management including gauze dressings, negative wound pressure dressings, immediate and delayed split skin grafting, and the shoelace closure.

Conclusions: There is considerable variation in the diagnosis and management of acute, traumatic compartment syndrome of the leg among Australian orthopaedic surgeons and registrars.

Continuous compartment pressure monitoring for tibia fractures: does it influence outcome? Harris IA, Kadir A, Donald G. *J Trauma.* 2006;60:1330–1335.

Study design and Results: Two hundred consecutive patients with acute extraarticular tibia fractures were randomized to receive compartment pressure monitoring or usual care. The monitored group received continuous compartment pressure for 36 hours and the nonmonitored

group received usual postoperative observations. In alert patients, the diagnosis of compartment syndrome was made clinically. In unconscious patients, a difference between compartment pressure and diastolic blood pressure (ΔP) less than 30 mm Hg was the criterion for fasciotomy. Patients were assessed for late sequelae of compartment syndrome (sensory loss, muscle weakness, contracture, and toe clawing) at 6 months. Eighty-nine percent of patients were followed up for a minimum of 6 months or until fracture union. Based on clinical criteria, there were five cases of compartment syndrome in the nonmonitored group. In the monitored group there were 18 patients with ΔP less than 30 mm Hg but these were evaluated clinically and none was considered to have a compartment syndrome and so did not proceed to fasciotomy. None of these patients had subsequent development of compartment syndrome or late sequelae. At 6 months, the complication rates and late sequelae in both groups were not significantly different. In both groups, patients with high-energy or open fractures had significantly more late sequelae.

Conclusion: Continuous pressure monitoring may not change the outcomes in patients with tibia fractures. The development of compartment syndrome may not be directly correlated with high compartment pressures.

Comments: The variations in diagnostic and management options practiced by Australian orthopaedic surgeons for compartment syndrome suggests a gap in our knowledge. Approximately three of four surgeons decompress all four compartments. That means that either 25% are operating too little or 75% are operating too much. (If the right answer is “it does not matter”, then the parsimonious surgeons are doing it right, as the extra work brings extra costs and risks.) The gaps in knowledge are best filled with outcomes studies such as that reported by Harris et al., but even that is imperfect, as we are not (morally) ready to let these studies run their course. For example, in the study by Harris et al., there were 18 patients who, based on pressure recordings alone, were indicated for surgery that would have been unnecessary. Likewise, to define the threshold at which it is safe to wait, one must toe the line, if not cross it, and some patients might not get the surgery they need. The study by Harris et al. clearly shows the value of clinical assessment and the ethical limits of prospective human trials.

Pearl: Management of compartment syndrome relies on the art of medicine, as there are risks and pitfalls to aggressive and passive approaches. The correct method balances a keen assessment of the clinical situation with knowledge of the sensitivity and specificity of the diagnostic tests and the patient’s tolerance for risk. Of course we would like to err on the side of caution, but because of the significant morbidity and costs associated with unnecessary fasciotomy, aggressive surgical indications are not

necessarily cautious, even if muscle ischemia could result from inaction.

Anatomy

Brachialis muscle anatomy: a study in cadavers.

Leonello DT, Galley IJ, Bain GI, Carter CD. *J Bone Joint Surg Am.* 2007;89:1293–1297.

Context: The brachialis muscle is an important elbow flexor whose precise course and variations have not been defined.

Study Design and Results: Eleven cadaveric upper limbs were dissected. The brachialis muscle was seen uniformly to consist of two heads: superficial and deep. The larger superficial head originated more proximally and inserted more distally than the smaller, fan-shaped deep head. The superficial head inserted via means of a thick round tendon onto the ulnar tuberosity. The deep head inserted onto the coronoid process via means of an aponeurosis. Most of the muscle was supplied by the musculocutaneous nerve, but the inferolateral fibers of the deep head were supplied by the radial nerve.

Conclusions: These observations of the brachialis differ from the textbook descriptions. The superficial head may be important in providing the bulk of flexion strength. The deep head may be important in initiating elbow flexion from full extension. The inferolateral fibers of the brachialis, together with the anconeus, provide a muscle sling around the ulnohumeral joint to be the dynamic rotatory restraint. It is positioned to be the dynamic stabilizer against rotatory instability.

