MAOA FIRST PLENARY SESSION
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1. Long-Term Survivorship and Analysis of Failures Modes of 1,000 Cemented Total Knee Arthroplasties

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PURPOSE: To examine the survivorship of 1,000 consecutive cemented condylar posterior cruciate retaining (PCR) TKAs of a single, modern modular design, and to analyze the complications, reasons for reoperation, and factors affecting long-term survival of this design.

METHODS: Retrospective review of 1,000 consecutive cemented PCR TKAs (modular tibial baseplate) performed in 745 patients (mean age 70 at operation) at one institution from 1987-1989. The mean follow-up of living patients with components in situ was 15.7 years (14.5-17.9).

RESULTS: Of the 1,000 TKAs, 65 had a knee reoperation, of which 45 involved implant removal or revision. Approximately one-third (16 of 45) of failed components were removed or revised for infection; one-third (16 of 45) for aseptic loosening or PE wear; and one-third (13 of 45) for other reasons (pain, instability, periprosthetic fracture, etc). The most common complications leading to the 20 reoperations *without* component removal were periprosthetic fracture (10 cases) and superficial wound problems (5 cases). Reoperation without revision for periprosthetic fracture had a bimodal chronology notable for early (under 5 years postop) reoperation for patella fracture (4 cases) and late (over 10 years postop) reoperation for femur fracture (6 cases). The overall 15-year survival free of component removal for any reason, component revision for any reason, revision for mechanical failure, and revision for aseptic loosening were: 93.7% (95% CI, 91.8%-95.6%), 95.9% (95% CI, 94.3%-97.5%), 97.0% (95% CI, 95.6%-98.4%), and 98.8% (95% CI, 97.9%-99.7%), respectively. Age less than 60 was predictive of decreased survival for all endpoints ($p<0.0001$). A diagnosis of previous HTO was predictive of decreased survival to revision for any reason ($p<0.02$), while a diagnosis of RA demonstrated a trend toward improved survival. Gender and BMI did not statistically significantly affect survival.

DISCUSSION: Survivorship of this cemented cruciate retaining implant was excellent at 15 years. Notably, for a modern cemented condylar TKA, only about one-third of reoperations and revisions were for mechanical implant failure. This suggests that, in addition to ongoing efforts to minimize long-term reoperation rates after TKA for mechanical failure, efforts should concentrate on prevention and effective treatment of prosthetic infection and periprosthetic fracture—which together made up the majority of reoperations in the first 17 years after modern TKA.

2. BMP 14 Gene Therapy Effectively Increases Tendon Tensile Strength in a Rat Model of Achilles Tendon Injury

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INTRODUCTION: Bone morphogenetic proteins (BMPs) are being used clinically to enhance bone formation in a variety of clinical settings. BMP14 induces neo-tendon formation when injected ectopically, and we examined the effects of adenovirus-mediated expression of BMP14 on Achilles tendon healing in a rat model. Many analogous clinical situations involving tendon injury could benefit from similar biologic augmentation.

METHODS: Ninety male Sprague-Dawley rats underwent complete transection of the Achilles tendon, followed by immediate surgical repair. Each animal then received either an intra-substance injection of adenovirus expressing BMP14 or a mock virus expressing green fluorescence protein (GFP). Sham control animals received no injection. Thirty animals were sacrificed at one, two, and three weeks after surgery. Tendons were sent for histology and biomechanical testing.

RESULTS: Two weeks post-surgery, the BMP14-treated tendons exhibited a two-fold increase in tensile strength and showed less gapping than either GFP or sham control groups ($p<0.01$). Although BMP14-treated tendons were stronger on average with less gapping at both one and three weeks post-surgery, load-to-failure measurements were not statistically significant. Histologic evaluation revealed no ectopic bone or cartilage formation in the BMP14 groups and no inflammation of the tendons in any of the adenoviral groups.

