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SCIENTIFIC PAPERS

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Paper #1

PATELLAR COMPLICATIONS FOLLOWING DISTAL FEMORAL REPLACEMENT AFTER BONE TUMOR RESECTION

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Introduction: Patellar Complications following by endoprosthetic reconstruction can occur due to anatomic, physiologic and surgical reasons. Patellar impingement upon tibial polyethylene is a complication unique to distal femoral replacement, and it is likely related to inaccurate joint line restoration and soft tissue contracture.

Materials and Methods: Forty-three patients were reviewed following reconstruction of distal femoral tumors using a rotating hinge endoprosthesis. Patients were followed clinically and radiographically for a minimum of 48 months or until death. Pain, functional scores and range of motion were obtained from a prospectively maintained data base. The Insall-Salvati ratio was measured on 3 post-operative radiographs and the mean score was recorded. The ratio of patella tendon length (LT) relative to patellar tendon height (HI), as described by Insall and Salvati, was also measured. In addition the position of the patella was correlated with anterior knee pain and functional scores utilizing (ISOLS) system.

Results: There were 35 patellar complications occurring in 27 patients (63%). Eleven (26%) cases of impingement were recorded. There was no difference in patellar pain between the group with impingement and the group without impingement. (p=0.296) The average range of motion in the impingement group was 88.6 degrees vs 93.1 in the non-impingement group. (p=0.769) The Insall-Salvavti ratio averaged 0.77 in the impingement group vs 1.04 in the non-impingement group. (p=0.193) The ratio of patellar tendon length (LT) to the height of the patellar tendon insertion (LT/HI) was 0.9 in the impingement group and 1.4 in the non-impingement group. (p=0.069) The ISOLS score for the impingement group was 21.2 vs 24.2 in the non-impingment group. (p=0.013). Patella baja occurred in 9 (21%) patients. The average ISOLS score for patients with patella baja was 20.1± 4.4 vs 24.8±3.9 in the group with normal patellar position. (p=0.004). Fracture occurred in 2 (5%) patients, and clinically significant avascular necrosis occurred in 2 (5%) patients. These patients were treated non-operatively.

Conclusion: Patellar complications after distal femoral resection and endoprosthetic reconstruction are common. Patellar impingement upon the tibial polyethylene bearing surface is an under appreciated complication of distal femoral replacement. It negatively effects the overall function of the knee when it occurs. Patella baja is also a relatively common complication after distal femoral resection, and it also has a negative impact on overall knee function. Aggressive post-operative physical therapy and meticulous reconstitution of the normal joint line may help prevent this complication.

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Paper #2

ALLOGRAFT-HOST UNION FOR LIMB SALVAGE OF MUSCULOSKELETAL TUMORS: A RETROSPECTIVE COMPARISON OF LOCKING TO DYNAMIC COMPRESSI0N PLATES

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Introduction: The past three decades have seen great progress in the treatment of patients with primary skeletal malignancies. Currently, the vast majority of these patients are treated with a combination of chemotherapy and limb-sparing surgery. Cadaveric allografts offer the benefit of biologic incorporation into the host bone. A comprehensive review of more than 800 allograft reconstructions at a single institution revealed that allograft survival beyond 3 years was associated with excellent long-term graft retention but allograft-host nonunion rates of 8-33% have been reported. The adverse effects of chemotherapy on graft incorporation are well known.
In recent years, locking plates have become popular for treatment of traumatic skeletal injuries, particularly in non-unions and fractures in osteoporotic bone. This would seem to be advantageous for use in allograft fixation, as allograft is avascular, and the time to healing is prolonged when compared to normal fracture healing. Rigid fixation with the option of unicortical screw purchase in the allograft also could help reduce stress risers and subsequently the risk of fracture, another mode of allograft failure. We undertook this study to compare allograft union with locking compared to dynamic compression plates.

Materials and Methods: Utilizing a computerized database approved by the Institutional Review Board at the host institution, patients meeting inclusion criteria were identified. Those patients less than eighteen years old who underwent resection of a malignant primary skeletal neoplasm with allograft reconstruction between January 1998 and June 2004 were included. These criteria were chosen in an effort to standardize the comparison cohort to the greatest possible extent in an effort to more directly compare locking to standard compression plates. Demographic, oncologic, surgical and follow up data were collected. The surgical date, operative time, blood loss, type of allograft (osteoarticular or intercalary), method of fixation, need for flap closure and margin status were determined. Follow up data included total follow up time, presence of postoperative complications and need for further operation(s). Radiographs for each patient were reviewed from the time of surgery to the latest follow up. Determination of union was made based upon the descriptions of Enneking and Campanacci. The time to union, if present, was noted. Any patient failing to show bony healing by 12 months postoperatively, or who required additional surgery to achieve healing was defined as having a nonunion.

Once all data were collected, patients were divided into groups based on whether initial fixation was achieved with a standard compression or locking plate. Mantel-Haenszel's log-rank test and Fisher's exact test were used to compare the two groups to determine if any statistically significant difference in union rates could be appreciated. A p-value of <.05 (95% confidence interval) was considered to be statistically significant.

Results: Thirty-nine patients meeting the inclusion criteria were identified Homogeneity of the study group with regards to age, sex, diagnosis, adjuvant therapy and presence or absence of metastases allowed for evaluation of allograft-host union as a relatively independent variable.

Statistical analysis revealed no significant differences between the groups for age, gender, blood loss, operative time or time to union. Though no statistical significance was demonstrated, comparison of overall union rates between groups suggested that healing might be improved with use of locking plates ($p < 0.25$, 95% confidence interval). Eight patients with standard plates had their plates revised after nonunion was established. Fewer procedures were performed proportionally for repair of nonunion in patients with locking plates than those with standard compression plates.

Discussion: Limb sparing resection accompanied by adjuvant therapy has become the standard for most patients with malignant primary bone sarcomas. Post-resection reconstruction remains quite challenging, particularly in the skeletally immature. Allografts offer the advantage of biologic incorporation, but may be associated with significant complications, particularly nonunion, fracture and infection. Locking plates have become increasingly popular for

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fixation of fractures in osteoporotic bone and nonunions. With respect to the risks of nonunion and fracture, the rigid fixed-angle construct and the ability to achieve stable fixation with unicortical screw purchase would seem to make these implants desirable for fixation of the allograft-host junction. In this study, of patients fixed with standard compression plates initially, 55.6% achieved union at an average of 14.6 months. In comparison, those with locking plates achieved a 75% union rate at an average of 13.1 months. Additionally, the locking plate cohort experienced no allograft fractures, compared to two in the standard plate group. With respect to additional procedures for nonunion, 8/13 in the standard plate group healed with plate revision and autogenous bone grafting. All four who were converted to locking plates healed without further intervention. 2/3 patients from the locking plate group who developed nonunion went on to union after autogenous grafting alone, while the other required plate revision and continues to have a persistent nonunion.

Due to insufficient power, no statistically significant difference was demonstrated. However, these data suggest that locking plates may provide some benefit when used for fixation of the allograft-host junction. There were two main limitations to this study. The first was the small sample size, which led to an inability to demostrate statistically significant differences between the groups. The second limitation was the shorter follow up period for patients with locking plates. However, the fact that improved union rates were seen in this group despite a relatively short follow-up interval is encouraging in lieu of the known natural history of allograft incorportation

The main strength of this study is the homogeneous patient population examined. Though most received chemotherapy (all but those diagnosed with adamantinoma), this cohort represented a relatively biologically favorable group for allograft incorporation. This allowed for more direct comparison between the implants in question. Certainly, more study is needed to settle this issue. While a randomized, controlled trial would be of tremendous benefit, perhaps larger retrospective series or even multi-institutional cooperative series would be more prudent for the short-term.

Paper #3

IS WIDE BETTER THAN INTRALESIONAL RESECTION IN OSSEOUS METASTASES OF RENAL CELL CARCINOMA?

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We studied local disease control and function in 48 patients with osseous metastases of renal cell carcinoma to further define the extent of resection needed to prevent recurrence and provide a functional result. Medical records of 48 patients treated for osseous metastases from renal cell carcinoma were retrospectively reviewed. Prognostic factors for survival were analyzed and treatment methods were compared with regard to recurrence, revision, and functional outcome. Survival for the entire group was 64% at 1 year, 22% at 3 years and 10% at 5 years. Solitary lesions ($p=0.03$), good performance status ($p=0.01$), and performance of nephrectomy ($p=0.04$) were identified as independent predictors of survival. Age, sex, presentation (metachronous or synchronous), and magnitude of resection were not found to be independent predictors of survival. Ten of 26 patients (38%) who underwent intralesional procedures developed local recurrence and required subsequent procedures within 15 months (range 1-22 months). Patients who had wide resection and reconstruction had good functional outcome, without local recurrence or need of revision. We recommend an aggressive approach in patients with solitary osseous metastases from renal cell carcinoma. Our data show that wide resection of osseous metastases from renal cell carcinoma provides better local disease control and enhances functional outcome over the duration of the patient's survival.

Paper #4

STABILITY OF KNEE SPANNING EXTERNAL FIXATION SYSTEMS FOR TRAUMATIC KNEE DISLOCATIONS

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Purpose: The relative degree of stability offered by different external fixation (XF) constructs is unknown. We compared the relative stability of four of the most common XF configurations commercially available for spanning the knee joint.

Methods: Synthetic composite femora and tibiae connected with cords to create an artificial knee joint were used. Four XF tested included: monotube with anterior femoral pins, monotube with anterior lateral femoral pins, two rods with anterior lateral femoral pins, and hinged fixator with medial and lateral connecting rods. All configurations were assembled placing the knee joint in anatomic alignment with 3 mm joint space and full extension. Six specimens of each XF were loaded non-destructively in varus/valgus, anterior to posterior shear, flexion/extension, axial compression, and internal/external rotation

Results: Values of structural stiffness in different loading modes are shown below. The hinged configuration was statistically most rigid in valgus loading followed by XF 3, 2 and 1, respectively ($p<0.01$). The hinged configuration was significantly stiffer in varus loading than XF 1 but not different from XF 2 and 3. This XF was statistically least rigid in flexion and extension. Torsional rigidity of the hinged consturct was significantly higher than the other three constructs. Torsional rigidity was not significantly different in the three other configurations ($p>0.05$). Shear rigidity (anterior to posterior translation of the tibia on the femur) of the hinged construct was statistically stronger than the other three constructs ($p<0.035$).

Configuration	Varus (Nm/mm)	Valgus (Nm/mm)	Flexion (Nm/mm)	Extension (Nm/mm)	Torsion (Nm/deg)	Compression (N/mm)	AP (N/mm)
1 Ant Mono	0.156±0.036	0.153±0.023	0.449±0.226	0.551±0.141	0.551±0.126	34.49±8.87	7.02±1.59
2 A-L Mono	0.215±0.070	0.238±0.100	0.333±0.232	0.321±0.128	0.612±0.185	47.19±11.90	5.82±1.37
3 A-L 2 rods	0.231±0.077	0.256±0.056	0.162±0.058	0.289±0.040	0.416±0.064	14.38±5.44	6.74±1.09
4 Hinged	0.283±0.109	0.348±0.052	0.069±0.010	0.114±0.019	0.822±0.136	17.99±8.53	10.2±2.33

Discussion: Monotube anterior pins vs. monotube anterior-lateral femoral pins: Comparison of configuration 1 (anterior femoral pins) to configuration 2 (anterior-lateral femoral pins) in the clinically relevant loading modes of varus, valgus, and torsion showed configuration 2 to be stronger. Configuration 1and configuration 2 are not statistically different when loaded in anterior/posterior shear. Overall, the anterior lateral pins are more stable than anterior pins when using the monotube construct.

Monotube anterior-lateral femoral pins vs. two rod configuration: Comparison of construct 2 (anterior lateral pins, monotube) to construct 3 (anterior lateral pins, two connecting rods) in the clinically relevant modes of varus, valgus and torsion showed construct 3 to be stronger in varus and valgus loading but slightly weaker in torsion. Construct 2 and construct 3 are not statistically different when loaded in anterior/posterior shear. Therefore, there appears to be an advantage to using the two connecting rods.

Construct 4, (hinged fixator in the locked mode) gave adequate stability (stronger than the static frames) but direct comparison may not be appropriate since the hinged fixator is more complicated to apply and used more tibial pins. The stability of the articulated fixator in the unlocked position was not tested.