Comments: This new understanding of the distal musculotendinous anatomy of the brachialis may allow new surgical techniques around the elbow. The tendon of the superficial head is well positioned to be harvested to allow reconstruction of (1) an irreparable distal biceps tendon, (2) a medial collateral ligament of the elbow, or (3) the annular ligament. This paper provides a better understanding of the two-headed structure and dual innervation from musculocutaneous and radial nerves.

Pearls: The brachialis has two heads, the superficial and deep, between which is the internervous plane which should be used for the anterolateral approach of the humerus.

Arthroplasty

Revision total hip replacement using cemented collarless double-taper femoral components.

Howie DW, Neale SD, Stamenkov R, McGee MA, Taylor DJ, Findlay DM. *J Bone Joint Surg Br.* 2007;89:879–886.

Context: Surgeons performing femoral revision have favored cementless stems, but it may be that the poor results attributed to cemented fixation were a result of poor stem design, first-generation cementing techniques, and perhaps overreliance on a standard-length femoral component. Cemented revision offers some advantages (accommodation of severe metadiaphyseal deficiency, a lower risk of intraoperative fracture, and avoidance of stem subsidence, thigh pain, and stress shielding among others) and may be worthy of another look.

Study Design and Results: This is a prospective cohort study of all 219 femoral revisions done with cemented double taper stems between 1984 and 2003 and analyzed by the length of revision stem. No patient was lost to followup. The patients were generally an older group with a mean age of 72 years. Survival to major rerevision for aseptic loosening at 9 years was 98% for long stems and 93% for standard stems with no additional revisions for loosening at up to 18 years. Subsidence, major stress shielding, and thigh pain were avoided.

Conclusions: The cemented long-stem results were excellent and probably could be attributed to the double-taper stem design and polished surface. The lack of complications provided patients with a reliable result and allowed early unrestricted mobilization. The thin tapered stem minimized the need for corrective femoral osteotomies.

Comments: This is another example of the value and importance of good outcome data and a well-maintained database. This database has now collected arthroplasty data for more than 20 years and shows that prospective followup can be achieved at very long term. This study provides solid evidence to support the notion that cemented long stems with polished tapers can provide durable results at up to 18 years and might be considered an alternative to cementless revision in the older patients with distinct potential advantages.

Pearls: A so-called double taper narrows in the sagittal and coronal planes as one moves distally down the stem. This is thought to promote better coupling with the cement and better distribution of forces.

Progression of acetabular periprosthetic osteolytic lesions measured with computed tomography.

Howie DW, Neale SD, Stamenkov R, McGee MA, Taylor DJ, Findlay DM. *J Bone Joint Surg Am.* 2007;89:1818–1825.

Context: Assessment and measurement of osteolysis around acetabular components can be difficult with plain radiographs, however, accurate knowledge of lesion size and progression is important for optimal clinical management of patients needing hip replacement. New-generation CT was used to investigate osteolysis and the factors associated with its progression.

Study Design and Results: This is a retrospective cross-sectional cohort study of 35 cementless Harris-Galante acetabular components with a minimum of 10 years duration. High resolution multislice quantitative CT with metal artifact suppression was used to measure the increase in osteolytic lesion volume over 1 year. There was considerable variation in the size and progression of osteolytic lesions around cementless acetabular components of the same design and long-term duration. Hips with higher polyethylene wear are more likely to have larger osteolytic lesions develop. Lesions greater than 10 cm³ were more likely to increase in size. This progression was significantly associated with larger initial lesion size, greater polyethylene wear rates, and larger prosthetic femoral heads.

Conclusions: CT is a powerful imaging technique to monitor acetabular osteolysis and may be useful to evaluate treatments aimed to prevent osteolysis.

Comments: Often our understanding of conditions is limited by the tools available to study them and it is from new observations that hypotheses are generated. This new CT imaging technique is a tool which enables patterns of periprosthetic osteolysis to be more accurately observed. With this technique the authors were able to study a series of components of the same design and long-term duration and compare the accurate measures of osteolysis with sensitive measurements of polyethylene wear and migration.

Pearl: There is a critical volume of osteolysis (10 cm³) above which osteolysis is likely to progress. This is a useful prognostic marker.