DISCUSSION: We have demonstrated that adenovirus-mediated BMP14 effectively improves tendon healing in this rat Achilles injury model. This effect of BMP14 was statistically significant at two weeks after injury. Thus, our data suggest that BMP14 gene therapy accelerates tendon healing above that of recombinant protein used in a similar model, and may be more effective for clinical applications.

3. A Biomechanical Evaluation of Arthroscopic Labral Tears: Does Biceps Load and Superior Labral Fixation Add to the Stability of a Combined Anterior-Superior Labral Tear? (Type 5 SLAP)

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PURPOSE: To assess glenohumeral stability in shoulders with a superior labral tear that extends down to the inferior aspect of the glenoid (a type 5 SLAP tear) with and without a load on the long head of the biceps.

METHODS: A combined SLAP and Bankart lesion was created arthroscopically in six fresh-frozen cadaveric shoulders. Each shoulder was treated with arthroscopic SLAP and Bankart repair with suture anchors and tested biomechanically. The sutures for the SLAP repair were arthroscopically removed and the shoulders were tested with an isolated Bankart repair and subsequently with no repair. The shoulders were tested with and without the long head of the biceps under load, in neutral and external rotation, and in 0° and 90° of abduction. The load was applied in the anterior-posterior (AP) and anterior-inferior (AI) planes.

RESULTS: Loading the biceps uniformly improved the stability of each shoulder at all positions tested. Biceps load made the most difference in the AP plane at zero abduction with 4/6 tests demonstrating significantly less displacement ($p<0.05$) and 6/6 with $p<0.08$. The AI plane at 0° of abduction was similar with 2/6 demonstrating significantly less displacement ($p<0.05$) and 5/6 with $p<0.08$. Significant differences in stability between full repair and no repair were detected. There was a significant difference ($p<0.05$) with the shoulder in 90° of abduction and neutral rotation when testing in the AP plane. There was a significant difference ($p<0.05$) at 0° of abduction in the AI plane. There was a trend toward a significant difference ($p<0.10$) at 90° of abduction and external rotation in the AP and AI planes. There was a trend that no significant difference between a Bankart repair and a Bankart/SLAP repair would be detected.

CONCLUSIONS: Loading the long head of the biceps adds significant stability at 0° of abduction in both planes tested, but did not significantly improve stability at 90° of abduction in either plane. It appears that there is no difference in stability between an isolated Bankart repair and a combined Bankart/SLAP repair.

4. Percutaneous Reduction and Fixation of Displaced Intra-Articular Calcaneus Fractures

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PURPOSE: The optimal treatment of displaced intra-articular calcaneal fractures (DIACF) is controversial. This is a retrospective cohort study to assess the initial results of percutaneous reduction and fixation (PC) in comparison to a concurrent control group treated with open reduction and internal fixation (ORIF).

METHODS: Between 2000 and 2004, 76 DIACF in 71 patients were treated operatively at a single institution by two surgeons with one of two methods. ORIF was performed through an extended lateral approach and fractures were fixed with plates and screws (27 fractures in 27 patients). PC was through small incisions with indirect manipulation, and the reduction achieved was secured with screws alone (49 fractures in 44 patients). Patient demographics, fracture characteristics, and complications were compared on all fractures at a minimum of four months follow-up. A total of 71 fractures (26 ORIF/45PC) had sufficient x-rays to be included in the radiographic analysis.

RESULTS: The patients and the fractures in the two groups were not significantly different. Radiographic measures of fracture reduction and maintenance of reduction at healing were not significantly different between the groups. Deep infection (operative drainage and/or IV antibiotics) occurred in 5/27 of the ORIF group and 0/49 of the PC group ($p=0.004$). The incidence of minor wound complications was 8/27 in the ORIF group and 4/49 in the PC group ($p=0.02$). The need for secondary operations including late subtalar fusions (1/27 and 2/49), and hardware removal (1/27 and 7/49) were not significantly different ($p=0.71$ and $p=0.25$ respectively).