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Comparison of group 4 (hinged but locked) to group 1, 2 and 3 showed group 4 to be stronger in clinically relevant modes of varus, valgus and torsion loading but is less resistant to normal joint flexion and extension. The hinged construct had the strongest rigidity in anterior to posterior shear. This was statistically significant (p-value<0.035).

Conclusion: When using the monotube construct, we recommend placement of the pins in the anterior position on the tibia and anterolateral position on the femur. This provides the most stable construct.

When comparing the monotube to the two rod construct, we recommend use of the two rod construct with anterior-lateral femoral pin placement and two connecting rods. This construct is the most rigid.

Surgeons utilizing the hinged XF can be assured that the stability of this frame when locked is as good as the static frames. It is statistically the most rigid construct in all clinically relevant modes of loading.

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Paper #5

ASSISTED REPRODUCTION OF THE ACL

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Background: The cruciate ligaments are extrasynovial structures protected from the fibrinolytic action of joint fluid by the semi permeable synovial membrane. The washing effect of synovial fluid inhibits movement, multiplication and growth of fibroblasts. This is a deterrent to collagen growth and healing of a damaged anterior cruciate ligament (ACL).

A partially absorbable prosthetic ligament shielded by a free synovial graft or dermal matrix can provide a framework to allow healing of the damaged cruiciate ligament avoiding the downside of auto or allograft reconstructions.

Methods: A braided synthetic ligament made of 75% degradable polyglycolic acid (PGA) filaments and 25% nondegradable Dacron threads measuring 6.5 mm was used to assist fibrous growth of the damaged ACL. A free synovial graft was wrapped around the intra-articular portion to allow protection from fibrinolytic effects of the hyaluronic acid in joint fluid.

Six dogs underwent bilateral anterior cruciate reconstruction using a PGA-Dacron ligament with a synovial wrap in the right knee. In the left knee the same surgery was performed without the synovial shield. The dogs were sacrificed one year after implantation.

Thirty-one humans with symptomatic ACL deficient knees underwent surgery using the PGA-Dacron ligament wrapped with a free synovial graft. Four knees were reconstructed within a month of injury. Twenty-seven knees were reconstructed an average of 15 months after injury. Nine patients had an ACL reconstruction on their other knee using auto graft techniques. Four patients underwent arthroscopic surgery 3 to 7 years after implantation of the PGA-Dacron ligament for other reasons.

Results: Low and high-powered microscopic examination of the dog ACL revealed abundant mature fibrous ingrowths in the knees shielded with the synovial wrap but not in the unprotected knees. Healthy fibrous tissue replaced the PGA and infiltrated and surround the Dacron filaments. Histological sections showed secondary vascular ingrowth and generous fibrous bone growth into the extra-articular portion of the ligaments in the anchoring tunnels.

In the humans, the average age at surgery was 26 (range 19-43). The range of motion was full within 3 months in all cases. There were no surgical complications. The mean follow-up was 11 years (range 7-19 years). All the patients returned to full activity with no pain or instability complaints. One patient had occasional joint effusions and 3 exhibited a positive pivot shift. Seven of 9 patients with an autograft on the other side preferred the PGA-Dacron ligament knee both in short and long term follow-up. There were no re-ruptures. The ligament graft looked healthy on the four "second look" arthroscopic procedures. More recent procedures have used an acellular cadaver dermal matrix with similar results

Discussions: The hyaluronic acid component of joint fluid inhibits fibroblastic activity and is a major deterrent to the formation of intra-articular adhesions that could form after even small injuries. An intact synovial membrane is semi permeable and excludes hyaluronic acid from the cruciates. With injury the shielding effect of the synovium is lost. Reestablishing the synovial membrane can result in healing of the injured ACL as long as a latticework exists to encourage fibrous and collagen tissue growth.

Conclusion: Biological restoration of the anterior cruciate ligament is possible with the use of a partially biodegradable replacement ligament. The technique of insertion is meticulous but the results may be superior to autograft techniques.

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Paper #6

THE DEVELOPMENT OF EARLY ARTHROSIS OF THE KNEE FOLLOWING ACL RECONSTRUCTION: THE FAILURE OF AN ORTHOPAEDIC PARADIGM

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Recent reports have highlighted the worrisome early development of arthrosis following ACL reconstructive surgery.(1,2,3,4,5,8) This phenomenon of post-operative arthrosis represents *a silent and disconcerting epidemic* with substantial implications for the development of pathophysiologic failure in ACL reconstructed knees, despite the achievement of normal structural and biomechanical characteristics following surgery (e.g. normal instrumented laxity, range of motion, muscle strength, and radiographs, etc.)

As has been previously reported, a method exists to detect the loss of osseous homeostasis that occurs at a time when the radiographs and even MRI bone signal are still normal - thus identifying knees “at risk” of developing early overt degenerative changes while the process may still be reversible.(6,7) Patients whose post-operative knee bone scans achieve normalcy - reflecting restoration of osseous homeostasis - have been shown to remain free of degenerative changes indefinitely (out to 13 years post operatively) barring a new injury. (8)

The primary principle of all orthopaedic treatment is to “restore musculoskeletal function”. The envelope of function is a new method to represent the capacity of the knee (or any musculoskeletal system) to generate, accept, redirect, and dissipate a range of biomechanical loads and yet still maintain tissue homeostasis of all the components. It is clear that the restoration of certain structural and biomechanical characteristics to normal values (the current standard of success of ACL reconstruction procedures) is insufficient to prove full restoration of the joint to its normal pre-injury physiological functional status. Yet, such patients are often told that they are “fixed” and therefore can and should proceed with an aggressive rehabilitation program and early return to high-end sporting activities such as soccer and basketball. Such advice (that follows directly from the conceptually-limited belief in the preeminence of the structural/biomechanical orthopaedic paradigm) only encourages patients to load their reconstructed knees out of their envelope of function, resulting, initially in loss of osseous tissue homeostasis and then eventual early irreversible degenerative changes.

The tissue homeostasis approach to patients with ACL reconstructed knees, which emphasizes the restoration and persistence of osseous homeostasis (proven by normal post operative bone scintigraphy), by means of careful, incremental, rehabilitation and continued loading within the envelope of function - has resulted in knees without the development of early arthrosis, barring a new injury. Therefore, it is recommended that the achievement of tissue homeostasis should be a goal in the management of orthopaedic patients, including those with symptomatic ACL deficiency, rather than the mere restoration of normal structural characteristics.

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Paper #7

ANTERIOR KNEE PAIN AND TOTAL KNEE ARTHROPLASTY: ARE THEY RELATED?

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Introduction: Anterior knee pain is often cited as a factor relating to patient dissatisfaction after total knee arthroplasty. In studies examining total knee arthroplasty, the incidence of anterior knee pain ranged from 2-11 percent. Factors implicated as causative in producing the pain include: implant design, surgical technique, component alignment, joint line restoration, and restoring patellar thickness.

Methods: Anterior knee pain was prospectively evaluated in 102 subjects: 51 TKA (PS design) subjects with patellar resurfacing by a single surgeon and 51 controls. All subjects were matched for age, sex, body mass index, and knee function score. Control subjects were excluded if they had prior knee surgery, trauma, or abnormal radiographs. A patellar score was calculated for all subjects using a specific questionnaire that examines anterior knee pain, quadriceps strength, and function.

Results: Hospital for Special Surgery mean score was 92.1 in the TKA group and 93.0 in the control group. Patellar mean score was 25.9 in the TKA group and 28.8 in the controls. In the TKA group 11 of 51 subjects (22%) reported anterior knee pain, most commonly described as mild (73%). In the control group, 7 of 51 subjects (14%) reported anterior knee pain, described as mild by 86%. The difference in anterior knee pain between the two groups (8%) is not statistically significant ($p = .44$).

Discussion/Conclusion: This data suggests that anterior knee pain is present in a certain percentage of the healthy population and that anterior knee pain following total knee arthroplasty may not be directly related to surgical factors.

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Paper #8

COMPARISON OF THE RESULTS BETWEEN UNILATERAL AND BILATERAL TOTAL KNEE ARTHROPLASTY: A STUDY OF 1000 CASES

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We compared 1076 cases of Total Knee Arthroplasty (TKA) performed by the two authors over a 4 year period. The interest of this study is to contrast the results obtained by the patients in each group. The data were collected in a prospective fashion.

The groups were not randomized but selected by the merits of necessary surgery. 314 (29%) of the knees were performed in bilateral fashion and 762 (71%) were performed in unilateral fashion. In the bilateral group 32% were males with 68% female having an average age 67.7 years and a body mass index (BMI) of 30. The unilateral group was similar with 27% male, 73% female and average age 69.7 years with average BMI 30.1. Osteoarthritis was the diagnosis in 98% of the cases.

Results tended to be constant after the first year. Using the Knee Society Clinical Rating Score both groups improved dramatically from preoperative scores of 38.5 (uni) and 37.7 (bilat) to 91.2 (uni) and 95.2 (bilat). These data imply that the bilateral group of patients had greater overall improvement in knee scores and the functional data are even more dramatic with pre op scores of 43.7 (uni) and 46.8 (bilat) and 84.1 (uni) and 92.2 (bilat).
Most studies of this type center on the medical advisablility of performing TKA in this cohort of patients. We have chosen to focus on the overall results. The functional scores imply the ability to perform normal daily activities. These were clearly most improved in those patients undergoing the bilateral procedure and parallel our impression that patients with significant bilateral disease do best with a simultaneous bilateral procedure.

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Paper #9

A KINEMATIC ALIGNMENT PARADIGM FOR TOTAL KNEE ARTHROPLASTY: APOLOGETICS AND CLINICAL RESULTS

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It is commonly stated that total knee replacement arthroplasties should be placed so that the arthroplasty components are perpendicular to the mechanical axis (middle hip – middle knee – middle ankle). In spite of this almost ubiquitous recommendation there is little experimental support for this recommendation and many knees replaced using this paradigm require ligamentous release at the time of insertion.

Kinematic research has established the average flexion axis of the knee joint as being near (but not exactly on) the epicondylar axis of the femur. The relationship of the average flexion axis to the extremity as a whole does not place it at right angles to the mechanical axis but rather at right angles to an axis marked by the origin of the quadriceps, the trochlear groove, the tibial tubercle and the neck of the talus. This "functional axis" departs from the mechanical axis by 3º. Although the 3º difference seems quite small it can lead to kinematics that require the medial collateral ligament to stretch 3mm further than its usual resting length. This 3mm of further deformation can amount to 3% strain of the ligament as a whole exceeding the 1% strain that is thought to be usual for the ligament. Such additional strain is not well tolerated by the ligament and can lead to over tightening of the medial side and thus a medial collateral ligament release.

An alignment technique that places the femoral component of a total knee such that the axis of flexion of the replaced knee is in the same position as that of the normal has been implemented over the past 4 years. During this period more than 300 knees with varus gonarthrosis have been placed. The technique cuts the distal femur in 3º of valgus relative to a rod placed from the top of the intercondylar notch into the shaft with the anterior and posterior femoral cuts perpendicular to the trochlear groove (marked by an AP clamp that marks this position). The tibia is cut at right angles to a line from the tibial tubercle to the neck of the talus (marked by the lateral edge of the tibialis anterior tendon at the ankle).

In these 300+ cases no superficial MCL and no lateral retinacular releases have been necessary. Ligamentous balancing was accomplished by placing the femoral component in the kinematically correct position with overall alignment governed by the tibial cut. Radiographic evaluation shows that the "joint line" is elevated slightly on the medial side and lowered slightly on the lateral side.

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Paper #10

DIFFERENCE BETWEEN THE EPICONDYLAR AND CYLINDRICAL AXIS OF THE KNEE: A FACTOR TO CONSIDER DURING COMPUTER-ASSISTED SURGICAL NAVIGATION IN TOTAL KNEE ARTHROPLASTY

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Introduction: Locating the true flexion-extension (FE) axis of the knee can play an important role in component placement in total knee arthroplasty (TKA), especially using contemporary computer-assisted surgical navigation. The purpose of this study was to determine if the commonly used trans-epicondylar axis (TEA) is an accurate and reproducible substitute for the FE axis of the knee.

Methods: Twenty-three fresh frozen cadaveric distal femurs (10 male, 48-66years; 13 female, 48-91 years) with intact soft tissue were imaged with computed tomography (CT) and reconstructed in 3-D virtual space. The TEA was compared to a line joining two points equidistant from the articular surface of each femoral condyle, the cylindrical axis (CA). Measures were performed by three observers three times for each specimen.