Treatment of staphylococcal prosthetic joint infections with debridement, prosthesis retention and oral rifampicin and fusidic acid. Aboltins CA, Page MA, Buising KL, Jenney AW, Daffy JR, Choong PF, Stanley PA. *Clin Microbiol Infect.* 2007;13:586–591.

Context: Staphylococcal infection is the most common cause of acute prosthetic joint sepsis and methicillin resistant organisms frequently are involved. There is controversy regarding early management of this problem.

Study Design and Results: A retrospective review of prospectively collected patient data of all patients undergoing primary total joint replacement between 1998 and 2003 at one institution identified 20 patients with acute staphylococcal infections (< 3 months symptoms) who were treated with an early aggressive protocol of at least one surgical debridement, and a regime of rifampicin and fusidic acid. There were 13 hips and seven knees in the study. At a median followup of 32 months, 10 of 11 patients with methicillin resistant infections were treated successfully with this regime. Two of the 20 patients (one knee and one hip) experienced treatment failure.

Conclusions: Aggressive debridement and prosthetic retention in combination with rifampicin and fusidic acid is

an effective treatment for acute staphylococcal prosthetic joint infections including methicillin and fluoroquinolone resistant organisms. This is a compelling alternative to immediate excision or revision arthroplasty and may be preferred for elderly or infirmed patients.

Comments: A drawback of this study was the exclusion of nine other patients with staphylococcal infections because some had received immediate single or subsequent two-stage revisions, no surgical intervention, or received different combinations of antibiotics. Had these nine patients been treated via the regime described, they may have contributed significantly to the outcome of this study. Notwithstanding this, the study cohort showed an excellent salvage rate (90%) at a median followup of 32 months.

Pearl: This study is a good reminder that conservative is not a synonym for nonoperative. Aggressive surgical management in the face of infection is indeed conservative. Addressing potential joint infections expeditiously with surgical debridement and directed antibiotic therapy affords patients the best chance of joint salvage.

Safety and efficacy of routine postoperative ibuprofen for pain and disability related to ectopic bone formation after hip replacement surgery (HIPAID): randomised controlled trial. Fransen M, Anderson C, Douglas J, MacMahon S, Neal B, Norton R, Woodward M, Cameron ID, Crawford R, Lo SK, Tregonning G, Windolf M; HIPAID Collaborative Group. *BMJ.* 2006;333:519.

Context: Ectopic bone formation is an unpleasant complication after hip arthroplasty. A short course of postoperative NSAIDs greatly reduces its occurrence. Because it is not possible to identify at-risk patients, routine prophylaxis has been suggested. Still, there are two countervailing arguments: namely, that reducing ectopic bone formation might not improve clinical outcomes, and even if it did, the additional risk of medication-related complications may outweigh that.

Study Design and Results: This is a multicenter (20 surgical centers in Australia and New Zealand), double-blind randomized placebo controlled clinical trial, stratified by treatment site and surgery (primary or revision). Nine hundred and two patients undergoing elective primary or revision total hip replacements received 14 days' treatment with ibuprofen (1200 mg daily) or a matching placebo within 24 hours of surgery. The main outcome measures were changes in self-reported hip pain and physical function 6 to 12 months after surgery (Western Ontario and McMaster University Arthritis index). There were no significant differences between the groups for improvements in hip pain (mean difference, -0.1; 95% confidence interval, -0.4–0.2; p = 0.6) or physical function (-0.1; -0.4–0.2; p = 0.5), despite a decreased risk of ectopic

bone formation (relative risk, 0.69; 0.56–0.83) associated with ibuprofen. There was a significantly increased risk of major bleeding complications in the ibuprofen group during the admission period (2.09; 1.00–4.39).

Conclusions: Based on these data, the use of routine prophylaxis with NSAIDs in patients undergoing total hip replacement cannot be supported.

Comment: This study points out the limits of proxy outcomes. Unless one studies the outcome of interest (hip

scores, as done here), one might be fooled into thinking that NSAIDs were indicated because they improved the proxy measure of ectopic bone formation.

Pearl: Practice guidelines must be based on clinically important outcomes rather than surrogates. We use DVT prophylaxis after joint replacement, for instance, to prevent pulmonary emboli, not distal leg clots, and a prophylactic should not be considered effective unless it addresses the outcome of interest.