CONCLUSION AND SIGNIFICANCE: The results of this study suggest that PC minimizes complications, while achieving and maintaining reductions as well as ORIF. The strength of this initial study of PC is the inclusion of a concurrent control group allowing comparison of outcome measures. However, the results should be interpreted with caution due to limited patient numbers, short follow-up, and undetected confounding factors.

5. Porcine Small Intestinal Submucosa (Restore Orthobiologic Implant) Augmentation of Chronic Two-Tendon Rotator Cuff Tears Treated with Open Surgical Repair. A Randomized Controlled Trial

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BACKGROUND: No published controlled study has evaluated the effectiveness of SIS augmentation of human rotator cuff repairs. The purpose of this study is to determine the effectiveness of SIS-Restore patch augmentation to repair chronic two tendon rotator cuff tears compared to repairs performed with the same techniques without SIS augmentation.

METHODS: Thirty shoulders with chronic two-tendon rotator cuff tears that were completely repairable by open surgery were randomized to either use SIS augmentation (Restore patch) or without the augmentation device. All patients completed a PENN shoulder score preoperatively and at their latest follow-up, which averaged 14 months (range 12-26.5). The size of the two-tendon tears was subcategorized into large or massive tears based on preoperative MRIs. Nine patients had large tears and 21 patients had massive tears. All patients underwent an MRI with intra-articular gadolinium one year after the repair to assess the status of the rotator cuff.

RESULTS: The percentage of patients with a healed rotator cuff in the SIS group was 27% percent, and in the control group was 60% ($p=0.11$). After adjusting for the effect of tear size on the rate of healing, repairs without SIS-Restore augmentation were 7% more likely to heal than repairs augmented with SIS-Restore ($p=0.07$). The postoperative PENN total score for the SIS-Restore group was 83 and for the control group was 91 ($p=0.07$). The postoperative PENN total score for the healed repairs was 96, and for the failed repairs was 81 ($p=0.02$). The preoperative to postoperative percentage change in the PENN satisfaction score for the healed repairs was 400%, and for the failed repairs was 50% ($p=0.05$).

CONCLUSIONS: In large and massive chronic cuff tears, SIS-Restore did not increase the rate of tendon healing or the clinical outcome scores. There is a trend for the SIS group to have less favorable clinical outcomes in these types of tears.

6. Open Reduction and Internal Fixation of Displaced Fractures of the Scapula at a Level One Trauma Center

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INTRODUCTION: There is limited data about the outcome of open reduction and internal fixation (ORIF) of displaced fractures of the scapula. The purpose of our study was to assess the initial outcome of ORIF of displaced fractures of the scapula at a level one trauma center.

METHODS: After human studies approval, our database generated 14 consecutive patients who had undergone ORIF of the scapula by a single surgeon over a 2½ year period for this retrospective case series.

RESULTS: There were ten males and four females with an average age of 32 (range, 21-50). Mechanisms of injury included MVA (6), MCA (5), bicycle accident (1), equestrian accident (1), and ATV accident (1). There were 2 displaced glenoid fractures (OTA 09-B), 11 scapular neck fractures (OTA 09-A), 5 body fractures (OTA 09-A), and 4 scapular spine fractures (OTA 09-A), with more than one major fracture pattern in nine patients. All patients underwent ORIF at an average of 7.8 days after injury. Internal fixation included an average of 1.85 titanium reconstruction plates, with an average of 7.2 screws (3.5 or 4.0 mm) per case. Anatomic reduction was achieved in 12 cases and near-anatomic reduction in 2. There were no postoperative infections. Minimum five-month follow-up was available for eight patients. Six patients did not return for follow-up after four months after surgery. The average follow-up (N=8) was 13 months (range, 5-29). Six patients (75%) were working at follow-up. Total UCLA shoulder function score was a mean of 27.5 (range, 20-35) out of a possible 35.