Results: Inter- and intra-observer variations were small but the differences between TEA and CA were statistically significant ($p < 0.05$) with an average difference between the two axes of ~5° (4.6° ± 1.8°, range 1.8° to 11.3°). The difference between axes decreased when projected from 3-D space to traditional 2-D planes (coronal and transverse).

Discussion: The decrease in difference between axes in 2-D planes may explain in part why this discrepancy has not been previously documented. The greater difference in 3-D space may account for “mid-range instability” that has been reported in TKA. The increased accuracy afforded by computer-assisted surgical navigation in TKA may be lost and increased malposition of components may occur if this discrepancy between reference axes is not appreciated and addressed.

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Paper #11

INTRAOPERATIVE LIGAMENT BALANCING FOR TOTAL KNEE ARTHROPLASTY

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Introduction: Complications after total knee arthroplasty such as instability, subluxation, excessive wear, and loosening have been attributed to poor soft-tissue balance. However, soft-tissue balance remains an art, largely based on the surgeon's experience. A tibial prosthesis was instrumented with force transducers to quantitated soft-tissue balance.

Methods: In vitro: Six cadaver knees were subjected to total knee arthroplasty. A tibial tray was instrumented with load sensors to measure axial compressive forces. Tibial tray forces were recorded during passive flexion and extension before and after balancing the tibiofemoral bone gaps and any soft-tissue release.

In vivo: The instrumented tibial tray was used as an intraoperative trial prosthesis in three patients during total knee arthroplasty. A similar approach was followed as described above for soft-tissue balancing. The knee was passively flexed and extended by the surgeon during data collection.

Results: In all knees (in vitro and in vivo) substantial measurable imbalance was recorded before soft-tissue balance (ratio of medial to lateral forces = 0.65 to 0.92). After soft-tissue balance the mediolateral force ratio was reduced at 0° and 90° flexion (0.45 to 0.49). However, some residual imbalance was still noted at 30° and 60° flexion (0.51 to 0.57). Tibial forces were substantially higher (32 to 81% increase) after a 2-mm thicker trial insert was tested.

Discussion: The imbalance at angles other than 0° and 90° may explain some of the wide variations in knee function and knee kinematics reported after total knee arthroplasty and the reported incidences of mid-flexion knee instability. Even a 2-mm increase in insert thickness, tibial forces increased substantially under passive knee flexion, which underscores the need not only for balancing the ligaments but also for obtaining optimum knee stability. An instrumented tibial device can be a valuable adjunct to enhance the value of computer navigation systems.

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Paper #12

A PRELIMINARY COMPARISON OF SHORT-TERM OUTCOMES OF MINIMALLY INVASIVE AND STANDARD APPROACHES TO TOTAL KNEE ARTHROPLASTY

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Introduction: This paper reports the early results of an ongoing multi-center study comparing the outcomes of minimally invasive and standard techniques for total knee arthroplasty (TKA) using the Nexgen implant (Zimmer, Inc. Warsaw, Indiana).

Materials and Methods: Prospective outcome assessments were conducted weekly over the first six weeks, and then at 3, 6, and 12 months after TKA. Subjects receiving a minimally invasive approach (MIS, including QS and Mini) were matched to those done through a standard approach, according to age, gender, body mass index (BMI), preoperative diagnosis, as well as preoperative levels of flexion, pain, function, and stiffness. Of 304 knees in the prospective study, 27 matched pairs were generated for comparing the MIS and standard groups. The average age and BMI were 68 and 31 in both groups, respectively. Categorical outcomes were evaluated using the chi-square test and Fisher exact test, while continuous outcomes were compared nonparametrically with the Wilcoxon rank sum test.

Results: Due to the lack of statistical power in this preliminary analysis, only a few of the postoperative differences between the surgical approaches reached a significant level. However, the MIS group showed several trends toward greater postoperative improvement, compared to patients receiving the standard technique. The average surgical times (skin-to-skin) were significantly longer for MIS procedures (84.4 min; range, 57-132) than for standard procedures (68.3 min; range, 55-97) ($p=0.002$). Incision lengths were significantly shorter in MIS cases (10.1 cm; range, 6-15) than for standard cases (12.1 cm; range, 9-22) ($p=0.001$). The groups did not differ in their rates or types of complications, implant alignment, or the rate of mechanical failure.

The MIS group tended to have greater total range of motion and less extension lag at all follow-up intervals. Average range of motion at 6 weeks was 116° (range, 95-140°) in the MIS group and 109° (range, 80-130°) in the standard group. At 6 months, the range of motion was 123° (range, 104-145°) in the MIS group and 116° (range, 87-135°) in the standard group. At 3 months the MIS group had significantly less flexion contracture (0.3°) than the standard group (8.5°) ($p=0.046$). Knee Society Clinical Scores at 6 weeks were 81 (range, 52-100) in the MIS group and 68 (range, 40-98) in the standard group ($p<0.03$).

MIS patients also reported significantly less pain than standard patients at weeks 4 through 6, based on WOMAC ($p=0.033$) and SF-36 ($p \leq 0.045$). Knee pain interfered with work less in the MIS group at weeks 4 and 6 (SF-36: $p\leq0.045$), than it did in the standard group. Knee pain also interfered less with sleep in the MIS group at week 5 (WOMAC: $p\leq0.029$; SF-36: $p\leq0.027$). These findings correspond to the less frequent use of over-the counter analgesics in the MIS group at week 2 ($p=0.023$) and week 6 ($p=0.036$).

Generally, the MIS patients had a better perception of health than standard patients, and at 2 weeks the global mental health subscale was significantly higher for the MIS group (54.3; range, 27-70) than for the standard group (47.6; range, 32-62) ($p=0.021$). The WOMAC scale also revealed a trend toward greater physical function at 3 and 6 months in the MIS group. At most postoperative intervals, MIS patients also tended to exhibit less bodily pain, more vitality ($p\leq0.028$) and emotional health ($p\leq0.049$), and less interference with their daily activities, compared to standard patients. By week 5, the MIS group had less morning stiffness ($p=0.017$) and less difficulty in performing household chores ($p=0.004$). By week 6 MIS patients had greater quadriceps strength ($p=0.049$) and less limitation in walking several blocks ($p=0.04$).

Discussion: This series offers a unique analysis model by comparing two matched cohorts of patients undergoing TKA by MIS, and standard surgical approaches. Other studies analyzing the results of MIS techniques, have either, not had a comparative group, or the control group used an unmatched cohort. Although the results presented here seem to favor an MIS approach, more definitive conclusions must await further data collection.

Paper #13

PRECOCIOUS OSTEOARTHRITIS IN A FAMILY WITH RECURRENT COL2A1 MUTATION

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The spondyloepiphyseal dysplasias are a heterogeneous group of dysplasias primarily involving the epiphyses and spine. We have identified a large Micronesian kindred segregating as an autosomal dominant form of mild spondyloepiphyseal dysplasia with precocious osteoarthritis. To determine the causative mutation in this kindred, a genome wide linkage scan was undertaken. A genetic linkage was established at a marker near the *Col2a1* gene. Using sequence analysis, a mutation resulting in an arginine to cysteine substitution at amino acid 75 in the major triple helical domain of exon 11 of *Col2a1* was identified. The Arg75Cys mutation has been identified previously in four independent kindreds with mild spondyloepiphyseal dysplasia and precocious osteoarthritis. Some clinical features were shared among the kindred including early osteoarthritis, platyspondyly with irregular vertebral endplates and degenerative changes in the hips. However, members of our kindred were normal in stature, had moderate deafness, lacked Schmorl's nodes and had flattened femoral condyles with a widened intercondylar notch, features which were not necessarily present in other kindreds sharing the same mutation. Thus, our data further expand the phenotypic spectrum of SED associated with mutations the Arg75Cys in *Col2a1*.

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Paper #14

TREATMENT OF CONGENITAL PSEUDOARTHROSIS OF THE TIBIA WITH VASCULARIZED FIBULAR GRAFT

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Purpose: To evaluate the treatment of congenital Pseudoarthrosis of the tibia (CPT) with Vascularized fibular graft (VFG).

Material and Methods: 26 cases of CPT were evaluated clinically and radiologically from 1994-2004. Fourteen male (53%), 12 female (47%). Fifteen right (57%) and 11 left (43%). Average follow-up 6.6 years (4 to 11 years). Average age at time of surgery 6.4 years(4 to 11 years). Nineteen out of the 26 had 22 previous surgical procedures. In 7 patients was the initial procedure. Two groups were studied, by the method of fixation used. Eighteen cases had external fixation and the remaining 8 had different types of internal fixation. In the external fixation group, had an average lengthening of 40mm (30-120 mm). Time with external fixation was 209 days (77-465 days). Fourteen patients (53%) needed additional surgeries for delayed union, residual angular deformities and four amputations. Eight cases had distal tibio-fibular syndesmosis stabilization by a screw.

Results: In the internal fixation group 6 cases (75%,) had independent gait, good result in 1/6 (16.6%), and fair in 5/6 (83.4%). Two cases (25%) ended with amputation. Five additional surgeries were practiced to correct no-union and angular deviation.

In the external fixation group 16 cases (88.8%) had independent gait, 11 (68.75%) with good result, 4 (25%) fair result and 1 (6.25%) bad results for rigid fibrous union. Additional surgeries were required in five cases (31.25%). Two cases (11.1%) ended with amputation. Fifteen out of 18 patients without distal syndesmosis stabilization had valgus ankle deformity, compared with 2 out of 8 in the screwed group.

Discussion: Treatment of the CPT is difficult and controversial with inconsistent results. Our experience with VFG with different types of internal fixation and external fixation showed, that external fixation gives better fixation and stabilization with decrease incidence of non-union, as well as provides facility for weight bearing deambulation.
The LLD corrected prior to the VFG avoid further treatment for correction of discrepancy. The large bone and soft tissue resected, avoided in our cases the recurrence reported in the literature. The high frequency of valgus deformity (83%) at the donor site of the unstabilized cases, compared with the 25% valgus deformities seen in the 8 cases with syndesmal screw, suggests the requirements of stabilization of the distal tibiofibular syndesmosis.

Conclusion: The high rates of satisfactory results obtained in the present study were seen with the external fixation group (88%). The use of the external fixation device allowed to correct leg length discrepancy and angular deviation prior to the vascularized graft, given better stabilization by compression, maintaining alignment and independent weight bearing. We consider this as the initial treatment for the atrophy type cases (Boyd II and V). The high incidence of ankle valgus deformity at the donor site indicates the need of stabilization of the distal tibio-fibular syndesmosis, and suggests the possibility of permanent stabilization by fusion.

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Paper #15

RESULTS OF SMITH PETERSON SPINAL OSTEOTOMIES IN CHILDREN

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Introduction: Treatment of spinal imbalance secondary to progressive or recurrent deformity following spinal fusion often involves osteotomies of the fusion mass. There are few reports of spinal osteotomies exclusively in children.

Objective: To determine the peri-operative risk and radiographic outcome of spinal osteotomies in children.

Methods: Retrospective chart and radiographic review of 26 patients undergoing Smith-Peterson osteotomies for treatment of progressive deformity following spinal fusion. In addition to osteotomy, patients either had extension of their fusion and re-instrumentation (Group 1; n=18) or a period of halo-gravity traction followed by extension and re-instrumentation (Group 2; n=8).

Patients in Group1 averaged 15 years of age, 1.4 previous spinal operations and 2.5 osteotomies. Patients in Group 2 averaged 11 years of age, 2.4 previous spinal operations and 3..3 osteotomies. Not surprisingly, the pre-operative Cobb angles were greater in Group 2. Traction was utilized an average of 110 days.

Results: In Group 1 blood loss was 52% of EBV, operative time was nine hours and there were five temporary neurologic deficits. In Group 2 blood loss was 54% of EBV, operative time was six hours, there were no neurologic complications. There was, however, one death in a patient with severe kypho-scoliosis and neurofibromatosis.
Although initial improvement was more significant, at final follow-up there was only modest improvement in coronal Cobb angles: 15% Thoracic and 27% Lumbar in Group 1 and 26% Thoracic and 50% Lumbar in Group 2. Sagittal Balance improved 22% in Group 1 but worsened 106% in Group 2. Trunk shift was most noticeably improved in both groups: 52% in Group 1 and 33% in Group 2. Extension of the fusion was a significant source of correction in both groups.

Conclusions: Spinal osteotomies in children provide modest radiographic improvement, most significantly improving trunk shift. Medical and surgical complications were common but there were no permanent neurologic deficits.

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Paper #16

RESULTS OF A NEW METHOD OF TREATMENT FOR IDIOPATHIC VERTICAL TALUS

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Background: The treatment of idiopathic vertical talus has traditionally consisted of manipulation and casting followed by extensive soft-tissue releases. However, this treatment is often followed by severe stiffness of the foot and other reported complications. The purpose of this study was to evaluate a new method of manipulation and casting ("reverse Ponseti"), followed by talonavicular pinning and a percutaneous tenotomy of the Achilles tendon in patients with idiopathic vertical talus.

Methods: Eleven consecutive patients with nineteen idiopathic vertical tali treated with this method were retrospectively reviewed with a minimum two-year follow-up. The principles of manipulation and plaster casting are similar to those used in the Ponseti method of correcting clubfeet but with the forces applied in the opposite direction. This is followed by talonavicular pinning and a percutaneous tenotomy of the Achilles tendon. Patients were evaluated clinically and radiographically at the time of initial evaluation, immediately postoperatively, and at the time of latest follow-up. Comparisons were made between radiographic values taken before treatment, immediately after treatment, and at latest follow-up. In addition, radiographic data at final evaluation were compared with normal values for age.

Results: Initial correction was obtained both clinically and radiographically in all nineteen feet. The mean number of casts required for correction was five (range, four to six). All patients underwent a percutaneous tenotomy of the Achilles tendon. Two patients had tibialis anterior tendon fractional lengthening and one had peroneal tendon fractional lengthening. Seven patients had percutaneous pinning of the talonaviuclar joint at the time of the Achilles tendon lengthening. No patient required extensive surgical releases. At final evaluation, mean ankle dorsiflexion was twenty-five degrees and mean plantar flexion was thirty-five degrees. Recurrent dorsal subluxation of the navicular occurred in three patients—all of whom did not have the talonavicular joint pinned initially. At latest follow-up there was a significant improvement ($p < 0.0001$) in all radiographic parameters compared to pretreatment values and all radiographic angles were within normal values for the patient's age.

Conclusions: This new method of serial manipulation and casting followed by talonavicular pinning and a percutaneous tenotomy of the Achilles tendon provides excellent results for the treatment of patients with idiopathic vertical talus in terms of clinical appearance of the foot, foot function, and radiographic correction at a minimum two year follow-up.

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Paper #17

CHARNLEY LOW-FRICTIONAL TORQUE ARTHROPLASTY IN YOUNG RHEUMATOID AND JUVENILE RHEUMATOID ARTHRITIS

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We studied 292 Charnley low-friction arthroplasties in a group of 195 young patients with an established diagnosis of rheumatoid arthritis.(RA) Their mean age at operation was 38.2 years (12 – 50); 168 (57%) were receiving steroids and 79 (27%) non-steroidal anti-inflammatory medication. The mean follow-up for the whole group was 14.5 years. 24 patients (33 hips) could not be traced, 61 (88 hips) have died and 25 (41 hips) had had a revision.

In the 85 patients (130 hips) still attending follow-up, their mean age at surgery was 36.3 years (17 – 50) and the mean follow-up was 20.2 years (10 – 36). 98% were pain free or had no more than an occasional discomfort, 44% claimed to have normal or near normal function, while 62% had a full or near full range of movements of the replaced hip. Radiologically 29 cups (22%) were considered to be loose. One stem (0.8%) was definitely loose and two stems (1.5%) were probably loose.

With revision for any indication as the end point the survival was 74.2% at 25 years follow-up. The survival of the patient at the corresponding follow-up times was 41.70%. Charnley low-friction arthroplasty outlasts the young patient with RA.

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Paper #18

●RETROACETABULAR STRESS-SHIELDING IN TOTAL HIP ARTHROPLASTY

Rocco P. Pitto, MD, PhD[1] (a-Wishbone Foundation New Zealand), Rainer Schmidt, MD[2], Lutz Arne Mueller, MD[2], Melissa Rossaak, MD[1]
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Little is known about periacetabular bone remodeling in total hip arthroplasty, and its clinical relevance. This study was designed to analyze bone density (BD) changes using quantitative CT-assisted osteodensitometry after cemented and uncemented total hip arthroplasty (THA).

Twenty-one consecutive uncemented press-fit cups with polyethylene liner (Trilogy, Zimmer, USA), 20 uncemented press-fit cups with alumina ceramic liner (Cerafit, (Ceraver Osteal, France), and 13 consecutive cemented cups (ZCA, Zimmer, USA) were inserted by one surgeon (RP) in one institution. All hips received a 28mm alumina ceramic femoral head. Age and gender of the patient were similar in the three cohorts. All hips were investigated using a standardized CT-mode. CT-scans were performed postoperatively, one year and 3 years after the index operation. Regions of interest (ROI) were generated ventrally, dorsally and cranially to the cup. CT-data were analysed with a dedicated software tool (CAPPA, Germany). Cancellous and cortical BD (CaHA mg/ml) was measured separately. The non-operated contralateral side was used as control.

Progressive cancellous BD decrease was seen in all 3 ROI (≤-35.4%) in both uncemented cup cohorts. Only slight increase of periacetabular cortical BD was observed (≤+5.1%). In contrast, cemented cups showed only mild and non-progressive cancellous (≤-13.4%) BD decrease in all ROI and no significant change of cortical BD.

A detailed quantitative analysis of periprosthetic acetabular bone was performed to investigate BD changes that occur following THA. We observed a progressive decrease of cancellous BD after insertion of uncemented acetabular components in all regions of interest adjacent to the implant, suggesting stress transfer to the cortical bone of the acetabular rim. This phenomenon could explain the onset of late migration of well-fixed cups observed with radiostereoanalysis. Moreover, stress-shielding with rarefaction of the retroacetabular bone structure could be the facilitator of wear-related osteolytic changes. Therefore, lesional treatment and retention surgery of well-fixed press-fit cups for the management of severe retroacetabular bone loss should be considered as palliative, and not therapeutic. In cemented cups only limited cancellous BD loss was seen, indicating a more physiological stress transfer to both cortical and cancellous pelvic bone. The findings of the study are clinically relevant, showing major stress-shielding in uncemented press-fit fixation.

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Paper #19

POLYMETHYLMETHACRYLATE PARTICLES INHIBIT OSTEOBLASTIC DIFFERENTIATION OF BONE MARROW OSTEOPROGENITOR CELLS

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Introduction: After total joint replacement, the prosthetic bed undergoes constant remodeling, during which wear particles are continuously released. Little is known about how wear particles affect mesenchymal cell differentiation, an important aspect of periprosthetic bone remodeling. This study investigated the effects of polymethylmethacrylate (PMMA) particles on the ability of bone marrow osteoprogenitor cells to proliferate and differentiate into osteoblasts in vitro.

Methods: Bone marrow cells were collected from the femurs and tibias of C57 mice and cultured in 6-well plates in DMEM containing 15% FBS and antibiotics. Adherent cells were then grown in osteogenic and non-osteogenic medium for up to 3 weeks. PMMA particles (1-10 µm) were added at various doses and time periods. Cells were stained for alkaline phosphatase and measured for DNA, and the von Kossa method was used to measure mineralized bone matrix.

Results: Murine bone marrow cells (BMCs) co-cultured with PMMA particles in osteogenic medium showed a dose-dependent decrease in osteoprogenitor proliferation, alkaline phosphatase expression, and mineralization. Undifferentiated BMCs pre-treated with PMMA particles in non-osteogenic medium for five days also showed a dose-dependent inhibitory effect on osteogenesis, which was sustained throughout subsequent growth in particle-free osteogenic medium. BMCs challenged with PMMA particles after the fifth day of incubation in osteogenic medium showed significant reductions in cellular proliferation but not alkaline phosphatase expression and mineralization, indicating that BMCs were more sensitive to particle treatment in earlier stages of differentiation.

Conclusion: This study demonstrated that PMMA particles inhibit osteoblastic differentiation of bone marrow osteoprogenitor cells, which may contribute to periprosthetic bone loss and implant failure.

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Paper #20

COMPARING PROXIMALLY COATED BEADED STEMS WITH AND WITHOUT HYDROXYAPATITE COATING

Joseph C. McCarthy, MD (a-Stryker Orthopaedics), Jo-ann Lee, MS
Boston, MA

Introduction: This study examines a proximally-coated, circumferentially-beaded femoral stem at mean 5-year follow-up. We wanted to determine the impact of a three-dimensional hydroxyapatite coating (periapatite, PA) on clinical and radiographic outcomes by comparing an identical femoral stem with and without the PA coating.

Materials and Methods: This study retrospectively examined 114 consecutive total hip arthroplasties at mean follow-up of five years (range, 4 – 7 years). The same porous-coated stem design was used for all cases. Seventy-five stems (65%) were treated with a three-dimensional hydroxyapapatite coating, and 39 stems (34%) were untreated (non-PA). . The results are based on radiographic findings and clinical evaluations using the Harris Hip Score. Results were compared using a matched pair analysis of 27 patients in each group. Patients were matched for sex, age, BMI, Dorr bone classification, and surgical approach.

Results: No instances of radiographic loosening or mechanical failure were observed in either group. There were no reoperations in the PA group. There were three acetabular revisions for recurrent dislocation in the non-PA group, and one additional surgery for a subsequent trauma resulting in cerclage wiring a traumatic proximal femoral fracture. That index stem is now ingrown and stable. At radiographic analysis, all stems were bony ingrown with no distal lysis in either group. Endosteal condensation was found proximally (zones 1, 2, or 7) in 90% of the non-PA group and in 92% of the PA group. The Harris Hip Scores at the six-week follow-up were as follows. At early follow-up (6-week) the average pain score of the non-PA group was 36 with an average total score of 73. The average pain score of the PA group was 42 with an average total score of 82. The average hip scores at two-year follow-up for the non-PA group and PA group were 94 and 95, respectively. At five-year follow-up the average hip scores of the non-PA group and the PA group were 93 and 98, respectively.

Conclusion: At five-year follow up the porous-coated femoral stem has demonstrated reliable bone ingrowth, no distal osteolysis, and proximal bone preservation both with and without proximal three-dimensional coating. The most appreciable difference was seen at the six-week follow-up. In this era of minimally invasive surgery, PA-coated hip stems may be a reasonable option for high demand patients with high expectations for early return to function.

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Paper #21

DIFFERENCE IN MECHANICAL AXIS MEASUREMENT BETWEEN COMPUTER ASSISTED SURGERY AND POSTOPERATIVE X-RAYS

***Remy S. Nizard, MD, PhD**, Anne Lachere, MD, Agnes Raould, MD, Laurent Sedel, MD
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Introduction: Computer assisted surgery is widely used in Europe. Several authors demonstrated that this technique is reliable, reproducible, and gives more often a mechanical axis, measured on full length weightbearing radiographs, that is within an acceptable range (3° valgus to 3° varus). However, the difference between the measurement performed during surgery and post-operative measurement is not known. The goal of this work is to determine the relationship between the peroperative measurements made with the computer and the postoperative measurement made on full length weightbearing radiographs.

Material and Methods: Forty-eight knees were included in this study. The patients were operated on by two senior surgeons with the CT-less Navitrack system; the preoperative measurement of the mechanical axis was performed in a standardized manner. All the patients had a postoperative full length weigthbearing radiographs. Care was taken to avoid major rotational misplacement of the knee when taking radiographs. Radiographs were taken when postoperative flexion deformity was resolved as much as possible (2–12 weeks after surgery). An independent observer who did not participate in the surgeries did the measurements.

Results: All the knees had a peroperative mechanical axis that was included in the 3° valgus – 3° varus range (from 2.4° valgus to 2.9° varus). Ninety-two percent of the knees (44 knees) had a postoperative mechanical axis that was included in the 3° valgus-3° varus range, 4 knees were out this range (all were at 4° varus). The mean difference between the preoperative and the postoperative axis was 1.6° ± 1.1 (range 0 to 5°); 90% of the knees had a difference that was 3° or lower. The difference between the peropertaive and postoperative axis was highly significant ($p<0.0001$). No correlation was observed between the per and postoperative axis.

Discussion: Before a widespread use of computer surgery for total knee replacement, the limitations of such systems have to be measured. The present work demonstrated that there is a significant difference between the preoperative measurement of mechanical axis and the postoperative full length weigthbearing radiographs. However, this difference is weak and seems to confirm that computer assisted surgery could be a useful tool.