DISCUSSION AND CONCLUSION: ORIF of displaced scapula fractures anatomic reduction was associated with a low complication rate and a good shoulder function at early follow-up in a small series of cases at a level one trauma center. Although our early results are promising, our study is constrained by small numbers and limited follow-up. Additional study is needed before changes in treatment can be supported.

7. A Prospective and Randomized Comparison of Morphine and Midazolam versus Propofol for the Reduction of Total Hip Arthroplasty Dislocations

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INTRODUCTION: Hip dislocation is a common postoperative complication associated with total hip arthroplasty. Closed reduction of hip dislocations routinely occurs in the emergency department and requires sedation of the patient to facilitate reduction. The safety and efficacy of morphine and Midazolam versus Propofol in the reduction of total hip arthroplasty dislocations are compared in a prospective, randomized study.

METHODS: Patients presenting with total hip dislocations were randomized to either sedation with morphine and Midazolam or sedation with Propofol. Time to reduction, quality of sedation, pain, complications of sedation, time to recovery, and time to discharge were recorded and analyzed.

RESULTS: Thirty-six patients were randomized in this study. Patients in the Propofol group had a shorter average time to reduction than those in the morphine group (5 versus 13 min, p=0.0013). Time to alertness after reduction was also shorter in the Propofol group (9 versus 73 min, p=0.0069). Ease of reduction was subjectively easier in the Propofol group (8.6 versus 6.6, p=0.0013, scale of 0-10 with 0=unable to reduce, 10=easily reducible). There was no difference appreciated between the groups with regard to pain scores and quality of sedation (p>0.05). Complications in the morphine group included nausea, vomiting, decreased blood pressure, and/or mild oversedation. Complications in the Propofol group included mild oversedation (oversedation defined as drop in oxygen saturation of >10%).

DISCUSSION: Sedation with Propofol was demonstrated to make reduction of total hip dislocations quicker and easier, with a faster recovery from anesthesia.

8. Intraoperative Fractures During Primary Total Knee Arthroplasty

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Iatrogenic intraoperative fractures during primary total knee arthroplasty have received little attention in the orthopedic literature. The purpose of this study was to review a large series of patients who sustained intraoperative fractures during the performance of primary total knee arthroplasty focusing on the demographics, prevalence, and outcome.
Between 1980 and 2000, 14,676 primary TKAs were performed at our institution. During that time period, 41 patients sustained 42 intraoperative fractures during their arthroplasty. There were 29 femur fractures, 12 tibia fractures, and 1 patella fracture. The mean follow-up after arthroplasty was 59 months.

There were 13 males and 28 females with a mean age of 66 years at the time of arthroplasty. The majority of patients had osteoarthritis. Of the 29 intraoperative femur fractures, 12 were located in the medial femoral condyle, 7 in the lateral femoral condyle, 5 in the supracondylar region, 3 in the medial epicondyle, and 2 in the lateral epicondyle. Of the 12 tibia fractures, 6 were located in the lateral tibial plateau, 3 in the medial tibial plateau, and 3 in the tibial shaft distal to the implant. Thirteen fractures occurred during bone preparation, 14 occurred during trialing, 3 occurred during cementation, and 1 occurred during exposure. Eleven fractures occurred at unspecified times during the case, 3 of which were diagnosed after obtaining the postoperative radiographs. Treatment methods varied depending on the fracture location and pattern and included observation, fixation with screws, addition of stems, bone grafting, and alteration of the postoperative rehabilitation. Knee Society scores and function scores improved from 61 and 39 preoperatively to 84 and 54 postoperatively. Seven patients went on to have revision at an average of 41 months from the index arthroplasty, including 2 for infection, 3 for instability, 1 for stiffness, and 1 for pain.

Intraoperative periprosthetic fracture is relatively uncommon during primary total knee replacement. It occurs slightly more commonly in females, on the femur, and the majority occur during preparation and trialing maneuvers. Satisfactory outcomes can be obtained with appropriate stabilization, but revision rates are higher than in a nonfractured cohort.

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