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Paper #22

ORTHOPAEDISTS BEHAVING BADLY

James D. Heckman, MD (d-Journal of Bone and Joint Surgery)
Journal of Bone and Joint Surgery, Needham, MA

Because of our perception of a growing rate of research misconduct, redundant publication, fraud, and plagiarism, the editors of the American and British volumes of the Journal of Bone and Joint Surgery and Clinical Orthopaedics and Related Research published a joint editorial in September 2004 entitled “Changing Ethical Standards in Scientific Publication.” The purpose of the editorial was to make readers aware the importance of preserving the integrity of the published word. The editorial advised our readers of our commitment to follow contemporary ethical standards, most particularly as outlined in the Guidelines on Good Publication Practice by the Committee on Publication Ethics (COPE).

Ironically, since the time of the publication of that editorial, the American volume of JBJS has experienced at least six episodes of author misbehavior. While each event is unique, and while the infractions range from innocent duplicate publication to frankly fraudulent reporting of data, all of the cases can be characterized by serendipitous discovery, a lack of attention to detail by the authors, and in most cases, a disregard for publication ethics by those authors. Highlights of the infractions will be presented, and the Journal’s response to them will be highlighted.

Paper #23

THE EFFECTS OF INTERMITTENT AXIAL COMPRESSION ON BONE HEALING

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Hospital for Special Surgery, New York, New York

Background: Abundant evidence exists that fracture healing can be influenced by mechanical loading. However, the specific loading parameters that are osteogenic remain unknown. The purpose of this study was to apply noninvasive external compression to mouse tibial osteotomies to determine the effects that particular variations in timing and load magnitude have on bone healing. In addition, the utility of microcomputed tomography in predicting the mechanical properties of callus was assessed.

Methods: Eighty 12-week old C57BL/J6 mice underwent surgical osteotomy of the left tibia followed by intramedullary nailing with a 27-gauge needle. Mice were divided into 6 groups based on days delayed until application of load (0 days or 4 days) and amplitude of cyclic load (0.5N, 1N, or 2N). Loading regimens were applied at 1 Hz for 100 cycles per day, 5 days per week for 2 weeks, using an external device that applied axial compression to the tibia. Bone healing was assessed by both microCT and four-point bend testing. Differences between groups were compared using one-way ANOVA and Bonferroni multiple comparison tests.

Results: In the group with a 4-day delay and 0.5N amplitude, the maximum bending moment was significantly higher (19.8 vs. 14.2 N-mm) than the control group. However, callus mineralized volume, mineral content and density were not significantly different between these groups. Callus strength decreased significantly as load amplitude increased from 0.5N to 2N in the 4-day delay groups. Groups in which loading began immediately following surgery (0-day delay) were significantly weaker than the control specimens. The overall volume and mineral content of calluses in these groups were, however, larger than controls. Bone mineral density at the osteotomy site did not show any significant differences between any of the groups, and neither bone mineral density nor content correlated with mechanical strength of the healing bones.

Conclusions: A short delay followed by cyclic application of a relatively low load led to improved fracture healing, as determined by increased callus strength, but this enhancement disappeared as load amplitudes increased. Load initiation immediately following fracture inhibited healing, regardless of the magnitude of load applied. MicroCT measurements of calluses in the early healing stage did not predict the mechanical strength of the fractures.

Clinical Relevance: These findings establish that controlled, noninvasive cyclic loading can improve the strength of healing callus and suggest that mechanical intervention could be effective in the clinical setting. For example, lower extremity fractures treated with flexible fixation, such as locked plates or intramedullary nails, may be stimulated to heal with a limited touchdown weightbearing protocol. As the loading parameters necessary to enhance fracture healing become refined, external compression may be used as a potent stimulus for treating fractures with decreased biological capacity. Additionally, radiographic parameters such as callus density may be inaccurate in predicting mechanical qualities during the early healing phase.

Paper #24

MEDICINE AND ORTHOPAEDICS IN ART

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Medicine in general and musculoskeletal disease and injury in particular, have been portrayed in the visual arts as they have been in literature (DeMaio, ABJS 2005). Although a comprehensive literature search is not possible, selective examples of painting and scultpture depicting injury or disease of interest to orthopaedic surgeons are presented and briefly discussed. The topic is introduced by viewing Rembrandt's "The Anatomy Lesson of Dr. Nicholas Tulp" with the remainder of the works arranged in chronological order beginning with an allegorical work by Hieronymus Bosch, "The Operation for the Stone" and ending with Ted Meyer's' "The Skeleton" a work from the AAOS eMOTION exhibit of 2001. These works, some twenty-five in number, exhibit a variety of subjects and artistic styles.

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Paper #25

HAVE TO SEND TO PHIL SEPARATELY

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Paper #26

EFFECT OF CORTICOSTEROID ON COLLAGEN GENE EXPRESSION IN INJURED ROTATOR CUFF TENDON

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Introduction: Subacromial corticosteroid injections are commonly utilized in the conservative management of rotator cuff disease. The beneficial anti-inflammatory and analgesic properties of corticosteroid are tempered by potentially significant side effects on connective tissue. Animal studies, performed primarily on Achilles and patellar tendons, have associated corticosteroid exposure with tendon atrophy and decreased biomechanical properties [1,2]. These studies, however, have yielded conflicting results that fail to clarify corticosteroid effects. The specific impact of corticosteroid on rotator cuff tendons is not well understood. It is difficult to apply conclusions from other tendon studies to the rotator cuff due to its unique anatomic location between an overlying bony arch and an underlying joint space. No study to date has examined the effects of corticosteroid on injured rotator cuff tendons. Our aim was to characterize the injury response of rotator cuff tendons through analysis of the type III to type I collagen expression ratio, a tendon injury marker, and examine the effects of corticosteroid on this response.

Methods: Sixty-six Sprague-Dawley rats with a mean body weight of 570 gm (422 – 700 gm) were used in this IACUC approved study. The rats were randomly assigned to four groups: control, steroid treated, tendon injury, and tendon injury plus steroid treatment. Six rats served as sham surgery control. Subcutaneous injections of antibiotics (gentamicin, 8mg/kg) were given pre-operatively. A 1 cm transverse skin incision was made along the lateral border of the acromion. A portion of the deltoid origin was released from the acromion by sharp detachment. The acromion was then gently retracted, exposing the infraspinatus tendon. Unilateral tendon injuries were created with full thickness defects across 50% of total infraspinatus tendon width, 1 mm from humeral insertion. Steroid treatments of a single, human equivalent methylprednisolone dose (0.6mg/kg) were injected into the subacromial space under direct visualization. Steroid treatment directly followed the creation of injury in the injury plus steroid treatment group. For closure, the fascia of the detached deltoid muscle was sutured to that of the trapezius muscle. The skin was then closed with staples.

At 1, 3, and 5 weeks post-injury, the infraspinatus tendon was harvested and snap frozen in liquid nitrogen. Total RNA was extracted from tendons using the RiboPure isolation system (Ambion, Austin, TX). Real time RT-PCR was performed on total RNA extracts using the Assays-on-Demand Gene Expression System (Applied Biosystems, Foster City, CA). Primer/probe sets specific for type I (alpha 2(I) chain) and type III (alpha 1(III) chain) collagen were used. The experimental mRNA levels were individually normalized to ribosomal 18s levels. The collagen III to collagen I ratio was computed for each sample. The data was analyzed using one-way ANOVA and Tukey's post-hoc procedure. Statistical significance was set at $p<0.05$.

Results: Tendon expression of normalized type III and type I collagen were separately characterized prior to calculation of the type III / I ratio. In the tendon injury group, a significant 5.0 fold ($p<.05$) increase in type III collagen expression was already present by 1 week post-injury. Type I collagen expression did not exhibit any significant increase above control levels until 5 weeks post-injury. Similar trends were also seen in the steroid treated and tendon injury plus steroid groups.

The collagen type III / I expression ratio remained at baseline at all time points in the control and sham groups. At 1 week, the collagen Type III / I ratio increased more than 4.0 fold ($p<.05$) above control in the tendon injury and tendon injury plus steroid groups (Figure 1). The ratio remained greater than 2.0 fold ($p<.05$) above control at 3 weeks in both groups and returned to baseline at 5 weeks. Interestingly at 1 week, the steroid treated group showed a significant increase in type III / I ratio, more than 4.5 fold ($p<.01$). This level decreased to baseline by 3 weeks.

Discussion: The objectives of this study were to: 1) characterize the role of type I and type III collagen in the injury response of rotator cuff tendons and 2) determine possible modulating effects of corticosteroid on this response.

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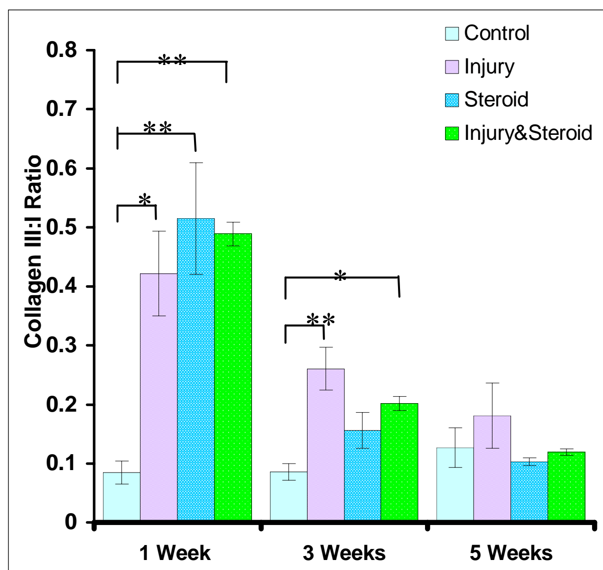
Type I collagen is the main collagen found in normal tendons, making up greater than 90% of total collagen content. When tendons are injured, an increased proportion of type III collagen is produced during the early injury/reparative response. Collagen protein typing of injured tendons have shown type III collagen content can acutely increase from <5% of total collagen content to >15% post-injury [3]. As injured tendons remodel and mature, baseline type III to type I collagen ratios are restored. This temporal change in collagen composition is reflected in the data from our injury group. As expected, a significant increase in the expression of type III collagen was evident by one week post-injury. Type I collagen expression, however, remained at baseline levels until a significant increase was observed at five weeks. This variation in expression levels is consistent with an active tendon injury response that progresses from acute phase towards maturation.

The type III to I collagen ratio between the injury and injury plus steroid groups suggest a single, human equivalent dose of corticosteroid does not significantly alter the acute phase response of an injured rotator cuff tendon. However, exposure of uninjured tendons to the same steroid dose initiated an injury response that was equivalent to that of structural injury. This significant steroid response in normal tendon was short-lived and the type III to I collagen ratio returned to control levels by three weeks. These findings suggest that a single dose of steroid has no long-term effect on collagen expression in either injured or uninjured rotator cuff tendons. At the same time, the significant effect seen in the steroid group suggests that even a single steroid dose might not be entirely benign in the short-term. The dramatic increase in type III to type I collagen expression can temporarily change rotator cuff tendon properties if the same proportions are translated to the protein level. It also raises concern of a potential cumulative steroid effect if consecutive doses are given before type III to I collagen ratios can return to baseline.

Figure 1. Collagen III to Collagen I Gene Expression Ratio vs. Time



* compared to control group $p<.05$
** compared to control group $p<.01$

References:

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Paper #27

IN-HOSPITAL MORBIDITY, MORTALITY AND ECONOMIC IMPACT OF SHOULDER VERSUS HIP AND KNEE ARTHROPLASTY FOR OSTEOARTHRITIS

Edward G. McFarland, MD (n), Kevin Farmer, MD, William Queale, MD, MPH, Jason Hammond, MD, Ekavit Keyurapan, MD
Lutherville, MD

Background: Although shoulder arthroplasty has been shown to have a low mortality with few complications, it is unclear how its safety compares with that of the more commonly performed hip and knee arthroplasties. Therefore, we compared common outcome parameters of the three procedures in patients with osteoarthritis.

Methods: We used a statewide hospital discharge database to identify patients who underwent primary hip, knee, or shoulder arthroplasty for osteoarthritis from 1994 to 2001. Multivariate analysis was used to compare in-hospital complications, mortality, length of stay, and total charges associated with those three procedures. Significance was set at $p < 0.05$.

Results: The percentage of patients who had at least one in-hospital complication was 15.5% (2393 of 15,414), 14.7% (5055 of 34,471), and 7.5% (seventy-five of 994) for hip, knee, and shoulder arthroplasties, respectively. The incidence of in hospital complications after shoulder arthroplasty was half that for hip or knee arthroplasty (OR, 0.46; 95% CI, 0.36-0.59). The average length of stay was 4.37 (range, zero to 129 days), 4.31 (range, zero to fifty days), and 2.42 (range, one to fifty-one days) days for patients undergoing hip, knee, and shoulder arthroplasty, respectively. Patients who underwent shoulder arthroplasty were one-sixth as likely as those who had hip or knee arthroplasty to have a length of stay more than six days (OR, 0.16; 95% CI, 0.11-0.22). The average total hospital charges were $15,436 (range, zero to $271,479), $14,668 (range, zero to $222,071), and $10,341 (zero to $106,054) for hip, knee, and shoulder arthroplasty, respectively, and patients undergoing shoulder arthroplasty were one-tenth as likely to surpass $15,000 as those having hip or knee arthroplasty (OR, 0.11; 95% CI, 0.08-0.14). There were no in-hospital deaths after shoulder arthroplasty, but there were twenty-seven deaths (twenty-seven of 15,414, 0.18%) after hip arthroplasty and fifty-four deaths (fifty-four of 34,471, 0.16%) after knee surgery, although we found no statistically significant difference among the groups.

Conclusions: Our study indicates that patients who undergo shoulder arthroplasty for osteoarthritis incur less cost, have a shorter length of stay, and are less likely to have in-hospital complications or die than those who undergo hip and knee arthroplasties. This retrospective study did not include operative details or patient satisfaction scores, but the results emphasize that shoulder arthroplasty can be considered as safe as more commonly performed arthroplasties.

Level of Evidence: Prognostic study, Level II-1 (retrospective study).

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Paper #28

ANTERIOR ELBOW CAPSULODESIS

Donald H. Lee, MD (n)
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The technique and role of an anterior elbow capsulodesis in restoring elbow instability following an unstable elbow fracture-dislocation is described. Six patients with an unstable posterior elbow fracture dislocation were retrospectively reviewed. The average age of the patients was 45.5 years. Five of the six patients had a Type I coronoid fracture and five patients had a radial head fracture. All patients had an associated posterior dislocation of the elbow. Two patients had previous surgery. All patients underwent elbow reconstruction with restoration of the ulnohumeral joint and lateral collateral ligament complex repair. Five patients had a radial head replacement. An anterior elbow capsulodesis was performed in all patients for residual, post-reconstruction, posterior elbow instability. A hinged fixator was used in one patient. At an average follow-up of 19 months (range 6-33 months), all patients had a stable elbow. The average extension-flexion arc was 26 to 133 degrees. Pronation and supination averaged 54 and 69 degrees, respectively. Conclusion: A stable elbow joint can be achieved by restoring ulnohumeral joint congruency, repairing the lateral collateral ligament complex and repairing or replacing an injured radial head. An anterior elbow capsulodesis is used when further stabilization of residual posterior elbow instability is needed.

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Paper #29

TREATMENT OF GIANT CELL TUMOR OF BONE: A META-ANALYSIS

Kimberly J. Templeton, MD (n)
University of Kansas Medical Center, Kansas City, KS

Introduction: Controversy exists regarding the ideal substance(in regard to local recurrence), either bone graft or PMMA, with which to fill in the resulting bone defect after treatment of giant cell tumor of the extremities.

Method: A MEDLINE search was performed for articles listed under “giant cell”,“tumor”, and “bone” in the English literature for the years 1984-2003, resulting in 990 articles. Articles that did not list curettage for extremity lesions were eliminated. This resulted in 45 articles that form the basis of this review.

Results: These studies yielded a total patient population of 635, with primary lesions only. The most common locations for the tumor were distal femur, proximal tibia, and distal radius. 306 patients received bone grafts; 329 patients received PMMA. Local recurrence occurred in 124 patients (range 2-322months). Recurrence was not related to the presence of a pathologic fracture but was related to the site of the tumor (proximal tibia 24%, distal radius 48%) and treatment modality: recurrences were seen in 61 (39%) of patients treated with bone graft alone; 24(22%) treated with adjuvants and bone graft; 4(4.8%) treated with PMMA alone; and 32(14.5%) treated with adjuvants and PMMA. There were 6 pulmonary metastases, all in patients with a local recurrence; 5 had been treated with bone graft alone. 14 studies reported functional outcome: most patients were in the good or excellent group, regardless of the use of bone graft or PMMA. Complications were few. Those patients treated with bone graft were more likely to experience a non-union or fracture; those treated with PMMA were more likely to develop pain in the adjacent joint.

Conclusion: Patients with giant cell tumors of the extremities appear to have a higher local recurrence rate if they receive bone graft rather than PMMA, especially if treated without adjuvant modalities. Regardless of the treatment method, most patients report good or excellent functional results.

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Paper #30

●USE OF HEMIPELVIS PROSTHESIS IN THE TREATMENT OF PELVIC SARCOMAS

B. Hudson Berrey, Jr., MD (n)
University of Florida, Jacksonville, FL

High-grade sarcomas of the pelvis present a particular challenge to the orthopaedic oncologic surgeon. Regional anatomy, adjacent vital structures and reconstruction are major considerations when undertaking the care of such patients. Functional restoration is a major undertaking with an attendant significant complication rate.

3 adult patients presented with high-grade sarcoma of the pelvis. 2 were female and 1 male. Diagnosis included high-grade chondrosarcoma, de-differentiated chondrosarcoma and osteosarcoma. All underwent radical resection of their tumors and were reconstructed with custom hemipelvis prosthesis with a constrained total hip component. Each is disease free for over 4 years, 2 continuously and 1 for 3 years following a local recurrence. One patient developed a deep infection that necessitated removal of the implant at which time local recurrence was found. This was resected through conversion to a standard hemipelvectomy. She remains disease free. A second patient had excellent function until she broke the prosthesis-sacral bolt while jet skiing. She underwent a revision of her implant and developed a subsequent infection that was treated with aggressive local debridement, flap coverage and antibiotics. She has maintained her implant and walks with the use of an occasional assisted device. The third patient has been continuously disease free but sustained a failure of his constrained acetabular liner that required revision. He has since returned to playing golf.

The methods of reconstructing the pelvis after internal hemipelvectomy for high-grade sarcomas include arthrodesis, allograft reconstruction or leaving a flail lower extremity. Each has significant risks and high complication rates. The use of custom hemipelvis prosthesis for such patients may provide a level of function better than previous methods of reconstruction, though a high rate of complication and subsequent surgery is expected for these patients. Further work on the design, anchoring and soft tissue reconstruction is required.

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Paper #31

THE IMPACT OF IMPROVED LIMB SPARING SURGERY ON ONCOLOGIC OUTCOME IN HIGH GRADE OSTEOSARCOMA

Miguel A. Ayerza, MD (n), Bruno Politi, MD, Sebastian Bettera, MD, Eduardo Abalo, MD, Luis A. Aponte-Tinao, MD, D. Luis Muscolo, MD
Italian Hospital of Buenos Aires, Buenos Aires, Argentina

Introduction: The purpose of this study was to analyze if limb sparing surgery in patients with non-metastatic high grade osteosarcoma affects final oncological outcome.

Methods: A retrospective study of one hundred forty-one patients with non-metastatic high grade osteosarcoma treated from 1980 to 2000 in a single institution with a multidisciplinary approach that included intravenous neoadjuvant chemotherapy was done. We compare rates of survival, limb-salvage treatment and amputation after limb-sparing procedure in two different decades. Forty-four patients were treated from 1980 to 1989, and ninety-seven patients from 1990 to 2000.

Results: The survival rate for the patients treated in the first decade was 39% at five years, while for those treated in the 90s' was 70% ($p < 0.001$). Limb salvage surgery rate for the patients treated in the first decade was 61% (27 out of 44) while for those treated in the 90s' was 95% (92 out of 97) ($p < 0.001$). In the limb salvage group 16 patients required an amputation due to local recurrence or other local complication, so final limb salvage rate in the first decade was 39% (17 out of 44) while in the 90s' was 89% (86 out of 97) ($p < 0.001$). These three differences were statistically significant.

Conclusions: We conclude that osteosarcoma patients treated in the last decade have significantly higher rate of limb-salvage treatment that did not compromise survival rate. Although there was a higher incidence in limb salvage procedures in the 90s' the indication for a secondary amputation decreased.

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Paper #32

A COMPARISON OF DUAL THREADED CONE AND EXTENSIVELY COATED TOTAL HIP ARTHROPLASTY

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UCLA School of Medicine, Los Angeles, CA

Background: Durable results with dual threaded cone and extensively coated hip arthroplasty designs have been reported, but no studies comparing the two prostheses have been published.

Methods: Sixty eight patients who had arthritis of the hip, a failed previous hip arthroplasty, or periprosthetic fracture were prospectively evaluated. Clinical and radiographic outcome and complication rates were compared.

Results: The dual threaded cone design was used in thirty four hips and extensively coated stems in thirty four. With the number of hips available, no benefit of the dual threaded cone over extensively coated designs could be demonstrated with respect to pain, walking, or function scores, or complication rates. Radiographs showed no difference in prosthetic alignment. Two hips treated with extensively coated stems for periprosthetic fractures showed subsidence not requiring revision surgery. One revision surgery for a septic hip arthroplasty treated with a dual threaded cone was complicated by an intraoperative fracture. There were no dislocations or deep infections.

Conclusions: No advantage of the dual threaded cone over the extensively coated hip arthroplasty design was observed with regard to the clinical results at early follow-up. Axial stability of the dual threaded cone design may prove an advantage in the management of periprosthetic fractures.

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Paper #33

●LONG TERM RESULTS OF ALL ALUMINA BEARINGS WITH METAL BACK SOCKET IN A ACTIVE GROUP OF PATIENTS UNDER 50

Laurent Sedel, Prof. MD (a-Ceraver Osteal), Pascal Bizot, MD, Simon R. Nizard, Prof. MD
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From a group of patients under fifty years of age operated consecutively between 1990 and 1994, we selected an active group excluding revision, Charnley class C and CDH Crowe 3. The prosthesis was hybrid type with a cemented titanium alloy stem. The socket was a press fit titanium alloy covered by a titanium mesh with an alumina insert. Eighty two hips in 74 patients, 43 males /31 females, mean age 43 (21 to50). 8 bilateral. Devanne rating system (3:14, 4:42, 5:18) .Sixty five were primaries, 17 had some previous operations. Surgical approach was posterolateral in 62, Hardinge type in 18 and transtrochanteric in 2. Postoperative complications: 2 dislocated before 3 months and never dislocated again. One had a DVT without PE.

Results: Ten hips in 6 patients (12%) could not be traced, 4 hips in 3 patients deceased. Leaving 65 patients (68 hips) fully examined. Follow up is from 6 to 14 (median 8,6years). Clinical evaluation (PMA rating): 90% 17 or 18. Radiological results: femur: 2 limited osteolytic lesion , no subsidence 4 radiolucent lines incomplete, socket side: no osteolysis, no migration, 23 radiolucent lines (2 in three zones).

Three hips were revised: one for ceramic head facture at 8.8 years, one bipolar loosening, one deep infection revised at 3 months. Global classification (Sedel) provided 57 class A, 3 class B, 3 class C and 2 class D. Survivorship curves depicted 93% survivors at 14 years (revision for any reason), and 98% at 14 years (revision for aseptic loosening).

Conclusion: This material provides excellent results at 14 years in a special active group of patients.

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Paper #34

●REDUCED DIAMETER OF THE NECK OF THE STEM AND ITS EFFECT ON THE INCIDENCE OF ASEPTIC CUP LOOSENING AND CUP REVISIONS IN CHARNLEY LOW FRICTIONAL TORQUE ARTHROPLASTY

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Wrightington Hospital, Lancashire, United Kingdom

Our previous studies of the Charnley low-frictional torque arthroplasty have established a very clear correlation between the depth of cup penetration, the incidence of cup migration and revision for aseptic loosening. Impingement of the neck of the stem on the rim of the cup was considered to be one of the causes. We compared our results where the 12.5mm diameter neck stem was used against those where a 10mm diameter neck was used. Two groups of patients: 715 (972 hips) with a 12.5mm diameter neck and 218 (261 hips) with a 10mm diameter neck were compared at a mean follow-up of 16.8 years (1-36) and 12.7 years (1-20) respectively. With the 10mm diameter neck the incidence of revisions for aseptic cup loosening was reduced from 13.0% to 4.6% a reduction of 64.6%.

At the time of the review a further 14.4% of cups were radiologically loose where the 12.5mm neck stem was used as compared with 7.3% where the 10mm neck stem had been used: a reduction of 49.3%.

With the 10mm diameter neck there has been a reduction of aseptic cup loosening and revisions from 27.4% to 11.9% an overall reduction of the failure of cup fixation of 56.6%.

Reducing the diameter of the femoral neck made no difference to the incidence of aseptic stem revision.

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Paper #35

PET SCANNING FOR PRIMARY MUSCULOSKELETAL MALIGNANT TUMORS

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F-18 fluorodeoxyglucose (FDG)-PET scans (PET) is a nuclear medicine diagnostic study used to detect metabolically active foci of disease. Its method of detecting these foci is based upon the increased accumulation of the F-18 tagged glucose by cells with increased metabolic activity. While inflammatory foci have increased uptake on PET scans it is used primarily as a screen for malignant disease. It is particularly useful in the evaluation of patients with breast cancer, lymphoma, and thyroid cancer. The role for PET scans in the management of patients with sarcomas has yet to be established.

Twenty-nine patients with a bone or soft tissue sarcoma had PET scans. Patients with a negative scan have been followed for more than two years to confirm the negative finding or had a biopsy. Patients with a positive scan had a biopsy. There were nine patients with a true positive, six with a true negative, seven with a false positive, two with a true positive and a false positive, three with a true positive and a false negative, and two with a false negative and a false positive. Although an occasional scan dramatically influenced treatment for the benefit of the patient there were sufficient scans with false positive or false negative findings to indicate that PET scanning for patients with sarcoma cannot be used as the only routine screening examination at their initial evaluation or in follow-up. It does play a role in the evaluation of patients at risk of having metastatic disease.

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Paper #36

●RADIOFREQUENCY ABLATION OF OSTEOID OSTEOMA: THE UNIVERSITY OF FLORIDA EXPERIENCE 1995-2005

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Eighty-five cases of osteoid osteoma have been treated with radiofrequency ablation at the University of Florida since 1995. The patient ages were 3-45 and the most common sites of involvement were the femur and tibia. The treatment involves a minimally invasive, CAT scan guided insertion of a needle followed by thermal ablation with heat generated by radiofrequency. The procedure is done through a puncture wound, typically under regional anesthesia and on an outpatient basis. No activity restrictions are imposed and symptoms typically resolve within 48 hours following the procedure.

Results: Eighty two cases were successfully treated with a single ablation, while two required a second radiofrequency ablation and one was treated with open surgical excision. No treatment related complications have occurred. All patients were able to return to full activity and discontinue the use of NSAIDS.

Discussion: Radiofrequency ablation has become the preferred method of treatment for osteoid osteomas resistant to non-operative management with NSAIDS. Historically osteoid osteomas were treated with surgical excision that had significant associated morbidities. The published success of this technique is one of the success stories in modern orthopedic minimally invasive surgery.

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Paper #37

C1-2 LATERAL MASS ANATOMY: IMPLICATIONS FOR TRANSARTICULAR SCREW FIXATION WITH INCOMPLETE ATLANTOAXIAL REDUCTION

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Introduction: Atlantoaxial arthrodesis using traditional posterior wire fixation methods necessitates having an intact posterior arch of C1. Transarticular screw fixation of the C1 lateral masses does not require a competent bony arch of C1 and can obviate the need for fusion to the occiput when the arch is deficient. The purpose of this study was to define the anatomy of the C1-2 lateral masses, and to assess the effect of progressive atlantoaxial subluxation on obtaining adequate and safe screw fixation.

Methods: The C1-2 motion segments of five human cadaveric cervical spines were cleaned of all muscle and ligamentous tissue. The joint surfaces were covered with a 0.0005" thick brass shim to enhance radiographic visualization. Wood spacers 3, 6, & 9 mm thick were sequentially placed in the atlanto-dens joint to create fixed pure anterior subluxations of C1 on C2. Axial radiographs were taken of each specimen for each 3mm of subluxation. The C1 and C2 articular surface images were digitized and the cross sectional area of each surface and the overlapping portion were calculated. The maximum sagittal and coronal diameters of the remaining joint contact area were also measured. Sagittal CT scan reconstructions were obtain of each specimen in 0, 3, 6, and 9mm of subluxation to assess the ability of posterior screw insertion techniques to transfix the joint.

Results: The average joint contact area of C1-2 was 2.08 cm2 for 0mm subluxation, 1.56cm2 for 3mm subluxation, 1.14cm2 for 6mm subluxation, and 0.84cm2 for 9mm subluxation. The average sagittal and coronal diameters of the joint contact area were 18.7mm and 15.2mm for 0mm subluxation, 14.7mm and 15.2mm for 3mm of subluxation, 11.9mm and 13.4mm for 6mm of subluxation, and 8.9mm and 12.2mm for 9mm of subluxation. CT analysis showed that for subluxation > 3mm, fixation could not be achieved using the standard 45° angle of insertion but was achievable by changing the insertion technique.

Discussion: Significant variation exists in the size and shape of the C1-2 articular surfaces. For up to 3mm of sagittal subluxation, the standard insertion angle of 45° can be used. As the subluxation approaches 6 to 9mm, a change in the screw insertion angle is required to achieve fixation and screw purchase in the C1 lateral mass. Reducing the insertion angle to 35° (ie. Less steeply inclined) for 6mm of subluxation and to 30° for 9mm of subluxation appears to achieve effective fixation. Preoperative CT analysis with sagittal reconstruction is recommended for all cases of fixed C1-2 subluxation.

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Paper #39

LOUIS A. SAYRE, MD, AND THE FIRST ACADEMIC DEPARTMENT OF ORTHOPAEDICS IN THE UNITED STATES

Henry H. Sherk, MD (n)
Philadelphia, PA

Dr. Sayre organized the first Department of Orthopaedics in this country at the Bellevue Medical School in New York in 1861. He was appointed as its first Professor. He had graduated from Physicians and Surgeons in the early 1840's and affiliated with Bellevue in 1853. He hosted the organizational meeting of the American Orthopaedic Association at his office on Fifth Avenue in 1887 but declined membership in it for two years because he thought it should be a subset of the American Surgical Association of which he was a member. He was a Charter member of the A.M.A. in 1847 and was the only orthopaedist to serve as its president (in 1880). He aggressively endorsed surgery in orthopaedics and came into serious conflict over this with Dr. Knight of the Hospital for the Ruptured and Crippled (later the H.S.S.) and Dr. Taylor of the New York Orthopaedic Hospital. His tour in Britain was marred by public disputes with Dr. Hugh Owen Thomas. His case books are on file at the New York Academy of Medicine and they document his care of hundreds of patients with tuberculosis of the spine, hip, knee, etc. He also cared for wounded Union soldiers who had come back to New York, as well as former slaves, children with club feet, scoliosis, and dislocated hips. He performed surgery on patients with orthopaedic deformities due to lead poisoning. He documented all of this with photographs and drawings. The N.Y. Academy records also include files on malpractice lawsuits, and charges of unethical conduct. This paper will briefly review his life and career and display some of the drawings and photographs in his case books.

Paper #40

●MICROFRACTURE AND BMP-7 SYNERGISTICALLY ENHANCE ARTICULAR CARTILAGE REPAIR

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Introduction: Microfracture is to treat full thickness articular cartilage injuries, usually from injuries to the joint. The repair tissue formed after microfracture is a mixture of hyaline cartilage and fibrocartilage, but it does not reach the ideal goal of 90 percent hyaline cartilage fill, 90 percent of the time. Since bone morphogenetic protein 7 (BMP-7) induces cartilage differentiation, we hypothesized that the addition of BMP-7 would improve the repair tissue generated by microfracture. We determined the effects of microfracture alone versus microfracture and BMP-7 in a full thickness chondral defect model in adolescent rabbits.

Methods: Full thickness defects 3x7mm in size were made in the articular cartilage of the patella groves of forty New Zealand white rabbits. The animals were divided into 5 treatment groups: (1) control defects, no further treatment. (2) microfracture alone: using 18 gauge needles, two 3 mm deep microfracture holes were made in the center of the defect, one proximally and one distally. Each hole was 1.5mm in diameter, and the holes were separated by 2mm. (3) BMP-7 alone: 10 micrograms of recombinant human BMP-7 (Stryker Corporation, Hopkinton, MA) dissolved in 10 microliters of 5mM hydrochloric acid, were painted onto the bone at the base of the chondral lesion and allowed to absorb for five minutes. (4) microfracture plus BMP-7 in a collagen sponge: ten micrograms of BMP-7 dissolved in 10 microliters of 5mM hydrochloric acid was absorbed onto a 2mm diameter by 3mm cylinder of a type I collagen sponge (Helistat Sponge, Integra Life Sciences, Plainsboro, NJ) for 15 minutes. This sponge was press-fit into the distal microfracture hole. (5) microfracture plus collagen sponge alone. The collagen cylinders without BMP-7 were press-fit into the distal microfracture hole. At 6 months, the rabbits were sacrificed, and the cartilage repair evaluated. The quantitative extent of healing was assessed by measuring both the surface area and thickness of repair tissue. Magnified digital photographs of the articular defects at sacrifice were compared to the immediate post treatment photographs to determine percent coverage. Digital image analysis of histology specimens was used to calculate the percentage thickness repair tissue as compared to adjacent normal articular cartilage. The quality of the repair tissue was determined by grading specimens for matrix type and cell distribution using the International Cartilage Repair Society Visual Histological Assessment Scale (JBJS 85A, Suppl 2: 45-57, 2003). Specimens with 2 or 3 were defined as having superior matrix or superior cell distribution, while specimens of 0 or 1 were defined as having inferior matrix or inferior cell distribution.

Results: Compared to microfracture alone, the combination of microfracture and BMP-7 in a sponge significantly increased the surface area and quality of repair tissue. There was an increase in percentage surface area covered, 60% vs. 50% ($p=0.0014$), however, there was no percentage increase in thickness. The combination treatment resulted in superior matrix more often (81% vs. 38%, $p=.048$). There was an increase in the surface area covered from 30%, with BMP-7 painted on a defect, to 60% with BMP-7 added to the microfracture holes in a collagen sponge ($p<.0001$). The percentage thickness improved from 34% to 60% ($p=0.0009$). The improvement in superior matrix went from 6% of specimens with BMP-7 painted on the defect, to 69%, with the microfracture and BMP-7 in a sponge ($p=0.003$).

Table 1 shows the improvement in quality for the various groups.

Treatment	Interior Matrix (ICRS 0 & 1)	Superior Matrix (ICRS 2 & 3)	p Values
Control	75%	25%	
BMP-7	94%	6%	p=0.2 vs. control
Microfracture	62%	38%	p=0.7 vs. control
Combination Treatment	31%	69%	p=0.02 vs. microfracture p=0.003 vs. BMP-7
Microfracture + Sponge	88%	12%	

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Conclusions: Microfracture and BMP-7 (in a collagen sponge added to every other hole) will synergistically enhance cartilage repair leading to larger amounts of repair tissue that more closely resembles native hyaline cartilage. Addition of BMP-7 may improve the clinical results of patients undergoing microfracture.

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Paper #41

COMPARISON OF BONE MARROW ASPIRATION AND BONE CORE BIOPSY AS METHODS FOR HARVEST AND ASSAY OF HUMAN CONNECTIVE TISSUE PROGENITOR

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Adult bone marrow contains connective tissue progenitors (CTPs) that can differentiate into a variety of connective tissues, such as bone, cartilage, muscle, fibrous tissue, and adipose tissue. Optimal methods for harvest, assay and transplantation of CTPs have important implications for tissue engineering applications, as well as the investigation of the effects of age, gender, disease and pharmacologic agents on these important tissue forming cells. Selection of optimal methods for harvest of CTPs (e.g. aspiration or bone biopsy) requires knowledge of their location within the various compartments within marrow and bone tissue. If CTPs are located within the most liquid portion of bone marrow tissue, aspiration might be expected to be an effective means of isolation. However, if CTPs are localized in the paratrabecular tissue, assay based on bone marrow aspiration is likely to underestimate their number and provide an inefficient means of clinical harvest. This study was designed to characterize the localization of CTPs within either the marrow space (MS), where cells can be mobilized from bone tissue by mechanical means; or the trabecular surface (TS), where cells must be mobilized only by enzymatic digestion of paratrabecular matrix.

Eight bone marrow aspirates and one 7 mm diameter transcortical iliac crest bone biopsy were obtained from the anterior iliac crest in 10 human subjects undergoing elective hip arthroplasty procedures in an IRB approved protocol with informed consent. Each marrow aspirate was limited to a 2 ml volume from a given needle site, to limit dilution with peripheral blood. Each sample was aspirated into 1ml of normal saline containing 1000 units of Na-Heparin, and then pooled as a 24 ml bone marrow (BM) sample for analysis. The cancellous bone portion of the transcoritcal biopsy was mechanically crushed in media to liberate cells marrow space, providing an MS fraction. Cells that remained adherent to the trabecular surface were then recovered by collagenase digestion to provide a TS fraction. Cell numbers of BM, MS, and TS fractions were counted, and cells from each fraction were assayed to determine the prevalence of CTPs in an established CTP colony formation assay.

A single cancellous bone core (mean volume 0.7 ml) provided a mean of 39x106 total cells (MS+TS), and a total of 3195 CTPs per sample, at a prevalence of 286 CTPs per 106 nucleated cells (SD 152). In contrast an average single bone marrow aspirate provided 58x106 nucleated cells and a total of 2142 CTPs per aspirate, with a prevalence of 41 CTPs per 106 nucleated cells (SD 36). Within a bone core sample, adjusting for bone volume, the total number of nucleated cells was highest in the MS fraction (53x106 nucleated cells/ml of cancellous bone tissue, SD 33x106 roughly 4.7 fold higher than the TS samples (17x106 cells/ml of cancellous bone tissue, SD 15x106). However, the prevalence of CTPs was highest in the TS fraction, 255 CTPs per 106 nucleated cells, (SD 138), compared to the 31 CTPs per 106 nucleated cells, (SD 26), in the MS fraction. Accounting for both cellularity and prevalence, the overall yield of CTPs was highest in the TS fraction, providing a mean of 2193 CTPs per sample, compared to 1001 total CTPs per sample in the MS fraction.

Cells and CTP data from marrow aspiration samples is very poorly correlated with the actual number and concentration of CTPs in bone cores, demonstrating that marrow aspiration may be poorly suited as a sampling strategy for the purpose of assessing tissue of aging, gender and disease associated changes in bone and marrow. These data further demonstrate that a mean of 70 % of all CTPs within bone and marrow tissue reside within tissue on the trabecular surface (TS fraction), where they are relatively inaccessible to harvest by bone marrow aspiration. However, variation between subjects is significant. In seven of ten subjects the total number of CTP colonies in the TS fraction were greater than that in the MS fraction, with a mean TS/MS ratio of 12, range 2 to 36. In contrast in 3 subjects, the MS fraction provided almost the same number of CTPs than the TS fraction, with a mean TS/MS ratio of 1.0, range 0.27 to 1.6. The source of this variation, and tendency for patients to be partitioned into either an MS or TS dominant phenotype is currently under investigation, and may be related to both variation in the histology of the bone surface and marrow space and to clinical variables related to age, gender and/or genetic factors.

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Paper #42

AN EXPERIMENTAL CANINE MODEL OF ENDOSTEAL OSTEONECROSIS INDUCED BY DEEP FREEZING

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Introduction: Orthopaedic instrumentation and implantation has been shown to affect the endosteal blood supply and may affect the healing process during fracture repair or bone growth to a prosthesis. New surgical techniques, implant materials, coatings, or pharmaceutical agents have been proposed to alter this detrimental affect on the endosteal blood supply. The purpose of this study was to create a predictable canine model of endosteal osteonecrosis of the proximal metaphysis and diaphysis of the femur for future study of these new modalities.

Methods: Ten mature male dogs were divided into five groups (two animals each) corresponding to length of time from surgery to sacrifice. Each dog had one proximal femoral canal instrumented with a custom made probe and liquid nitrogen was passed through the probe under pressure in three freeze-thaw cycles (1minute freeze followed by a 10 minute thaw). The contralateral femur was used as a control with canal instrumentation but no freezing. Calcein was injected intravenously as a bone-labeling agent at intervals prior to sacrifice. The dogs were sacrificed at one, three, six, twelve, and twenty-four weeks and the proximal femurs were examined grossly and histologically.

Results: All animals recovered and were walking 1-3 days post-operatively. There were no wound complications or femur fractures. Liquid nitrogen treatment consistently induced necrosis of the bone and bone marrow without gross tissue necrosis of the outer femoral cortex or surrounding soft tissues.

At one week post-operatively, there was clear demarcation of the necrosis in a circular shape corresponding to the probe. The periosteum remained viable and occasional bone forming activity was noted by fluorescent labeling in the endosteum. Changes near the border of necrosis included fibrous tissue proliferation, differentiation of marrow stromal cells to osteoblasts, and early osteoid formation around necrotic trabeculae.

By 3 weeks post-operatively, mesenchymal cell proliferation and new bone formation was characteristic. An osteogenic front with osteoblasts and a strong patchy fluorescent labeling was noted at the border between necrotic and viable tissue. Necrotic trabecular bone was undergoing resorption by osteoclasts.

By 6 weeks the regeneration of bone and marrow tissue progressed towards the center of the necrosis. New bone formation followed the migration and proliferation of mesenchymal cells in the marrow accompanied by regenerated blood vessels. Necrotic bone was progressively replaced by new bone in both the trabecular marrow and cortical bone. New bone formation was active at the endosteal and periosteal surfaces, with creeping substitution of the necrotic cortical bone. The regeneration of bone and marrow tissues was not complete by 24 weeks postoperatively, however, a new haversian system was established with live osteocytes arranged concentrically.

Discussion: This study demonstrates that treating a long bone with a cryoprobe inside the marrow cavity can reproducibly induce endosteal osteonecrosis. Histological findings are consistent with the morphology of bone and marrow necrosis. Although regeneration of necrotic bone starts early, it takes longer than 24 weeks to complete. This animal model might be useful for testing surgical or pharmaceutical treatments that can shorten the process of regeneration.

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Paper #43

THE GAIT CHARACTERISTICS AND RESPONSE OF ANKLE KINEMATICS IN PATIENTS WITH UNILATERAL KNEE, BILATERAL KNEE AND UNILATERAL HIP ARTHRITIS.

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Background: The relationship between lower extremity arthritis and functional gait patterns are expressed as an abnormal gait. The abnormal gait is an adaptation of the function of the involved joint and the response of the surrounding uninvolved joints. This study investigated the relationship of unilateral knee osteoarthritis, bilateral knee arthritis and unilateral hip arthritis to ankle joint kinematics.

Methods: A sample of patients who were undergoing pre-operative evaluation for total joint replacement was studied using a motion tracking system (Peak Motus). There were 95 patients identified with osteoarthritis. 50 patients with unilateral knee arthritis (avg. age 62.9), 23 patients with unilateral hip arthritis (avg. age 54.5) and 22 patients with bilateral knee arthritis (avg. age 63.34) were studied. Gait cycle characteristics for all patients included involved and uninvolved cadence (steps/minute), gait velocity (m/s), loading response (s), and swing and stance ratios (%). Ankle GRF and moments were calculated at initial contact, mid-stance and end contact (decay).

Results: Descriptive statistics reported as calculated mean.
Cadence (steps/min) for unilateral knee arthritis involved -100.76, uninvolved -100.75, unilateral hip arthritis involved – 103.1, uninvolved – 103.02, and bilateral knee arthritis involved (right) – 94.77, and uninvolved (left) – 98.18.
Gait velocity (m/s) for unilateral knee arthritis involved – 0.94, uninvolved – 0.94, unilateral hip arthritis involved – 0.94, uninvolved – 0.94, and bilateral knee arthritis involved (right) – 0.88, uninvolved (left) – 0.76.
Loading response (s) for unilateral knee arthritis involved – 0.19, uninvolved – 0.18, unilateral hip arthritis involved – 0.18, uninvolved – 0.18, and bilateral knee arthritis involved (right) – 0.26, and uninvolved (left) – 0.21.
Stance Ratio (%) for unilateral knee arthritis involved – 64.8, uninvolved – 66.1, unilateral hip arthritis involved – 64.8, uninvolved – 66.2, bilateral knee arthritis involved (right) – 66.9, and uninvolved (left) – 67.8.
Swing Ratio (%) for unilateral knee arthritis involved – 35.1, uninvolved – 33.8, unilateral hip arthritis involved – 35.1, uninvolved – 33.7, bilateral knee arthritis involved (right) – 33.1, and uninvolved (left) – 32.1.

Ankle moments were standardized for body weight (n/kg). Descriptive statistics reported as calculated mean.
Initial contact moments for unilateral knee arthritis involved – 0.048, uninvolved – 0.038, unilateral hip arthritis involved – 0.114, uninvolved – 0.05, bilateral knee arthritis involved (right) - -0.67, uninvolved (left) – 0.136.
Mid-stance moments for unilateral knee arthritis involved – 0.844, and uninvolved – 0.739, unilateral hip arthritis involved – 0.773, uninvolved – 0.81, and bilateral knee arthritis involved (right) 0.55, and uninvolved (left) – 1.01.
End contact moments for unilateral knee arthritis involved - -0.005, uninvolved – 0.012, unilateral hip arthritis involved - - 0.0027, uninvolved – 0.072, bilateral knee arthritis involved (right) - -0.18, and uninvolved (left) – 0.013.

Conclusions: The gait characteristics of patients with bilateral knee arthritis demonstrated gait abnormalities when compared to both unilateral knee and hip arthritis with a decrease in cadence, gait velocity, and a swing ration. An increase was noted in load response and stance ratio. Ankle GFR and moments were also found to be altered in the patients with bilateral arthritic disease than in unilateral hip or knee arthritis suggesting an alteration of ankle function in response to bilateral disease. Our study demonstrated the changes in ankle function as a result of arthritic conditions of unilateral knee, hip and bilateral knee arthritis. Gait characteristics and ankle moments in unilateral knee and hip arthritis were found to be similar.

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Paper #44

A UNIQUE DIGITAL EXPRESSION OF TIBIAL PLATE FIT ON NORMAL HUMANS

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Background: Implant manufacturers are producing "anatomic" periarticular plates for the treatment of proximal tibia fractures. An objective analysis was performed in order to assess the accuracy of the designation "anatomic".

Method: 101 cadaveric tibias and 8-hole medial and lateral Zimmer anatomic periarticular plates were mapped using a Microscribe G2LX digitizer, Rhinoceros software, and Matlab software. Plate fit was expressed as 1) the angles of alignment between the plate and the tibia, and 2) the volume of free space between the plate and the bone.

Results: The misalignment of the plates to the tibial plateau ranged from: medial, -5° to +8°; and lateral, -13° to +10°. The total volume of space under the plates were: medial, 1883 ± 661 mm3; and lateral, 1751 ± 470 mm3. Plates with uniformly distributed volume were called "even". Plates that failed to make contact with the middle portion of the tibia "spanned". Plates that made premature tibial contact, causing distal plate elevation, "impinged". For the medial plate, 56 were even, 10 spanned, and 35 impinged. For the lateral plate, 36 were even, 60 spanned, and 5 impinged. Plate fit can be predicted from an AP image of the tibia. As the medial metaphysis flattened, the volume under the distal part of the plate increased (R = 0.592) due to impingement. As the lateral metaphysis deepened, the volume under the middle part of the plate increased (R = 0.476) due to spanning.

Conclusion: The criteria for an adequate fit required an "even" fit and a total volume less than 2000 mm3. The medial plate fit adequately onto only 46 of 101 tibia, and the lateral plate onto only 26 of 101 tibia.
Clinical Relevance - Natural anatomic variation prevented the "anatomic" plates from adequately fitting everyone of the 101 tibias. The fit between a plate and tibia can be predicted from an AP image of the tibia. A flat tibial metaphysis will cause plate "impingement", whereas a deep metaphysis will cause plate "spanning".

*If noted, the author indicates something of value received. The codes are identified as: a- research or institutional support; b- miscellaneous funding; c- royalties; d- stock options; n- no conflicts disclosed, and * disclosure not available at the time of printing. For full information, refer to page 6.*

●If noted, the FDA has not cleared the drug and/or medical device for the use described in this presentation (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 6.